KINGDOM OF SAUDI ARABIA
Technical and Vocational Training Corporation
Director General for Curricula

المملكة العربية السعودية
المؤسسة العامة للتدريب التقني والمهني
الإدارة العامة للمناهج

المؤسسة العامة للتدريب التقني والمهني
Technical and Vocational Training Corporation

الخطط التدريبية للكليات التقنية

Training Plans for Colleges of Technology

CURRICULUM FOR

Department
Of Chemical Engineering

Major
Chemical Production

نسخة أولية (تحت المراجعة)

Under Revision Draft

A Bachelor's Degree

Trimesters

1444 H – 2022 G

Index

Program Description

This program of Chemical Production is designed so as to meet the training needs of the local labor market, following professional International standards set for Chemical Engineering Technology.

This curriculum was designed as to match the local labor markets needs and it is based on the National Professional Standards for Chemical Production Technicians.

The curriculum includes training on the general skills in English, mathematics, and computer and human communication methods and dealing with others.

It also includes training in basic skills in computers and operating systems and awareness of the trainee on the importance of safety tools and how to apply them, in addition to specialized skills in the field of chemical production such as those related to the chemical industry and energy.

The curriculum also keeps pace with the rapid development in the field of chemical production and the needs of the industrial market.

The focus during training will be on the practical side and link it to theoretical information in most of the specialized courses through intensive basic practical training and the application of a cooperative training program with sectors related to the trainee's field of study.

The duration of the program is 1820 hours of training. The graduate of this department is awarded the Intermediate University Degree in the field of chemical production.

The graduate is expected to work in areas related to chemical production as chemical equipment operator.

The Theoretical and Practical Tests and Graduation Projects Determine Learning Outcomes and Trainee Levels for each program.

The training courses contain a theoretical part and a practical part. The practical part is tested as a practical test and the theoretical part is a theoretical test with different evaluation methods

The Bachelor Degree Graduate gets the seventh level in the Saudi Arabian Qualifications Framework (SAQF).

Admission Requirements: The applicant must have a diploma in Chemical Production and Chemical Laboratories.

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المؤسسة العامة للتدريب التقني والمهني
Technical and Vocational Training Corporation

Department of
Chemical Engineering
Major
Chemical Production

The Curriculum Framework Distributed on Trimesters توزيع الخطة التدريبية على الفصول التدريبية لمرحلة البكالوريوس بالنظام الثلثي

1st Trimester	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	الفصل التدريبي الأول
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	ENGL 301	English Language (1)		4	4	0	2	6		لغة انجليزية ١	٣٠١ انجل	١	
	2	MATH 301	Mathematics (1)		4	3	2	1	6		رياضيات ١	٣٠١ رياض	٢	
	3	PHYS 301	Physics		4	3	2	1	6		فيزياء	٣٠١ فيزي	٣	
	4	KCHE 331	Chemical Processes		4	4	0	2	6		العمليات الكيميائية	٣٣١ نكيم	٤	
	Total Number of Units				16	14	4	6	24	المجموع				

2nd Trimester	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	الفصل التدريبي الثاني
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	ENGL302	English Language (2)	ENGL 301	4	4	0	2	6	٣٠١ انجل	لغة انجليزية ٢	٣٠٢ انجل	١	
	2	MATH 302	Mathematics (2)	MATH 301	4	3	2	1	6	٣٠١ رياض	رياضيات ٢	٣٠٢ رياض	٢	
	3	KCHE 332	Organic Chemistry		5	3	4	0	7		كيمياء عضوية	٣٣٢ نكيم	٣	
	4	KCHE 333	Thermodynamics	KCHE 331	5	5	0	0	5	٣٣١ نكيم	ثيرموديناميكا	٣٣٣ نكيم	٤	
	Total Number of Units				18	15	6	3	24	المجموع				

3rd Trimester	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	الفصل التدريبي الثالث
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	STAT 303	Statistics and Probability		3	3	0	1	4		الإحصاء والإحتمالات	٣٠٣ احصا	١	
	2	KCHE 365	Applied Mass Transfer	KCHE 331	6	4	4	0	8	٣٣١ نكيم	انتقال المادة التطبيقي	٣٦٥ نكيم	٢	
	3	KCHE 321	Computer Chemical Process Drawing		3	0	6	0	6		رسم العمليات الكيميائية بالكمبيوتر	٣٢١ نكيم	٣	
	4	KCHE ***	Elective Course 1		2	2	0	1	3		مقرر اختياري١	*** نكيم	٤	
	Total Number of Units				14	9	10	2	21	المجموع				

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

و.م : وحدات معتمدة، مح : محاضرة، عم : عملي/ ورش، تم : تمارين، س.أ : ساعات اتصال أسبوعي

4th Trimester	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	الفصل التدريبي الرابع
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	GNRL 404	Quality Tools and Applications		3	3	0	1	4		أدوات الجودة و تطبيقاتها	٤٠٤ عامة	١	
	2	KCHE 341	Petrochemicals		2	2	0	1	3		البتروكيماويات	٣٤١ نكيم	٢	
	3	KCHE 444	Water Treatment		2	2	0	1	3		معالجة المياه	٤٤٤ نكيم	٣	
	4	KCHE 322	Computational Method for Engineering Application		5	2	6	0	8		التطبيقات الهندسية بالحاسب	٣٢٢ نكيم	٤	
	5	KCHE 434	Advanced Separation Processes	KCHE 331	6	4	4	0	8	٣٣١ نكيم	عمليات الفصل المتقدمة	٤٣٤ نكيم	٥	
	Total Number of Units				**18**	**13**	**10**	**3**	**26**	**المجموع**				

5th Trimester	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	الفصل التدريبي الخامس
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	GNRL 402	Engineering Project Management		3	3	0	1	4		إدارة المشاريع الهندسية	٤٠٢عامة	١	
	2	KCHE 414	Polymer Science		4	4	0	1	5		علم البوليمر	٤١٤ نكيم	٢	
	3	KCHE 411	Chemical Reaction Engineering	KCHE 331	6	4	4	0	8	٣٣١ نكيم	هندسة التفاعلات الكيميائية	٤١١ نكيم	٣	
	4	KCHE 446	Process Control	KCHE 331	6	4	4	0	8	٣٣١ نكيم	التحكم في العمليات	٤٤٦ نكيم	٤	
	Total Number of Units				**19**	**15**	**8**	**2**	**25**	**المجموع**				

6th Trimester	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	الفصل التدريبي السادس
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	GNRL 403	Communication tools and soft skills		3	3	0	1	4		مهارات الإتصال	٤٠٣ عامة	١	
	2	KCHE 413	Plant Design and Economics	KCHE 331	4	4	0	0	4	٣٣١ نكيم	تصميم واقتصاديات العمليات الكيميائية	٤١٣ نكيم	٢	
	3	KCHE 465	Applied Materials Science and Corrosion		3	3	0	1	4		علم المواد و التآكل	٤٦٥ نكيم	٣	
	4	KCHE 491	Graduation Project	KCHE 414	5	2	6	0	8	٤١٤ نكيم	مشروع التخرج	٤٩١ نكيم	٤	
	Total Number of Units				**15**	**12**	**6**	**2**	**20**	**المجموع**				

CRH: Credit Hours **L: Lecture** **P: Practical** **T: Tutorial** **CTH: Contact Hours**

و.م : وحدات معتمدة، مح : محاضرة، عم : عملي/ ورش، تم : تمارين، س.أ : ساعات اتصال أسبوعي

Total Number of Semesters Units	CRH	L	P	T	CTH	المجموع الكلي لوحدات البرنامج
	و.م	مح	عم	تم	س.أ	
	100	78	44	18	140	

Total Contact Hours × 13	Co-operative Training	المجموع الكلي لوحدات التدريب	التدريب التعاوني	ساعات الإتصال الكلية × ١٣
1820	0	1820	٠	١٨٢٠

Elective Courses

Elective Courses -1	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	المقررات الإختيارية - ١
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	KCHE 424	Writing Skills		2	2	0	1	3		مهارات الكتابة الفنية	٤٢٤ نكيم	١	
	2	KCHE 461	Renewable Energy		2	2	0	1	3		الطاقة المتجدده	٤٦١ نكيم	٢	
	CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours										و.م : وحدات معتمدة، مح : محاضرة، عم : عملي/ ورش، تم : تمارين، س.أ : ساعات اتصال أسبوعي			

Brief description

Course Name	Chemical Processes	Course Code	KCHE 331	Credit Hours	4
Description	The course aims to acquire trainee basics kills to do principles technical chemical calculations. The course submits detailed explanation of the units of measurement systems and dimensions used in industrial processes. In addition, it gives the trainee the ability to deal with processes variables and how to calculate the chemical composition of the mixtures and solutions. In addition, it provides a full explanation of the laws of material and energy balance and its applications on industrial units whether single or multiple. The course also helps the trainee to understand and accommodate other specialized courses.				

