# Universida<sub>de</sub>Vigo

## Subject Guide 2017 / 2018

Chemical er	aineerina				
Subject	Chemical				
Subject	engineering				
Code	V11G200V01502				
Study	(*)Grao en Química				
programme					
Descriptors	ECTS Credits	Choose	Year	Quadmester	
<b>T</b>	g General-th	Mandatory	3rd	1st	
Teaching	Spanish				
Department					
Coordinator	González de Prado. Begoña				
Lecturers	Canosa Saa, Jose Manuel				
	González de Prado, Begoña				
	Yañez Diaz, Maria Remedios				
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Web			<del></del>		
description	This subject is an introduction to Chemical Engineering, where the knowledge gained in the previous Scription Chemistry degree courses is related to Chemical industry processes. The mail goal is to enable the students to learn the basic knowledge about material and energy balances so that they can applied it to the design of separation processes such as distillation or liquid-liquid extraction. This subject gives the basis to understand other subjects such as Environmental Quemistry, Food Chemistry and Industrial Chemistry.				
Competenci	ies				
Code					
C1 Demons chemica C16 Demons	strate knowledge and understanding of essential fact al terminology, nomenclature, units and unit conversi strate knowledge and understanding of essential fact	s, concepts, princip ions. s, concepts, princip	les and theories: les and theories:	Major aspects of	
procedu	ires in chemical engineering				
C19 Apply ki	nowledge and understanding to solve basic problems	s of quantitative and	l qualitative natu	ure	
C20 Evaluate	e, interpret and synthesize data and chemical inform	ation			
C21 Recogni	ze and implement good scientific practices for measure	urement and experi	mentation		
C22 Process	and perform computational calculations with chemic	cal information and	chemical data		
C23 Present	oral and written scientific material and scientific arg	uments to a special	Ized audience	ation of any chacific	
risks as	sociated with its use	flical properties, inc	lualing the evalu	action of any specific	
C27 Monitor, record t	<ul> <li>7 Monitor, by observation and measurement of physical and chemical properties, events or changes, and document and record them in a consistent and reliable way</li> </ul>				
C28 Interpre	8 Interpret data derived from laboratory observations and measurements in terms of their significance and relate them to				
C29 Demons	strate skills for numerical calculations and interpretat	ion of experimental	data, with spec	ial emphasis on	
precisio	precision and accuracy				
D1 Commu	Communicate orally and in writing in at least one of the official languages of the University				
D3 Learn in	3 Learn independently				
D4 Search a	Search and manage information from different sources				
D5 Use info	5 Use information and communication technologies and manage basic computer tools				
D6 Use mat represe	5 Use mathematics, including error analysis, estimates of orders of magnitude, correct use of units and data representations				
D7 Apply th	neoretical knowledge in practice				
D8 Teamwo	ork				
D9 Work in	dependently				
D10 Work at	10 Work at a national and international context				
D12 Plan and	d manage time properly				
Make de					

D14 Analyze and synthesize information and draw conclusionsD15 Evaluate critically and constructively the environment and oneself

Expected results from this subject Training and Learning Results P Training and Learning P Training and P Training and P Training and Learning	Learning outcomes			
*)  Know the different unit systems.  (1)  C1  C1  C1  T  C1  C1  C1  C1  C1  C1	Expected results from this subject	Training and Learning		
**)       C1       D7         Know the different unit systems.       C1       D7         interpret the flow charts of chemical processes.       C16       C20         Differentiate the steady, non-steady, continuos and batch operations       C16       D3         C19       D7       C20       D9         Know and know how to apply the mass and energy balances in steady or not steady processes,       C16       D3         with or without chemical reaction and with recycle, purge and bypass streams       C16       D3         Know and know how to apply the mass, energy and momentum conservation laws       C16       D3         C19       D7       C20       D9         Pose and solve the design equations to the ideal chemical reactors.       C16       D3         C19       D7       C20       D9         Calculate the heat transfer mechanisms       C16       D3       C20         C20       D4       C20       D4       C20       D6         C219       D4       C20       D4       C20       D6         C20       D4       C20       D6       C21       D1       C22         Calculate the heat transfer mechanisms       C16       D7       C21       D4       C22       C20 <t< th=""><th></th><th></th><th>Results</th></t<>			Results	
Know the different unit systems.       C1       D7         interpret the flow charts of chemical processes.       C16       C19         C20       C20       C20         Differentiate the steady, non-steady, continuos and batch operations       C16       D3         C20       C20       D9         Know and know how to apply the mass and energy balances in steady or not steady processes, C16       D3         with or without chemical reaction and with recycle, purge and bypass streams       C19       D7         C20       C20       D9       C20       D9         Know and know how to apply the mass, energy and momentum conservation laws       C16       D3       C19       D7         C20       D9       C20       D9       C20       D9       C20       D9         Pose and solve the design equations to the ideal chemical reactors.       C16       D3       C20       D4       C20       D4       C20       D6       D7       D9       D7       D9       D7       D9       D7       D9       D4       C20       D6       D7       D9       D4       C20       D6       D7       D9       D9       D7       D9       D9       D1       D9       D1       D1       D1       D2       D1 <td></td> <td></td> <td></td>				
clig         interpret the flow charts of chemical processes.       Clig         clig       Differentiate the steady, non-steady, continuos and batch operations         clig       Differentiate the steady or not steady processes,         clig       Differentiate themical reaction and with recycle, purge and bypass streams         clig       Differentiate the mass, energy and momentum conservation laws         clig       Differentiate the design equations to the ideal chemical reactors.         clig       Differentiate the heat transfer mechanisms         clig       Differentiate the heat transfer mechanisms         clig       Differentiate the heat transferred by conduction and convection in simple systems and the heat         clig       Clig         clig       Different operation units and their application.	Know the different unit systems.	C1	D7	
Interpret the now charts of chemical processes.       C10         C19       C19         C20       C10         Differentiate the steady, non-steady, continuos and batch operations       C16       D3         C19       C20       C20       C20         Know and know how to apply the mass and energy balances in steady or not steady processes, with or without chemical reaction and with recycle, purge and bypass streams       C16       D3         C20       C20       C20       C20       C20         Know and know how to apply the mass, energy and momentum conservation laws       C16       D3         C20       C20       C20       D4         C20       C20       C20       D4         C20       C20       D4       C23         Pose and solve the design equations to the ideal chemical reactors.       C16       D3         C19       D4       C23       D5         Differentiate the heat transfer mechanisms       C16       D3       C20         C20       D6       D7       D9       D9         Calculate the heat transferred by conduction and convection in simple systems and the heat       C16       D4         transferred in shell and tube type heat interchanger.       C20       C20       C20         C2	Interrupt the flow shouts of shows and successes			
C19         C20         Differentiate the steady, non-steady, continuos and batch operations       C16       D3         C19       D7         C20       D9         Know and know how to apply the mass and energy balances in steady or not steady processes, with or without chemical reaction and with recycle, purge and bypass streams       C16       D3         C20       D9         Know and know how to apply the mass, energy and momentum conservation laws       C16       D3         C20       D9         Pose and solve the design equations to the ideal chemical reactors.       C16       D3         C20       D9         Pose and solve the heat transfer mechanisms       C16       D3         C16       D3       C20       D4         C20       D4       C20       D4         C20       D6       D7       D9         Pose and solve the design equations to the ideal chemical reactors.       C16       D3         C16       D3       C19       D4         C20       D6       D7       D9         Calculate the heat transfer mechanisms       C16       D4       D3         Calculate the heat transferred by conduction and convection in simple systems and the heat       C16       D4 <tr< td=""><td>interpret the flow charts of chemical processes.</td><td>C10</td><td></td></tr<>	interpret the flow charts of chemical processes.	C10		
C10       D3         C116       D3         C120       D7         C20       D9         Know and know how to apply the mass and energy balances in steady or not steady processes, with or without chemical reaction and with recycle, purge and bypass streams       C16       D3         C17       C20       D9         Know and know how to apply the mass, energy and momentum conservation laws       C16       D3         C19       D7       C20       C20         Pose and solve the design equations to the ideal chemical reactors.       C16       D3         C20       D4       C23       D5         Differentiate the heat transfer mechanisms       C16       D3         C19       D4       C23       D5         Differentiate the heat transfer mechanisms       C16       D3         C20       D6       D7       D9         Calculate the heat transferred by conduction and convection in simple systems and the heat       C16       D4         C21       D1       C22       D6       C23       D1         C22       D6       C24       C24       D6       C25       D10         C22       D6       C25       D10       C27       D16       C22       D6 <t< td=""><td></td><td>C20</td><td></td></t<>		C20		