Course Name	Organic Chemistry	Course Code	KCHE 332	Credit Hours	5
Description	The course offers comprehensive understanding of the basic principles of organic chemistry. The course describes chemical bonding, structure properties, nomenclature, synthesis, and reactions of alkanes, alkenes, alkynes, alcohols, ethers, alkyl halides, elimination and nucleophilic substitution reactions., kinetic and thermodynamic aspects governing these reactions.				

Course Name	Thermodynamics	Course Code	KCHE 333	Credit Hours	5
Description	This course aims to provide the trainee with the basic concepts of thermodynamics and its applications. It explains concept of heat, work, and internal energy and shows the relationship between them. In addition, it provides the trainee a detailed explanation of the first law of thermodynamics and its applications on different systems. Also explains the second law of thermodynamics, its applications, and its relationship with the first law of thermodynamics. It discusses also some steam cycles and its industrial applications.				

Course Name	Applied Mass Transfer	Course Code	KCHE 365	Credit Hours	6
Description	This course introduces the student to basic principles of mass transfer operations and their applications in the chemical industry, such as diffusion, absorption, extraction, distillation, evaporation, drying, fluidization, size reduction, and mechanical separations. Description of the equipment's used for the above operations is also dealt with. This course is supported by laboratory experiments and exercise.				

Course Name	Computational Method for Engineering Applications	Course Code	KCHE 322	Credit Hours	5
Description	This course provides skills to solve some selected chemical engineering problems by use the computer programs. Also, flowcharts, tables and calculations can be done by those programs. Use of commercial software packages such as Excel and Matlab.				

Course Name	Chemical Reaction Engineering	Course Code	KCHE 411	Credit Hours	6
Description	This course includes the following: Mole Balances, Conversion and Reactor Sizing, Rate laws and Stoichiometry, Isothermal Reactor Design, Collection and Analysis of Rate data, No isothermal Reactor Design, Catalysis and catalytic reaction.				

Course Name	Petrochemicals	Course Code	KCHE 341	Credit Hours	2
Description	This course introduces the student to the various processes involved in the technology of petrochemicals production, the raw materials used, their composition, and processing. It also deals with chemical reactions and conversion processes that produce the precursors, and intermediates needed for further processing into petrochemicals. The production of selected petrochemicals, along with a local case study, will be covered with emphasis on unit processes and operations employed. The course is supported by laboratory experiments.				

Course Name	Advanced Separation Processes	Course Code	KCHE 434	Credit Hours	6
Description	This subject deals with the application of the science and engineering science that you have learned to the separation of chemical mixtures. Specific processes considered will include Basic concepts of Distillation, absorption, adsorption and ionic separations. The object of the subject is twofold: to understand how separation work, and to further develop your ability to apply basic principles to the solution of specific problems.				

Course Name	Plant design & Economics	Course Code	KCHE 413	Credit Hours	4
Description	The course aims at giving the trainee the basic skills to deal with the economics of optimal chemical processes where they will be trained on the steps for project design and industrial development. The trainee will learn the general points that he should take into account when designing any project such as security, safety and environmental protection from pollution and provide the necessary services for the project and other considerations. Training will be performed on the estimate of the cost of the project at all stages after taking a general idea of accounting. This course will present a comprehensive study on the process profitability in general and investment costs and appropriate alternatives. The trainee will also have a clear and enough view for optimal design of equipment used in the factory and find the optimum method to choose necessary materials for manufacturing.				

Course Name	Process Control	Course Code	KCHE 446	Credit Hours	6
Description	The aim of this course is to expose students to the concepts of dynamic behavior, physical and empirical modeling, computer simulation, measurement and control technology, basic control concepts, feedback, feed-forward and stability. These are important for understanding of many complex systems of interest in chemical engineering and also to be able to design and operate modem plants. It includes an overview of process control system design with some illustrative examples and theoretical models of chemical processes. Dynamic behavior of processes and feedback control strategies are also dealt with. Furthermore, frequency response methods also covered. Performance of laboratory experiments is a component of this course to reinforce the students understanding of fundamental principles of process dynamics and control.				

Course Name	Polymer Science	Course Code	KCHE 414	Credit Hours	4
Description	Polymer science is considered in present-day an important science in the engineering and chemical fields, due to their economic impact and various applications. This course provides the trainee with the basic topics of polymer engineering at the rate of two hours per week. The trainee is introduced through this course on the chemistry of polymers and polymer molecules and the mechanism of their reactions, and studies their method of manufacture and their finished products. Also through the study of physical, chemical and mechanical properties, the trainee can compare the different types of polymers and their industrial applications.				

Course Name	Applied Materials science & Corrosion	Course Code	KCHE 465	Credit Hours	3
Description	This course focuses on basic elements of materials science, which relate the materials properties and types to the microscopic behavior atoms.				

Course Name	Renewable Energy	Course Code	KCHE461	Credit Hours	2
Description	Renewable Energy is an elective upper division course. It is a necessary course for Environmental Studies students who are interested in energy as a possible career, and a useful elective course for engineers interested in renewable energy. This course provides an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and applications.				

Course Name	Water Treatment	Course Code	KCHE 444	Credit Hours	2
Description	This course aims to give the trainee the basic skills for the treatment of wastewaters. In this course training will be carried through theoretical information by two lectures per week in addition to training on the following subjects: introduction to pollution, water pollution, wastewater treatment and uses of treated waters.				

Courses Detail Description

Department	Chemical Engineering		**Major**	Chemical Production					
Course Name	Chemical Processes		**Course Code**	KCHE 331					
Prerequisites			**Credit Hours** **CRH**	**4**		CTH		6	
				L	**4**	P	**0**	T	**2**

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

The course aims to acquire trainee basic skills to do principles technical chemical calculations.

The course submits detailed explanation of the units of measurement systems and dimensions used in industrial processes.

In addition, it gives the trainee the ability to deal with processes variables and how to calculate the chemical composition of the mixtures and solutions.

In addition, it provides a full explanation of the laws of material and energy balance and its applications on industrial units whether single or multiple.

The course also helps the trainee to understand and accommodate other specialized courses.

Topics:

- Units and dimensions
- Chemical compassion
- Material balances without chemical reaction
- Material balances with chemical reaction
- Energy balances

Experiments: If applicable, it will support the course topics.

References :

- Richard M. Felder and Ronald W. Rousseau; "Elementary principle of chemical processes", John Wiley, 3th Edition, 2005
- David M. Himmelblau; "Basic Principles and Calculations in Chemical Engineering", McGraw-Hill, 7th Edition, 2004

Details of Theoretical Contents		
	Contents	**Hours**

1	**Basic chemical calculations:**
	• Units and Dimensions:
	  ○ Introduction
	  ○ Systems of units
	  ○ Conversion of units
	  ○ Dimensional homogeneity
	• Chemical Composition:
	  ○ Mole and molecular weight
	  ○ Mass fraction and mass percent
	  ○ Mole fraction and mole percent
	  ○ Molecular weight of mixture
		10

2	**Material Balance:**
	
	• Material balance without chemical reaction:
	  ○ General concept of material balance
	  ○ General low of material balance
	  ○ Material balance in continuous processes at steady state for one unit
	• Material balance in continuous processes at steady state for:
	  ○ Multiple units
	  ○ Recycle and bypass calculations
	• Material balance with chemical reaction:
	  ○ Stoichiometry
	  ○ Limiting reactant
	  ○ Excess reactants
	  ○ Conversion
	  ○ Multiple reactions
	  ○ Yield
	  ○ Selectivity
	  ○ Recycle and purge
		34

3	**Energy balance:** • Types of energy • General low of energy balance • Energy balance on closed systems without chemical reaction • Energy balance on open systems without chemical reaction • Enthalpy calculation • Simultaneous material and energy balances • Heat of reaction • Heat of formation • Heat of combustion • Material balance with chemical reaction	**34**
		78

Textbook:	Richard M. Felder and Ronald W. Rousseau; "Elementary principle of chemical processes", John Wiley, 3th Edition, 2005

Department	Chemical Engineering	**Major**	Chemical Production
Course Name	**Organic Chemistry**	**Course Code**	**KCHE 332**
Prerequisites		**Credit Hours** CRH	**5** CTH 7
		L **3** P **4** T **0**	

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

The course offers comprehensive understanding of the basic principles of organic chemistry. The course describes chemical bonding, structure properties, nomenclature, synthesis, and reactions of alkanes, alkenes, alkynes, alcohols, ethers, alkyl halides, elimination and nucleophilic substitution reactions., kinetic and thermodynamic aspects governing these reactions.

Topics :

- Hydrocarbons
- Aromatic hydrocarbons
- Alkyl halides
- Alcohols and phenols
- Aldehydes and Ketones
- Carboxylic Acids and their derivatives
- Amines

Experiments:

References :

William H. Brown , Introduction to organic chemistry, 1996
Herbert Meislich, Howard Nechamkin ,Jacob sharefkin, organic chemistry, second edition

Detailed of Theoretical Contents		
No.	**Contents**	**Hours**
	Structure and properties • Carbon compounds • Structure of atoms • Covalent bonds • Function groups • Formal charge • Types of organic reactions	**4**
	Hydrocarbons ▪ Alkanes o Structural isomerism o Nomenclature of alkanes o Resource of alkanes o Synthesis of alkanes o Physical properties	**2**
	▪ Alkenes and alkynes o Structural o Nomenclature o Synthesis o Thermal Cracking o Reaction of alkenes and alkynes	**2**

	Aromatic hydrocarbons • Introduction • Benzene • Aromatic properties • Physical properties • Nomenclature derivatives of benzene • Synthesis of aromatic composite • Reaction of aromatic composite	**4**
	Alkyl halides • Introduction • Physical properties • Synthesis of Alkyl halides • Reaction of Alkyl halides	**4**
	Alcohols and phenols • Introduction • Nomenclature • Physical properties • Synthesis	**4**
	Ethers • Introduction • Nomenclature • Physical properties • Synthesis	**2**
	Aldehydes and Ketones • Introduction • Nomenclature • Physical properties • Synthesis	**5**
	Carboxylic Acids and their derivatives • Introduction • Nomenclature • Physical properties • Synthesis • Reaction	**6**
	Amines • Introduction • Nomenclature • Physical properties • Synthesis • Reaction	**6**
		39

Textbook:	**William H. Brown , Introduction to organic chemistry**, **1996**. **Herbert Meislich, Howard Nechamkin ,Jacob sharefkin**, **organic chemistry**, **second edition**.

Detailed of Practical Contents		
No.	**Contents**	**Hours**
	Qualitative analysis	**12**
	Functional group	**20**
	Synthesis of organic componnet	**20**
		52

Textbook:	**William H. Brown , Introduction to organic chemistry**, **1996**. **Herbert Meislich, Howard Nechamkin ,Jacob sharefkin**, **organic chemistry**, **second edition**.

Department	Chemical Engineering		**Major**	Chemical Production					
Course Name	Thermodynamics		**Course Code**	KCHE 333					
Prerequisites	KCHE 331		**Credit Hours CRH**	**5**	CTH	5			
				L	**5**	P	**0**	T	**0**

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This course aims to provide the trainee with the basic concepts of thermodynamics and its applications. It explains concept of heat, work, and internal energy and shows the relationship between them.

In addition, it provides the trainee a detail explanation of the first law of thermodynamics and its applications on different systems.

Also explains the second law of thermodynamics, its applications, and its relationship with the first law of thermodynamics.

It discusses also some steam cycles and its industrial applications.

Topics:

- Basic Thermodynamics Terminologies
- First law of thermodynamics
- Gases and single phase systems
- Second law of thermodynamics
- Steam tables and vapor cycles

Experiments: If applicable, it will support the course topics.

References:

- R. Joel, " Basic Engineering Thermodynamics ", Dorling Kindersley (India), 5th Ed, 2008.
- J.M. Smith and H.C. Van Ness and M.M. Abbott, " Introduction to Chemical Engineering Thermodynamics ", McGraw-Hill, 6th Ed., 2005.
- Y.A. Cengel and M.A. Boles, " Thermodynamics: An Engineering Approach ", McGraw-Hill, 25th Ed., 2006.

Details of Theoretical Contents		
	Contents	**Hours**
1	**Basic concepts and Terminologies of thermodynamics:** • Introduction • Terminologies of thermodynamics • Relation between work and the pressure-volume diagram • Relationship between work and the polytrophic process • Relationship between work and the hyperbolic process • Statement of the Zeroth law of thermodynamics	**11**
2	**First low of thermodynamics:** • Definition of closed and open-systems • Energy forms in thermodynamic systems • Statement of the First law of Thermodynamics • Applications of the first law to a closed- system and an open- system	**12**
3	**Gases and Single-Phase Systems:** • The gas laws and their applications • Statement of Joule's Law for a gas • Definitions of the specific heat capacities of a gas • Application of the Non-Flow Energy Equation to a gas: ○ Subjected to constant volume heating	**10**

	○ Subjected to constant pressure heating ○ Undergoing a polytrophic process ○ Under adiabatic conditions ○ Under isothermal conditions	
4	**Second law of thermodynamics:** • The principle of the thermodynamic engine and calculation of thermal efficiency • Definition of reversible and irreversible processes • Statement of the Second Law of Thermodynamics • Relationship between the first law and the second law • The concept of Entropy and the Third Law of Thermodynamics • Entropy as a function of temperature and volume • Entropy as a function of temperature and pressure	**14**
5	**Steam tables and Vapor Cycles:** • Definition of steam tables • Properties of saturated steam and superheated steam • Main features of the steam power plant • The Carnot steam power cycle and efficiency • Thru Rankin steam power cycle and efficiency • Basic definitions related to refrigeration processes • Characteristics and examples of refrigerants • The vapor compression refrigeration cycle	**18**
		65
Textbook:	R. Joel, "Basic Engineering Thermodynamics ", Dorling Kindersley (India), 5th Ed, 2008.	

Department	Chemical Engineering		**Major**	Chemical Production					
Course Name	Applied mass transfer		**Course Code**	KCHE 365					
Prerequisites	KCHE 331		**Credit Hours CRH**	**6**		CTH	8		
				L	**4**	P	**4**	T	**0**

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This course introduces the student to basic principles of mass transfer operations and their applications in the chemical industry, such as diffusion, absorption, extraction, distillation, evaporation, drying, fluidization, size reduction, and mechanical separations.

Description of the equipment's used for the above operations is also dealt with.

This course is supported by laboratory experiments and exercises.

Topics:

- Principles of Mass Transfer
- Evaporation
- Drying of process Materials
- Membrane Separation Process
- Experiments

Experiments: If applicable, it will support the course topics.

References:

- Transport Processes and Separation Process Principles , C.J. Geankoplis, Prentice , Hall, 4th Edition, 2003

Details of Theoretical Contents		
	Contents	**Hours**
1	**introduction to Mass Transfer and Diffusion:** • Molecular Diffusion in Gases • Molecular Diffusion in Liquids • Molecular Diffusion in Biological Solutions and Gels • Molecular Diffusion in Solids • Numerical Methods for Steady- State Molecular Diffusion in Two Dimensions.	**10**
2	**Types of Evaporation Equipment and operation Methods:** • Overall Heat Transfer Coefficient in evaporators • Calculation Methods for Single-Effect Evaporators • Calculation Methods for Multiple-Effect Evaporators • Condensers for Evaporators • Evaporation of Biological Materials • Evaporation using Vapor Recompression	**12**
3	**Introduction and Methods of Drying:** • Equipment for Drying • Vapor Pressure of Water and Humidity • Equilibrium Moisture Content of Materials • Rate of – Drying Curves • Calculation Methods for Constant – Rate Drying Period • Calculation Methods for Falling – Rate Drying Period • Combined Convection ,Radiation ,and Conduction Heat Transfer in Constant – Rate Period • Drying in Falling Rate Period by Diffusion and Capillary Flow	**14**