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C20       C20         Know and know how to apply the mass, energy and momentum conservation laws       C16       D3         C19       D7         C20       D9         Pose and solve the design equations to the ideal chemical reactors.       C16       D3         C20       D4       C23       D5         Differentiate the heat transfer mechanisms       C16       D3         C20       D4       C20       D6         Differentiate the heat transfer mechanisms       C16       D3         C20       D6       D7       D9         Calculate the heat transferred by conduction and convection in simple systems and the heat       C16       D4         cransferred in shell and tube type heat interchanger.       C16       D7         dentify the different operation units and their application.       C16       D7         C20       C20       C20       C20         Elaborate and interpretate vapour-liquid, liquid-liquid and gas-liquid flow diagrams.       C21       D1         C27       D12       C28       D13         C29       D14       D15       D15         Solve mass balances for flash and batch distillation, liquid-liquid and solid-liquid extraction and c21       D6       C23       D8         C	with or without chemical reaction and with recycle, purge and bypass streams	C19	D9	
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C23       D5         Differentiate the heat transfer mechanisms       C16       D3         C19       D4       C20       D6         C19       D4       C20       D6         Differentiate the heat transferred by conduction and convection in simple systems and the heat       C16       D4         Calculate the heat transferred by conduction and convection in simple systems and the heat       C16       D4         Calculate the different operation units and their application.       C16       D7         C19       C20       C20       C20         Elaborate and interpretate vapour-liquid, liquid-liquid and gas-liquid flow diagrams.       C21       D1         C23       D8       C25       D10         C24       C28       D13       C29       D14         Solve mass balances for flash and batch distillation, liquid-liquid and solid-liquid extraction and absorption.       C21       D6         C25       D10       C22       D8       C23       D1         C25       D12       C22       D6       C23       D8         C25       D13       C29       D14       D15         Color       C25       D12       C27       D13         C25       D12       C27       D13 </td <td></td> <td>C20</td> <td>D4</td>		C20	D4	
Differentiate the heat transfer mechanisms       C16       D3         C19       D4         C20       D6         D7       D9         Calculate the heat transferred by conduction and convection in simple systems and the heat       C16       D4         transferred in shell and tube type heat interchanger.       C16       D7         identify the different operation units and their application.       C16       D7         C19       C20       C20       C20         Elaborate and interpretate vapour-liquid, liquid-liquid and gas-liquid flow diagrams.       C21       D1         C23       D8       C25       D10         C27       D12       C28       D13         Solve mass balances for flash and batch distillation, liquid-liquid and solid-liquid extraction and absorption.       C21       D6         C23       D8       C25       D10         C24       D6       C27       D12         C25       D10       C27       D12         C20       C22       D8       C23       D8         C25       D12       C26       C27       D12         C26       D12       C27       D12       C27       D12         C25       D12       C22		C23	D5	
C19       D4         C20       D6         D7       D9         Calculate the heat transferred by conduction and convection in simple systems and the heat       C16       D4         transferred in shell and tube type heat interchanger.       C16       D7         Identify the different operation units and their application.       C16       D7         C19       C20       C20         Elaborate and interpretate vapour-liquid, liquid-liquid and gas-liquid flow diagrams.       C21       D1         C22       D6       C23       D8         C25       D10       C27       D12         C28       D13       C29       D14         Solve mass balances for flash and batch distillation, liquid-liquid and solid-liquid extraction and absorption.       C21       D6         C23       D8       C25       D10       C27       D12         C28       D13       C22       D8       C23       D14	Differentiate the heat transfer mechanisms	C16	D3	
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Elaborate and interpretate vapour-liquid, liquid-liquid and gas-liquid flow diagrams.       C21       D1         C22       D6       C23       D8         C25       D10       C27       D12         C28       D13       C29       D14         D15       D15       D16       C22       D8         Solve mass balances for flash and batch distillation, liquid-liquid and solid-liquid extraction and absorption.       C21       D6         C23       D18       C25       D10         C24       D15       D15         Solve mass balances for flash and batch distillation, liquid-liquid and solid-liquid extraction and C21       D6         C23       D10       C25       D12         C25       D12       C27       D13         C27       D13       C28       D14		C19		
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C22 D6 C23 D8 C25 D10 C27 D12 C28 D13 C29 D14 D15 Solve mass balances for flash and batch distillation, liquid-liquid and solid-liquid extraction and absorption. C21 D6 C22 D8 C23 D10 C22 D8 C23 D10 C25 D12 C25 D12 C27 D13 C28 D14	Elaborate and interpretate vapour-liquid, liquid-liquid and gas-liquid flow diagrams.	C21	D1	
C23 D8 C25 D10 C27 D12 C28 D13 C29 D14 D15 Solve mass balances for flash and batch distillation, liquid-liquid and solid-liquid extraction and absorption. C21 D6 C22 D8 C23 D10 C25 D12 C28 D13 C29 D14 D15 C21 D6 C22 D8 C23 D10 C25 D12 C27 D13 C28 D14		C22	D6	
C25 D10 C27 D12 C28 D13 C29 D14 D15 Solve mass balances for flash and batch distillation, liquid-liquid and solid-liquid extraction and absorption. C21 D6 C22 D8 C23 D10 C25 D12 C28 C28 D13 C29 D14 D15 C21 D6 C22 D8 C23 D10 C25 D12 C27 D13 C28 D14		C23	D8	
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Solve mass balances for flash and batch distillation, liquid-liquid and solid-liquid extraction and C21 D6 C22 D8 C23 D10 C22 D14 C22 D8 C23 D10 C25 D12 C27 D13 C28 D14		C27	D12	
Solve mass balances for flash and batch distillation, liquid-liquid and solid-liquid extraction and C21 D6 absorption. C22 D8 C23 D10 C25 D12 C27 D13 C28 D14		C28	D13	
Solve mass balances for flash and batch distillation, liquid-liquid and solid-liquid extraction and C21 D6 absorption. C22 D8 C23 D10 C25 D12 C27 D13 C28 D14		C29	D14	
absorption. C21 D6 C22 D8 C23 D10 C25 D12 C27 D13 C28 D14	Calles was a balance of a flack and batch d'alle the line in the idea of a flat in the idea of a structure of a		D15	
C22 D8 C23 D10 C25 D12 C27 D13 C28 D14	Solve mass balances for flash and batch distillation, liquid-liquid and solid-liquid extraction and	C21	D6	
C23 D10 C25 D12 C27 D13 C28 D14	absorption.	C22	D8	
C27 D13 C28 D14		C25	D10 12	
C28 D14		C2J	D12 D13	
		C28	D13	
C29 D15		C29	D15	
Determine the number of theoretical stages in separation units for simple mixtures C16 D7	Determine the number of theoretical stages in separation units for simple mixtures	C16	D7	
C19	betermine the number of theoretical stages in separation ands for simple mixtales.	C19	57	
C20		C20		
Carry out and monitor separation processes in operation units at laboratory level. C21 D1	Carry out and monitor separation processes in operation units at laboratory level.	C21	D1	
C22 D6	,	C22	D6	
C23 D8		C23	D8	
C25 D12		C25	D12	
C27 D13		C27	D13	
C28 D14		C28	D14	
C29 D15		C29	D15	