	• Equations for Various Types of Dryers • Freeze – Drying of Biological Materials • Unsteady – State Thermal Processing and Sterilization of Biological Materials	
4	**Introduction of types of Membrane Separation Processes:** • Liquid Permeation Membrane Separation Processes • Gas Permeation Membrane Processes • Complete-Mixing Model for Gas Separation by Membranes • Complete-Mixing Model for Multicomponent Mixtures • Cross – Flow model for Gas Separation by Membranes • Derivation of Equations for Countercurrent and Cocaaurrent Flow for Gas Separation by Membranes • Derivation of Finite-Difference Numerical Method for Asymmetric membranes	**16**
		52
Textbook:	Transport Processes and Separation Process Principles , C.J. Geankoplis, Prentice , Hall, 4th Edition, 2003	

Details of Practical Contents		
	Contents	**Hours**
1	**1st Experiment: Verification of the Diffusion Phenomena**	12
2	**2nd Experiment: Determination of the Diffusivity of Selected Gases**	4
3	**3rd Experiment: Determination of the Diffusivity of Liquids**	6
4	**4th Experiment: Determination of the Liquid Film Mass Transfer Coefficient**	6
5	**5th Experiment: Verification of the Principles of Evaporation Using Saline Water**	6
6	**6th Experiment: Verification of the Principles of Steam Distillation Process**	6
7	**7th Experiment: Calculation of Selected Parameters of Distillation**	4
8	**8th Experiment: Verification of the Distribution Law of a Solute between Two Immiscible liquids**	8
		52
Textbook:	Transport Processes and Separation Process Principles , C.J. Geankoplis, Prentice , Hall, 4th Edition, 2003	

Department	Chemical Engineering	**Major**	Chemical Production
Course Name	**Computer Chemical Processes Drawing**	**Course Code**	**KCHE 321**
Prerequisites		**Credit Hours CRH**	**3** CTH 6
		L **0** P **6** T **0**	

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This course mainly focuses on exposure of students to various equipment used in chemical industries and prepares them to practice making of the detailed equipment drawings.

The students can be used several softwares for making the computerized drawing such as chemcad, Aspen tech, solid edge and SmartDraw for Windows etc.

Topics :

- Essentials of Drawing
- Equipment Symbols
- Proportionate Drawings of Some Parts of Equipment
- Proportionate Drawings of Some Common Equipment
- Dimensioned Drawings of Some Pipe Fittings
- Dimensioned Drawings of Some Valves
- Dimensioned Drawings of Some Pumps
- Introduction to Computer Aided Design and Drawing

References :

1. Douglas, J. Conceptual Design of Chemical Processes. New York, NY: McGraw-Hill Science/Engineering/Math, 1988. ISBN: 0070177627.

2. Seider, W. D., J. D. Seader, and D. R. Lewin. Product and Process DesignPrinciples: Synthesis, Analysis, and Evaluation. 2nd ed. New York, NY: Wiley,2004

3. Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwitz.Analysis, Synthesis, and Design of Chemical Processes, 2nd Edition, 2002,Prentice Hall

4. L.T. Biegler, I.E. Grossmann and A.W. Westerberg, Systematic Methods ofChemical Process Design, Prentice Hall, 1997

5. SmartDraw for Windows Desktop, https://www.smartdraw.com/

Detailed of Theoretical Contents		
No.	**Contents**	**Hours**
1	**Essentials of Drawing**: 1.1 Compass tools 1.2 Mini drafter 1.3 Neatness 1.4 Finish 1.5 Drawing Sheets 1.6 Layout of drawing sheets 1.7 Revision panel 1.8 Title block 1.9 Numbering of sheets 1.10 Parts List 1.11 Numbering and Referencing 1.12 Referencing	**4**

	1.13 Folding drawing sheets and prints 1.14 Lines and Symbols Used in Dimensioning 1.15 Representation of Section Plane	
2	**Equipment Symbols:** 2.1 Important Equipment Symbols 2.2 Piping Symbols and Pipe Joints	**4**
3	**Proportionate Drawings of Some Parts of Equipment:** 3.1 Vessel components 3.1.1 Vessel Openings and Nozzle Attachments 3.1.2 Pad Attachments to Vessel Wall with Tapped Holes for Studs 3.1.3 Extended Nozzle with Flanged Joint 3.1.4 Nozzle with Flanges at Either End 3.1.5 Nozzle with Bent Tube Inside and Flanged Attachment 3.1.6 Manhole and Cover 3.1.7 Flanged Cover for the Vessel 3.1.8 Loose Flange for Vessel 3.1.9 Jacketed Vessel 3.2 Pipe Flanges	**8**
4	**Proportionate Drawings of Some Common Equipment:** 4.1 Shell and tube heat exchanger 4.1.1 Schematic Shell and Tube Heat Exchanger 4.2 Typical 1–1 Shell and Tube Heat Exchanger 4.3 A typical photo of arrangement of tubes in the heat exchanger 4.4 Reboiler with internal floating head 4.5 Heat Exchanger with expansion bellows (1-1 STHE) 4.6 Double pipe heat exchanger 4.7 Reaction vessels 4.7.1 Typical Reaction Vessel 4.8 Evaporators 4.8.1 Standard Short Tube Vertical Evaporator 4.8.2 Tube Layout of Short Tube Vertical Evaporator 4.9 Long tube vertical evaporator 4.10 External calendria vertical short tube evaporator 4.11 Basket Type Short Tube Vertical Evaporator 4.12 Distillation or Fractionating column	**12**
5	**Dimensioned Drawings of Some Pipe Fittings:** 5.1 Pipe joints 5.1.1 Flanged Pipe Joint 5.1.2 Assembled View of Flanged Pipe Joint 5.1.3 Hydraulic Pipe Joint 5.1.4 Assembled View of Hydraulic Pipe Joint	**10**
6	**Dimensioned Drawings of Some Valves:** 6.1 Valves 6.1.1 Gate Valve 6.1.2 Non-rising Gate Valve Description	**10**

	6.1.3 Parts Drawing of Non-rising Gate Valve 6.2 Stop Valve 6.2.1 Part Drawing of Stop Valve: drg 1 of 2 and drg 2 of 2 6.3 Junction stop valve .4 Non-return valve (NRV) 6 6.5 Feed check valve 6.6 Rams bottom safety valve	
7	**Dimensioned Drawings of Some Pumps:** 7.1 Pump 7.1.1 Centrifugal Pump 7.1.2 Description of Centrifugal Pumps 7.2 Gear pump 7.2.1 Theory of Operation 7.2.2 Description of Parts of Gear Pump 7.3 Reciprocating pump 7.3.1 Photographic Views of Some Reciprocating Pumps 7.4 Plunger or Ram Pump	**10**
8	**Introduction to Computer Aided Design and Drawing:** 8.1 Introduction 8.2 Drafting and Documentation 8.3 Streamlined Drawing Creation 8.4 Documenting the Largest Assemblies 8.5 Drawing Automation with Quick Sheet Templates 8.6 Software System Requirements 8.7 applications in Chemical Processes	**20**
		78
Textbook:	SURESH C. MAIDARGI- **“**CHEMICAL PROCESS EQUIPMENT—DESIGN AND DRAWING”, VOLUME I, SECOND EDITION”, PHI LEARNING PRIVATE LIMITED, DELHI, 2016	

Department	Chemical Engineering	Major	Chemical Production						
Course Name	Petrochemicals	Course Code	KCHE 341						
Prerequisites		Credit Hours CRH	2		CTH	3			
			L	2	P	0	T	1	

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This course introduces the student to the various processes involved in the technology of petrochemicals production, the raw materials used, their composition, and processing. It also deals with chemical reactions and conversion processes that produce the precursors, and intermediates needed for further processing into petrochemicals.

The production of selected petrochemicals, along with a local case study, will be covered with emphasis on unit processes and operations employed. The course is supported by laboratory experiments.

Topics:

- Raw Materials for Petrochemicals.
- Hydrocarbon and Non-Hydrocarbon Intermediates for Petrochemicals.
- Petrochemicals from Basic Raw Materials.
- Synthesis Gas.
- Ammonia.
- Urea.
- Ethylene and Polyethylene.

Experiments: If applicable, it will support the course topics.

References:

1) Petrochemical Process Technology, by Mall I D, Macmillan, Inc., 1st Edition, 2008

Details of Theoretical Contents		
	Contents	**Hours**

1	**Raw materials for petrochemical:**
	• Introduction.
	• Natural gas.
	• Properties of natural gas.
	• Natural gas treatment processes:
	  ○ Sweetening process.
	  ○ Demethanization process.
	  ○ Fractionation process.
	  ○ Refrigeration process.
	• Crude oils:
	  ○ Composition of crude oils.
	  ○ Properties of crude oils.
	  ○ Crude oil classification.
	• Coal, oil shale, tar sand and gas hydrates.
		8

2	**Hydrocarbon and Non-Hydrocarbon Intermediates for Petrochemicals processes:** • Physical separation processes. • Conversion process.	**6**

	• Production of olefins. • Production of hydrogen. • Production of sulfur. • Production of carbon black.	
3	**Petrochemicals from Basic Raw Materials:** • Petrochemicals based on methane. • Petrochemicals based on ethylene. • Petrochemicals based on propylene. • Petrochemicals based on C4 olefins and olefins. • Petrochemicals based on benzene toluene and xylene.	**6**

4	**Synthesis Gas:**
	• Introduction.
	• Production processes:
	  ○ Steam reforming process.
	  ○ Partial combustion process.
	• Economics of synthesis gas production.
		4

5	**Ammonia**: • Introduction. • Description of the production process of ammonia. • Reaction and equilibrium conditions in ammonia synthesis. • Effect of catalysis on the rate of reaction in ammonia synthesis. • Design and operation of an ammonia synthesis converter. • Uses and economics of ammonia production.	**5**
6	**Urea:** • Introduction. • Description of the production process of urea. • Major engineering problems associated with urea production. • Growth of urea production and important uses.	**4**

7	**Ethylene and Polyethylene:**
	• Ethylene properties and sources.
	• Manufacture of ethylene.
	• Polyethylene properties and basic reactions.
	• Production processes of polyethylene:
	  ○ High-pressure polymerization process.
	  ○ Medium – pressure polymerization process.
	  ○ Low – pressure polymerization process.
	• Comparison of polyethylene polymerization processes.
	• Common uses of polyethylene.
		6

		39
Textbook:	Petrochemical Process Technology, by Mall I D, Macmillan, Inc., 1st Edition, 2008	

Department	Chemical Engineering	Major	Chemical Production						
Course Name	Water Treatment	Course Code	KCHE 444						
Prerequisites		Credit Hours CRH	2		CTH	3			
			L	2	P	0	T	1	

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course description:

This course aims to give the trainee the basic skills for the treatment of wastewaters. In this course, training will be carried through theoretical information by two lectures per week in addition to training on the following subjects: introduction to pollution, water pollution, wastewater treatment and uses of treated waters.

Topics:

- Water pollution
- Wastewater treatment
- Design of wastewater station
- Disposal of the products of treatment
- Uses of treated water

Experiments: If applicable, it will support the course topics.

References:

1) Wastewater Engineering: Treatment and Reuse by George Tchobanoglous, Franklin L. Burton, and H. David Stensel, 2002

Details of Theoretical Contents		
	Contents	**Hours**
1	**Water pollution:** • Sources of water pollution. • Wastewaters.	4
2	**Philosophy of wastewater collection and treatment:** • Planning and design of sewage. • Philosophy of sewage treatment.	6
3	**Primary treatment of wastewater:** • Sedimentation.	6
4	**Secondary treatment of wastewater:** • Fundamentals of applied microbiology. • Description of the activated sludge process. • Design of activated sludge systems. • The design of the aerator to the activated sludge process. • Filtration by distillation and design fundamentals. • Other air treatment systems. • Fundamentals of anaerobic treatment. • Design of anaerobic reactors. • Design of UASB reactors.	6
5	**Advanced treatment of wastewater:** • Nitrification: Description of the process and design. • DE nitrification: Description of the process and design.	6

	• Removal of phosphorus and other advanced treatment.	
6	**Residuals Management:** • Management basics of remaining. • Design of residual management operation**.**	**5**
7	**Design of wastewater treatment plant:** • Disposal of treatment products. • Uses of treated wastewater**.**	**6**
		39
Textbook:	Wastewater Engineering: Treatment and Reuse by George Tchobanoglous, Franklin L. Burton, and H. David Stensel, 2002	

Department	**Chemical Engineering**	**Major**	**Chemical Production**						
Course Name	**Computational Method for Engineering Applications**	**Course Code**	**KCHE 322**						
Prerequisites		**Credit Hours** **CRH**	**5**		CTH	8			
			L	**2**	P	**6**	T	**0**

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This course provides skills to solve some selected chemical engineering problems by use the computer programs. Also, flowcharts, tables and calculations can be done by those programs. Use of commercial software packages such as Excel and Matlab.

Topics :

- Excel Program
- Matlab Program
-

Experiments:

- Excel applications
- Matlab applications

References : Gilat, A., "MATLAB: An introduction with Applications", 4th edition, 2010

Detailed of Theoretical Contents		
No.	**Contents**	**Hours**
1	**The computer in chemical engineering** • The Importance • Used Programs	**8**
2	**Basics of Excel program** • Introduction • Worksheets & Workbooks • Tables • Charts • Formula & Calculations	**8**
3	**Matlab Program** • Introduction • Flowcharts • Matrices • Charts & Tables • Solving Equations (Linear & Non – Linear)	**10**
		26
Textbook:	Gilat, A., "MATLAB: An introduction with Applications", 4th edition, 2010	

Detailed of Practical Contents		
No.	**Contents**	**Hours**
1	**Basics of Excel program** • Worksheets & Workbooks • Tables • Charts • Formula & Calculations	**39**

2	**Matlab Program** • Flowcharts • Matrices • Charts & Tables • Solving Equations (Linear) • Solving Equations (Non – Linear)	**39**
		78
Textbook:	Gilat, A., "MATLAB: An introduction with Applications", 4th edition, 2010	

Department	**Chemical Engineering**		**Major**	**Chemical Production**					
Course Name	**Advanced Separation Processes**		**Course Code**	**KCHE 434**					
Prerequisites	**KCHE 331**		**Credit Hours CRH**	**6**		CTH	8		
				L	**4**	P	**4**	T	**0**

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This subject deals with the application of the science and engineering science that you have learned to the separation of chemical mixtures. Specific processes considered will include Basic concepts of Distillation, absorption, adsorption, ionic separations, and other techniques.

The object of the subject is twofold: to understand how separation work, and to further develop your ability to apply basic principles to the solution of specific problems.

Topics :

- **Introduction**
- **Basic concepts of Distillation**
- **Absorption**
- **Separation By Adsorption Techniques**
- **Ionic Separations**
- **Other Techniques**

References :

- Lacey, R.E. and S.Loaeb - " Industrial Processing with Membranes ", Wiley –Inter Science, New York, 1972.
- King, C.J. " Separation Processes ", Tata McGraw - Hill Publishing Co., Ltd.,1982.
- Ronald W.Roussel - " Handbook of Separation Process Technology ", John Wiley, New York, 1987.
- Kestory, R.E. - " Synthetic polymeric membrances ", Wiley, New York, 1987.
- Osadar, Varid Nakagawa I - " Membrance Science and Technology ", Marcel Dekkar (1992).
-Seader, J. D., and Ernest J. Henley. *Separation Process Principles*. New York, NY: Wiley, 1998. ISBN: 9780471586265.

Detailed of Theoretical Contents		
No.	**Contents**	**Hours**
1	**Introduction:** Review of conventional processes, Recent advances in separation techniques based on size, special characteristics of substances, Process surface properties, ionic properties and other cross flow filtration, cross flow electro filtration, dual concept, Theory and equipment used in solid - liquid separations involving a second liquid, Siro-floc functional filter, Surface based filter.	**8**
2	**Basic concepts of Distillation:** Vapour - Liquid equilibrium pressure - temperature -concentration - phase diagram - isothermal and isobaric equilibrium - Relative Volatility - Raoult's law - ideal solutions deviations from ideality - Minimum and maximum boiling azeotropes - Partially miscible liquids distillation - Insoluble liquids(Steam distillation) - Enthalpy - concentration diagrams - Treatment of multicomponent systems-Different distillation Methods : Flash Vapourisation of binary mixture - Simple distillation of binary mixtures -Vacuum distillation - Continuous rectification methods - brief discussion on general characteristics of tray and packed tower - Azeotropic and extractive distillation, low pressure distillation and molecular distillation. Multistage Tray tower Design : Material and enthalpy balance of a fractionator - Ponchon and Savarit and McCabe - Thiele Method -Enriching section with total condenser and reflux below the bubble point - partial condenser - Stripping section. Complete fractionation- Feed below bubble point - Feed tray	**10**