Determine experimentally some properties of interphenomena: viscosity, coefficients of convection,	erest from the point of view of transport density.	C16 C20 C21 C22 C23 C25 C27 C28 C29	D1 D4 D5 D7 D8 D10 D12 D13 D14	
Work with continuous and batch chemical reacto	rs at laboratory level.	C16 C21 C22 C25 C27 C28 C29	D15 D1 D4 D5 D6 D7 D8 D12 D13 D14 D15	
Contents				
Subject 1. Introduction to Chemical Engineering	Origin, concept and evolution of the Chemical Engineering. Discontinuous and continuous operation. Stationary and non stationary state. Cocurrent and countercurrent operations. Classification of the unit operations. Systems of units			
Subject 2. Mass and energy balances	General equation of balance. Mass balances in systems without chemical reaction in stationary and non stationary state. Recycle, purge and bypass. Mass balances in systems with chemical reaction in stationary and non stationary state. Energy balances. Energy balances in systems with chemical reaction in stationary state.			
Subject 3. Design of ideal reactors	Speed of reaction. Ideal reactors: batch stirred tank reactor, continuos stirred tank reactor and plug flow reactor			
Subject 4. Heat transfer	Mechanisms of heat transfer. heat transfer through flat walls, cylindrical and spherical. Heat exchangers.			
Subject 5. Distillation	Vapour-liquid equilibria. Phase diagrams for binary mixes. Simple and flash distillation. Multistage distillation			
Subject 6. Liquid-liquid extraction	Liquid-liquid equilibrium for binary and ter distribution coefficients. Liquid-liquid extra countercurren contact.	nary systems: b action in cocurre	inodal curve and nt and	
Laboratory sessions	Experimental determination of some prope of view of the design of basic operations: v convection, density. Operation with chemi Experimental determination of phase equi capacity of extraction of several solvents i extraction.	erties of interest viscosity, coeffic cal reactors at la librium curves. / n a process of s	from the point ients of ab scale. Analysis of the olid-liquid	