	location - Effects of reflux ratio - total reflux - minimum reflux - Optimum reflux. Reboiler arrangements - use of open steam - Use of multiple feeds - efect of heat loss - Introduction of feed and its influence on operating lines - q-lines and location of tray - Fractionation of azeotropic and partially miscible binary mixtures - Tray efficiencies. Continuous Contact Equipment: Concepts of transfer units - HTU and NTU - and height of the enriching section and stripping section - Graphical methods.	
3	**Separation by Absorption:** Equilibrium solubility of gases in liquids- Selection of solvent for absorption and stripping- Design of single stage counter-current flow absorption tower (packed tower)- Design of packed tower- Design of packed tower based on overall mass transfer coefficient- Counter-current multi-stage absorption (Tray absorber)- Continuous contact equipment- Absorption with chemical reaction- Absorption accompanied by irreversible m^{th} order reactions- Absorption resistance.	**10**
4	**Separation By Adsorption Techniques:** adsorbents, Normal adsorption techniques, Affinity Mechanism, Types and choice of chromatography. Types of equipment and commercial processes, chromatography and immune and process economics. Recent advances	**12**
5	**Ionic Separations:** Controlling factors, Applications, Types of equipment employed for electrophoresis, Di-electro dialysis, Commercial Processes. electrophoresis, Ion exchange chromatography.	**12**
		52
Textbook:	-Schoew, H.M. - " New Chemical Engineering Separation Techniques ", Interscience Publishers, 1972. -Basic Principles Of Membrane Technology, Marcel Mulder, Kluwer Academic Publishers, 1997	

Detailed of Practical Contents		
No.	**Contents**	**Hours**
1	Distillation experiment using pilot plant : Determination of VLE, steam requirement and vapourisation efficiency, efficiency steam distillation, verification of Rayleigh's equation for simple distillation, Distillation in packed columns, HETP.	**12**
2	Absorption experiment using pilot plant: Verification of design equation for height of packing in packed tower absorption of ethanol in water, absorption of carbon dioxide in sodium carbonate solution. Surface evaporation - Free convection mass transfer.	**12**
3	Adsorption : Determination of adsorption isotherm	**14**
4	Application on Ion Exchange Chromatography	**14**
		52
Textbook:	Ing. Reinhard Billet “Packed Towers: In Processing and Environmental Technology”, VCH Verlagsgesellschaft mbH, Weinheim, 2005	

Department	Chemical Engineering	Major	Chemical Production						
Course Name	Polymer Science	Course Code	KCHE 414						
Prerequisites		Credit Hours CRH	4			CTH		5	
			L	4	P	0	T	1	

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

Polymer science is considered in present-day an important science in the engineering and chemical fields, due to their economic impact and various applications.

This course provides the trainee with the basic topics of polymer engineering at the rate of two hours per week. The trainee is introduced through this course on the chemistry of polymers and polymer molecules and the mechanism of their reactions, and studies their method of manufacture and their finished products. Also through the study of physical, chemical and mechanical properties, the trainee can compare the different types of polymers and their industrial applications.

Topics:

- Introduction to polymer science.
- Molecular weight of polymers.
- Polymers reactions.
- Thermal transition in polymers.
- Polymerization.
- Polymers properties and their applications.

Experiments: If applicable, it will support the course topics.

References:

1) Ebewele, R., " Polymer Science and Technology", CRC Press, Florida, 2015.

Details of Theoretical and practical Contents		
	Contents	**Hours**
1	**Introduction to polymers**: • Importance of polymers. • Definitions. • Degree of polymerization. • Copolymers. • Types of polymers (thermoplastics, thermosets, elastomers).	**10**
2	**Molecular weight of polymers:** • Effect of molecular weight. • Calculation of molecular weight average. • Practical measurement of molecular weight.	**10**
3	**Polymerization reactions:** • Step-growth reaction. • Chain reaction. • Copolymers reactions and factors affecting them. • Homogeneous and heterogeneous polymerization.	**10**
4	**Thermal transitions in polymers:** • Glass transition temperature. • Factors affecting glass transition temperature.	**11**

	• Boiling point.	
5	• Polymer processing. • Injection molding. • Blow molding. • Rotational molding. • Forming.	**12**
6	**Polymer properties and applications:** • Properties of thermoplastic. • Examples and applications. • Thermosets properties. • Examples and applications. • Elastomers properties. • Examples and applications.	**12**
		65
Textbook:	Ebewele, R., " Polymer Science and Technology", CRC Press, Florida, 2015.	

Department	Chemical Engineering		**Major**	Chemical Production					
Course Name	Chemical Reaction Engineering		**Course Code**	KCHE 411					
Prerequisites	KCHE 331		**Credit Hours CRH**	**6**		CTH		8	
				L	**4**	P	**4**	T	**0**

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

This course includes the following: Mole Balances, Conversion and Reactor Sizing, Rate laws and Stoichiometry, Isothermal Reactor Design, Collection and Analysis of Rate data, Nonisothermal Reactor Design, Catalysis and catalytic reaction.

Topics:

- Mole Balances
- Conversion and Reactor Sizing
- Rate laws and Stoichiometry
- Isothermal Reactor Design
- No isothermal Reactor Design
- Catalysis and Catalytic Reaction

Experiments: if applicable it will support the course topics.

References:

- H.ScottFogler ((Elements of Chemical Reaction Engineering)) 4th Edition, 2006

Details of Theoretical and Practical Contents		
	Contents	**Hours**
1	**Mole Balances** (Rate law Definition .and Equations ,Batch Reactors and continuous Reactor)	**18**
2	**Conversion and Reactor Sizing** (Definition,Design Equation of Batch System and Flow system,Reactor in Series)	**18**
3	**Rate laws and Stoichiometry** (Basic Definitions ,Stoichiometry table)	**18**
4	**Isothermal Reactor Design** (Design structure for Isothermal reactors, Scale-up of liquid phase, Design of CSTR)	**18**
5	**Nonisothermal Reactor Design** (Energy Balance,nonisothermal continuous-flow reactors at steady state,unsteady state operation,multiple steady states).	**16**
6	**Catalysis and Catalytic Reaction** (Definitions and properties, steps in a catalytic reaction, Rate law synthesis,mechanism and rate limtingstep,catalyst reactivation)	**16**
		104
Textbook:	H.ScottFogler ((Elements of Chemical Reaction Engineering)) 4th Edition, 2006	

Department	Chemical Engineering		**Major**	Chemical Production					
Course Name	Process control		**Course Code**	KCHE 446					
Prerequisites	KCHE 331		**Credit Hours CRH**	**6**	CTH	8			
				L	**4**	P	**4**	T	**0**

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

The aim of this course is to expose students to the concepts of dynamic behavior, physical and empirical modeling, computer simulation, measurement and control technology, basic control concepts, feedback, feed-forward and stability.

These are important for understanding of many complex systems of interest in chemical engineering and to be able to design and operate modem plants.

It includes an overview of process control system design with some illustrative examples and theoretical models of chemical processes.

Dynamic behavior of processes and feedback control strategies are also dealt with.

Furthermore, frequency response methods also covered. Performance of laboratory experiments is a component of this course to reinforce the students understanding of fundamental principles of process dynamics and control.

Topics

- Introduction to Process Control
- Theoretical Models of Chemical Processes
- Laplace Transforms
- The Transfer Function and state-space models
- Dynamic Behavior of First-Order and Second-Order processes
- Dynamic Behavior and Stability of Closed-Loop Control Systems
- PID Controller Design, Tuning, and Troubleshooting
- Frequency Response Methods
- Control System Design Based on Frequency Response Analysis

Experiments: If applicable, it will support the course topics.

References:

- Instrumentation for Process Measurement and Control, Norman A. Anderson, 3rd Ed., CRC Press LLC, 1998.
- Modern control Engineering, K. Ogata, 4th Edition, Prentice-Hall, Inc., 2002
- Design of Feedback Control Systems, R. T. Stefani, B. Shahian, and G. H. Hostetter, 4th Edition, Oxford Univ. Press. Inc., 2002

Details of Theoretical Contents		
	Contents	**Hours**
1	**Introduction to Process Control** • Representative process control problems • Illustrative example of a blending process • Classification of process control strategies • Illustrative example of a distillation column • The hierarchy of process control activities • An overview of control system design	**4**
2	**Theoretical Models of Chemical Processes** • The rationale for dynamic process models • General modeling principles • Degrees of freedom in modeling	**3**

	• Dynamic models of representative processes • Solution of dynamic models and the use of digital simulators	
3	**Laplace Transforms** • The Laplace transform of representative functions • Solution of differential equations by Laplace transform techniques • Partial fraction expansion • Other Laplace transform properties • 5. A transient response example	**3**
4	**The Transfer Function and state-space models** • Development of transfer functions • Properties of transfer functions • Linearization of nonlinear models • State-space and transfer function matrix models	**6**
5	**Dynamic Behavior of First-Order and Second-Order processes** • Standard process inputs • Response of first - order processes • Response of integrating processes • Response of second - order processes	**6**
6	**Dynamic Behavior and Stability of Closed-Loop Control Systems** • Block diagram representation • Closed-loop transfer functions • Closed-loop responses of simple control systems • Stability of closed-loop control systems • Root locus diagrams	**6**
7	**PID Controller Design, Tuning, and Troubleshooting** • Performance criteria for closed-loop systems • Model-based design methods • Controller tuning relations • Controllers with two degrees of freedom • On-line controller tuning • Guidelines for common control loops • Troubleshooting control loops	**6**
8	**Frequency Response Methods** • Sinusoidal forcing of a first-order process • Sinusoidal forcing of an nth-order process • Bode diagrams • Frequency response characteristics of feedback controllers	**10**
9	**Control System Design Based on Frequency Response Analysis** • Closed-loop behavior • Bode stability criterion • Quist stability criterion • Gain and phase margins • Closed-loop frequency response and sensitivity functions • Robustness analysis of control systems	**8**
		52
Textbook:	Instrumentation for Process Measurement and Control, Norman A. Anderson, 3rd Ed., CRC Press LLC, 1998.	

Details of Practical Contents		
	Contents	**Hours**
1	**Operation of the control manual valve and knowledge of its properties**	**4**
2	**Operation of an electric control valve**	**6**
3	**Determination of Cv flow coefficient of valves**	**6**
4	**Operation of engine valves and the study of its properties**	**6**
5	**Control of the liquid level in a tank using the two-mode gauging level (Control of pump work)**	**6**
6	**Control of the liquid level in a tank using the two-mode level gauge (Control in the work of input and output valves)**	**6**
7	**Study of the properties of the two-mode controller**	**6**
8	**Study of the properties of the proportional controller**	**6**
9	**Study of the properties of the proportional-differential controller**	**6**
		52
Textbook:	Instrumentation for Process Measurement and Control, Norman A. Anderson, 3rd Ed., CRC Press LLC, 1998.	

Department	Chemical Engineering	**Major**	Chemical Production
Course Name	Plant Design & Economics	**Course Code**	KCHE 413
Prerequisites	KCHE 331	**Credit Hours CRH**	**4** CTH 4
			L **4** P **0** T **0**

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

The course aims at giving the trainee the basic skills to deal with the economics of optimal chemical processes where they will be trained on the steps for project design and industrial development.

The trainee will learn the general points that he should take into account when designing any project such as security, safety and environmental protection from pollution and provide the necessary services for the project and other considerations.

Training will be performed on the estimate of the cost of the project at all stages after taking a general idea of accounting.

This course will present a comprehensive study on the process profitability in general and investment costs and appropriate alternatives.

The trainee will also have a clear and enough view for optimal design of equipment used in the factory and find the optimum method to choose necessary materials for manufacturing.

Topics:

- Process design development
- General design considerations
- Cost and asset accounting
- Cost estimation
- Interest and investment cost
- Depreciation
- Profitability, alternative investments and replacements
- Optimum design
- Materials and fabrication selection

Experiments: if applicable it will support the course topics.

References:

- Max S. Peters and Klaus D. Timmerhaus, "Plant Design and Economics for Chemical Engineers", 4th edition, McGraw – Hill, Inc., 1991.
- F. C. Jelen and J. H. Black, "Cost and Optimization Engineering", 3th edition, McGraw Hill, Inc., 1992.

Details of Theoretical Contents		
	Contents	**Hours**
1	**Process design development** • Introduction • Design information from the literature • Flow diagrams • The preliminary design • Comparison of different processes • Equipment design and specifications	**4**
2	**General design considerations** • Health and safety hazards • Loss prevention • Environmental protection • Plant location	**8**

	• Plant layout • Plant operation and control • Utilities • Structural design • Storage • Materials handling	
3	**Cost and asset accounting** • Outline of accounting procedure • Basic relationships in accounting • The balance sheet • The income statement • Maintaining accounting records • Cost accounting methods	**4**
4	**Cost estimation** • Cash flow for industrial operations • Factors affecting investment and production cost • Capital investments • Estimation of capital investment • Cost indexes • Cost factors in capital investments • Estimation of total production cost	**4**
5	**Interest and investment cost** • Types of interest • Nominal and effective interest rates • Continuous interest • Present worth and discount • Annuities • Relationships for continuous cash flow and continuous interest of importance for profitability analyses • Costs due on interest on investment	**4**
6	**Depreciation** • Types of depreciation • Service life • Salvage value • Present value • Methods for determining depreciation	**4**
7	**Profitability, Alternative investments and replacements** • Profitability standards • Alternative investments • Replacements • Practical factors in alternative investment and replacement studies	**8**
8	**Optimum design** • Incremental costs • General procedure for determining optimum conditions • Comparison of graphical and analytical methods • The break-even chart for production schedule and its significance for optimum analysis	**8**

	• Optimum production rates in plant operations • Optimum conditions in cyclic operations • Fluid dynamics (optimum economic pipe diameter) • Heat transfer (optimum flow rate of cooling water in condenser) • Mass transfer (optimum reflux ratio)	
9	**Materials and fabrication selection** • Materials of construction • Low and high temperature materials • Fabrication of equipment	**8**
		52
Textbook:	Max S. Peters and Klaus D. Timmerhaus, "Plant Design and Economics for Chemical Engineers", 4th edition, McGraw – Hill, Inc., 1991.	

Department	Chemical Engineering		**Major**	Chemical Production					
Course Name	Applied Materials Science& Corrosion		**Course Code**	KCHE 465					
Prerequisites			**Credit Hours** **CRH**	**3**		CTH	4		
				L	**3**	P	**0**	T	**1**

CRH**: Credit Hours** L**: Lecture** P**: Practical** T**: Tutorial** CTH**: Contact Hours**

Course description :

This course focuses on basic elements of materials science, which relate the materials properties and types to the microscopic behavior atoms.

Topics:

- Atomic Structure and Interatomic Bonding
- The Structure of Crystalline Solids
- Mechanical Properties of Metals
- Phase Diagram
- Applications and Processing of Metal Alloys

Experiments: If applicable, it will support the course topics.

References:

- Materials Science and Engineering An Introduction, W.D. Jhon Wiley&Sons.2007

Details of Theoretical Contents		
	Contents	**Hours**
1	**Introduction** • Historical Perspective • Materials Science and Engineering • Why Study Materials Science and Engineering? • Classification of Materials • Advanced Materials • Modern Materials' Needs	**6**
2	**Atomic Structure and Interatomic Bonding** • Introduction • ATOMIC STRUCTURE • Fundamental Concepts • Electrons in Atoms • ATOMIC BONDING IN SOLIDS • Bonding Forces and Energies • Primary Interatomic Bonds • Secondary Bonding or van der Waals Bonding • Molecules	**10**
3	**The Structure of Crystalline Solids** • Introduction • CRYSTAL STRUCTURES • Fundamental Concepts • Metallic Crystal Structures • Density Computations	**8**
4	**Mechanical Properties of Metals** • Introduction • Concepts of Stress and Strain • ELASTIC DEFORMATION	**8**

	• Stress-Strain Behavior • An elasticity **Elastic Properties of Materials** • PLASTIC DEFORMATION • Tensile Properties • True Stress and Strain • Elastic Recovery after Plastic • Deformation • Compressive, Shear, and Torsional • Deformation • Hardness oration	
5	**Phase Diagram** • Introduction • DEFINITIONS AND BASIC CONCEPTS • Solubility Limit • Phases • Microstructure • Phase Equilibrium • One-Component (or Unary) Phase • Diagrams • Equilibrium Diagrams Having Intermediate Phases or Compounds • Eutectic and Paratactic Reactions • Transformations • The Gibbs Phase Rule • THE IRON–CARBON SYSTEM • The Iron–Iron Carbide (Fe–Fe3C) Phase Diagram • Development of Microstructure in Iron–Carbon Alloys • The Influence of Other Alloying Elements	**10**
6	**Applications and Processing of Metal Alloys** • Introduction • TYPES OF METAL ALLOYS • Ferrous Alloys • Nonferrous Alloys • FABRICATION OF METALS • Forming Operations • Miscellaneous Techniques • THERMAL PROCESSING OF METALS • Heat Treatment of Steels	**10**
		52
Textbook:	Materials Science and Engineering An Introduction, W.D. Jhon Wiley&Sons.2007	

Elective courses

Department	Chemical Engineering	Major	Chemical Production						
Course Name	Writing Skills	Course Code	KCHE 424						
Prerequisites		Credit Hours CRH	2		CTH	3			
			L	2	P	0	T	1	

CRH: **Credit Hours** L: **Lecture** P: **Practical** T: **Tutorial** CTH: **Contact Hours**

Course description :

- This course mainly is a necessary course for Environmental Studies students who are interested in energy as a possible career, and a useful elective course for engineers interested in renewable energy. This course provides an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and applications.
-

Topics:

- Introduction
- Solar Energy
- Wind Energy
- Other Renewable Systems

Experiments: If applicable, it will support the course topics.