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	13	30	43
Troubleshooting and / or exercises	25	50	75
Laboratory practises	40	3	43
Autonomous troubleshooting and / or exercises	0	10	10
Presentations / exhibitions	5	5	10
Tutored works	1	10	11
Short answer tests	2	8	10
Long answer tests and development	3	20	23
*The information in the planning table is for guidan	ce only and does n	ot take into account the hete	erogeneity of the students.

Methodologies	
	Description
Master Session	During these classes (one hour per week) the teacher will explain the most relevant aspects of the
	subject. The students will have the available documentation on Tem@.

Troubleshooting and / or exercises	There will be a set of exercises of each subject available for the students. Some of these exercises will be solve in class and other ones will be solved by each student and presented to the teacher in order to be corrected.
Laboratory practises	Laboratory sessions will last 3.5 hours. The experimental procedure will be available for the students and they will have to write a report for each session.
Autonomous troubleshooting and / or exercises	The students will have to solve some exercises and questions and they will have to present them to the teacher before the deadline.
Presentations / exhibitions	The students will have to make an oral presentation related to the theoretical bases, experimental procedure, obtained results and conclusions for some of their laboratory sessions.
Tutored works	The students will have to write an individual report about one subject related to Chemical Engineering. The teacher will indicate them the main points of the subject that they will have to develop and the recommended literature.

Personalized attention			
Methodologies	Description		
Troubleshooting and / or exercises	In the assigned hours of tutoring the professor will solve any doubts regarding the subject		
Autonomous troubleshooting and / or exercises	In the assigned hours of tutoring the professor will solve any doubts regarding the subject		
Tutored works	In the assigned hours of tutoring the professor will solve any doubts regarding the subject		

Assessment				
	Description	Qualification	Train Lea Re	ing and arning sults
Laboratory practises	The qualification will depend on the laboratory work and the laboratory report made by the students. Laboratory sessions are mandatory.	10	C21 C22 C23 C25 C27 C28 C29	D1 D6 D8 D10 D12 D13 D14 D15
Autonomous troubleshooting and / or exercises	The students will have to deliver, in the terms indicated, the problems proposed of each subject.	5	C1 C16 C19 C22	D3 D7 D9
Presentations / exhibitions	The students will make an oral presentation related to laboratory work.	5	C16 C20 C23	D4 D5 D7 D8 D14
Tutored works	The students will realise, and will deliver in the date indicated, an individual work on a subject proposed to the start of course.	5	C1 C16 C20 C23	D1 D3 D14
Short answer tests	They will realise two short exams, one about the subjects 1 and 2 and another one about the subjects 3 and 4.	20	C1 C16 C19	D1 D6 D7 D9
Long answer tests and development	At the end of the course the students have to do an exam related to all the subjets.	55	C1 C16 C19	D1 D6 D7 D9

#### Other comments on the Evaluation

Short and long exams. They will realise two short exams along the term. In the final exam, all topics will be evaluated and it is necessary to reach a minimum of 3 out of 10 points to take into account the other elements of evaluation. In case of not reaching the minimum note, the final qualification will be the one obtained in the long exam. Laboratory sessions. The laboratory sessions (lab work and report) and the oral presentation are mandatory and they are 15% of the final qualification. It is indispensable to have a minimum grade of 5 out of 10 points in this section. 50% or more laboratory sessions non-attendance means not to pass the course, independently of the results obtained in the other elements of

evaluation. The participation of the student in any of the exams (short exams and long exam), two or more laboratory sessions or the delivery of 20% or more of the works required by the professor, involves the condition of "presented" and the obtention of a qualification. June final exam. A long exam of all the matter that will suppose 75% of the qualification will be done. The students will keep the grades of obtained in laboratory sessions, oral presentation, autonomus exercices and tutored work obtained along the course.

### Sources of information

Basic Bibliography

Calleja y otros, Introducción a la Ingeniería Química, Síntesis, 1999

W.L. McCabe, J.C. Smith y P. Harriot, **Operaciones unitarias en Ingeniería Química**, McGraw-Hill, 2007

## **Complementary Bibliography**

R.M. Felder, **Principios elementales de los procesos químicos**, Limusa Wiley, 2003

C.J. Geankoplis, **Procesos de transporte y principios de procesos de separación**, Grupo editorial patria. México, 2007 José Felipe Izquierdo y otros, **Introducción a la Ingeniería Química. Problemas resueltos de balances de materia y energía**, Reverté, 2015

#### Recommendations