References:

1) Godfrey Boyle, " Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.

Detailed of Theoretical Contents		
No.	**Contents**	**Hours**
1	**Overview of Technical Research and Report Writing:** • Definition and Nature of Writing Skills. • Properties of Writing Skills. • Basic Principles of Writing Skills. • Styles in Writing Skills. • The Role of Writing Skills.	**5**
2	**Information Structure/Techniques in Writing Skills:** • Formal Definition. • Mechanism Description. • Process Description. • Classification. • Cause and Effect. • Comparison and Contrast.	**6**
3	**Types of Technical Report:** • Report Layout and Format. • Proposal. • Progress Report. • Feasibility and Recommendation Study. • Laboratory and Project Report. • Instructions and Manuals. • Research Report.	**16**

4	**Writing Documentation and Abstract.**	**6**
5	**Preparing of Visuals and Presentation.**	**6**
		39
Textbook:	Pocket Book of Writing Skills for Engineers and Scientists", McGraw-Hill, 2007.	

Department	Chemical Engineering	Major	Chemical Production						
Course Name	Renewable Energy	Course Code	KCHE461						
Prerequisites		Credit Hours CRH	2		CTH	3			
			L	2	P	0	T	1	

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course description :

This course mainly is a necessary course for Environmental Studies students who are interested in energy as a possible career, and a useful elective course for engineers interested in renewable energy. This course provides an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and applications.

Topics:

- Introduction
- Solar Energy
- Wind Energy
- Other Renewable Systems

Experiments: If applicable, it will support the course topics.

References:

2) Godfrey Boyle, " Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.

Detailed of Theoretical Contents		
No.	**Contents**	**Hours**
1	**Introduction:** • Energy: Past, Today, and Future. A brief history of energy consumption. • Energy & Environment. • Non-renewable energies.	**6**
2	**Solar Energy:** • Sun and its Energy: Basics of Solar Energy. • Solar Energy in the Past. • Solar Energy Resources. • Solar Thermal Energy. • Solar Photovoltaic.	**10**
3	**Wind Energy:** • Historical Background. • Wind Resources. • Wind Turbines. • Environmental Impact.	**11**
4	**Other Renewable systems:** • Biomass. • Wave and Tidal. • Hydroelectricity. • Geothermal. • Others.	**12**

	39
Textbook:	Godfrey Boyle, " Renewable Energy, Power for a sustainable future", Oxford University Press, in association with The Open University, 2004.

Appendix Laboratory Equipment, Workshops and Laboratories

No.	Laboratory name / workshop	Capacity of training	Number of trainers	Training courses benefiting from the laboratory / workshop / lab
1	Separation Processes lab	12	12	Advanced Separation Processes - Applied Mass Transfer - project
2	Organic chemistry lab	12	12	Organic chemistry
3	Process Control lab	12	12	Process Control- project
4	Chemical Reaction lab	12	12	Chemical Reaction Engineering
5	Computer lab	12	12	Computer Chemical Process Drawing - Computational Method for Engineering Application
6	Project lab	4	4	project

List of Detailed Equipment for Each Laboratory, Workshop or Lab

Lab and Workshop's for all		
No.	**Product's Name**	**Quantity**
1.	Distillation column	1
2.	Gas Absorption column	1
3.	Chemical reactor unit (Batch Reactor,CSTR,CSTR in Series and Tubular reactor)	4
4.	Dryer	1
5.	Liquid –solid extraction	1
6.	Process Control unit	6
7.	Diffusion in Liquids &Gases unit	2
8.	Computer(Excel Program + Matlab Program)	12
9.	Glassware, balances, hot plat, hot water path, stirrer)	12
10.	Evaporator	1
11.	Ion Exchange Chromatography	2

References

Textbooks	**1.**	Richard M. Felder and Ronald W. Rousseau; "Elementary principle of chemical processes", John Wiley, 3th Edition, 2005
	2.	David M. Himmelblau; "Basic Principles and Calculations in Chemical Engineering", McGraw-Hill, 7th Edition, 2004
	3.	R. Joel, " Basic Engineering Thermodynamics ", Dorling Kindersley (India), 5th Ed, 2008.
	4.	J.M. Smith and H.C. Van Ness and M.M. Abbott, " Introduction to Chemical Engineering Thermodynamics ", McGraw-Hill, 6th Ed., 2005.
	5.	Y.A. Cengel and M.A. Boles, " Thermodynamics: An Engineering Approach ", McGraw-Hill, 25th Ed., 2006
	6.	H.ScottFogler ((Elements of Chemical Reaction Engineering)) 4th Edition, 2006
	7.	Petrochemical Process Technology, by Mall I D, Macmillan, Inc., 1st Edition, 2008
	8.	Materials Science and Engineering An Introduction, W.D. Jhon Wiley&Sons.2007
	9.	Transport Processes and Separation Process Principles , C.J. Geankoplis, Prentice , Hall, 4th Edition, 2003
	10.	Ebewele, R., '' Polymer Science and Technology", CRC Press, Florida, 2000.
	11.	Wastewater Engineering: Treatment and Reuse by George Tchobanoglous, Franklin L. Burton, and H. David Stensel, 2002
	12.	Instrumentation for Process Measurement and Control, Norman A. Anderson, 3rd Ed., CRC Press LLC, 1998.
	13.	Modern control Engineering, K. Ogata, 4th Edition, Prentice-Hall, Inc., 2002
	14.	Design of Feedback Control Systems, R. T. Stefani, B. Shahian, and G. H. Hostetter, 4th Edition, Oxford Univ. Press. Inc., 2002
	15.	Max S. Peters and Klaus D. Timmerhaus, "Plant Design and Economics for Chemical Engineers", 4th edition, McGraw – Hill, Inc., 1991.
	16.	F. C. Jelen and J. H. Black, "Cost and Optimization Engineering", 3th edition, McGraw Hill, Inc., 1992.
	17.	Douglas, J. Conceptual Design of Chemical Processes. New York, NY: McGraw-Hill Science/Engineering/Math, 1988. ISBN: 0070177627.
	18.	Seider, W. D., J. D. Seader, and D. R. Lewin. Product and Process Design Principles: Synthesis, Analysis, and Evaluation. 2nd ed. New York, NY: Wiley, 2004
	19.	Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwitz. Analysis, Synthesis, and Design of Chemical Processes, 2nd Edition, 2002
	20.	Gilat, A., "MATLAB: An introduction with Applications", 4th edition, 2010
	21.	- Lacey, R.E. and S.Loaeb - " Industrial Processing with Membranes ", Wiley –Inter Science, New York, 1972.
	22.	King, C.J. " Separation Processes ", Tata McGraw - Hill Publishing Co., Ltd., 1982.

	23.	Ronald W.Roussel - " Handbook of Separation Process Technology ", John Wiley, New York, 1987.
	24.	Kestory, R.E. - " Synthetic polymeric membrances ", Wiley, New York, 1987
	25.	Osadar, Varid Nakagawa I - " Membrance Science and Technology ", Marcel Dekkar (1992).
	26.	Seader, J. D., and Ernest J. Henley. *Separation Process Principles*. New York, NY: Wiley, 1998. ISBN: 9780471586265.
	27.	Godfrey Boyle, " Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.
	28.	29. William H. Brown , Introduction to organic chemistry, 1996 Herbert Meislich, Howard Nechamkin ,Jacob sharefkin, organic chemistry, second edition
	30.	Pocket Book of Writing Skills for Engineers and Scientists", McGraw-Hill, 2007.