Ministry of Higher Education and Scientific Research

University of Technology

Chemical Engineering Department

B.Sc. Program in Chemical Engineering

OUTLINE OF SYLLABUSES ALLOCATIDN OF SUBJECTS AND WEEKLY LOAD

(2022-2027)

Iraq- Baghdad

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1. Introduction:

1.1 Department of Chemical EngineeringHistory

Department of chemical engineering was established in 1975 after the establishment of the University of Technology directly to cover Iraq's growing need for chemical engineers on the basis of industrial development and coverage plans.

Since 1975, the University of Technology has expanded which led to expansion the chemical engineering department. This expansion included the development of the curriculum and establishment of specialized programs of undergraduate studies as well as the accumulated experience of the department has been invested to expand the postgraduate programs of the Diploma, Masters, PhD and increasing the number of students in these programs. The first batch of the students in specialty chemical engineering was graduated in 1979 at a rate of 100 engineers per year in the country.

The department currently offers three programs specialization that are constructed by careful of technical courses to provide specialized knowledge,

1. **Chemical Processing Engineering**
2. **Chemical and Petroleum Refinery Engineering**
3. **Chemical Engineering and Oil Pollution**

1.2 Program Educational Objective:

The undergraduate programs in chemical engineering at the university of technology has a strong focus on the integration of engineering science and process design with complementary areas of study in bioprocess engineering, environmental engineering, fuels and energy, materials and oil and gas refining engineering. Undergraduate are prepared for life-long opportunities to participate in diverse sectors of the economy and to assume leadership roles throughout their professional careers.

The graduates of the **Chemical Engineering Programs** are expected to :-

- **a.** To prepared engineers with basic scientific and chemical knowledge.
- **b.** To give the graduates the ability to design the factories which are related to the chemical, petroleum, petrochemical and food industry.
- **c.** To prepare graduates able on operation and management of the chemical factories through concentrating on the theoretical and practical side.
- **d.** To enrich the learning process with the high studies curriculum and the applied scientific researches, also stressing on its role to serve the society and solving its problems.

The educational program of Chemical Processing Engineering are to produce graduate who:-

1- Able to engage engineering theories with chemical engineering practice to design and analyze process problems taking into account environmental impacts and safety.
2- Effective communication team work and Successful leadership in chemical engineers related careers (industries, water treatment, catalytic reactor).
3- Maintain a lifelong interest in learning for personal and professional developments.

The educational program of Chemical and Petroleum Refinery Engineering are to produce graduate who:-

1- Achievea successful graduated with a broad knowledge in refinery,petrochemicals , gas industries and other related processes.
2- Integrate academic preparation with Chemical and Petroleum Refinery Engineering technology developments
3- Work effectively in a team environment and well communicate with other professional collages

The educational program of Chemical Engineering and Oil Pollutionare to produce graduate who:-

1. Practice environmental engineering science in a manner that is ethically responsible and consistent with regulatory and social concerns.
2. Have a broad knowledge and critical thinking skills required to analyze industrial and petroleum pollution problems taking into account, safety, and societal impact.
3. Be exposed to current and emerging technologies and have the ability to pursue life-long learning through continuing education or post-graduate education.

1.4Iraqi Program Education (IPE):

A program outcome is a skill, understanding, knowledge, or any other characteristic that describes what students are expected to know and are able to do bythe time of graduation as well as during their professional career.

The student outcomes for the Chemical Processing Engineering Program , Chemical and Petroleum Refinery EngineeringProgram and Chemical Engineering and Oil PollutionProgramat the department of chemical engineering - University of technology are encompass all of the IPE Criterion outcomes (1-7):-

1. An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.

2. An ability to apply the engineering design process to produce solution that meet specified needs with consideration for public health and safety, and global, cultural, social, environmental, economic, and other factors as appropriate to the discipline.
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
4. An ability to communicate effectively with a range of audiences.
5. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solution in global, economic, environmental, and societal contexts.
6. An ability to recognize the ongoing need to acquire new knowledge, to choose appropriate learning strategies, and to apply this knowledge.
7. An ability to function effectively as a member or leader of a team that establishes goals, plans tasks, meets deadlines, and creates a collaborative teams and inclusive environment.

1.5Programs Curriculum

The curriculum for the **Chemical Engineeringprograms**have been designed by the faculty to produce a graduate broadly acquainted with tools and principles that would be used in the engineering field. While designed to develop the essential knowledge, skills, and abilities needed for professional practice or graduate study.

Also, the curriculum is designed that students may acquire the abilities and skills to be productive in the workplace upon graduation. With several additional years of relevant work experience, our graduates are capable of demonstrating that the program educational objectives have been met. The curriculum and its associated prerequisite structure support the attainment of the student outcomes.

1.5.1.Course Description

The **Chemical Engineering** programs curriculum have been deliberately designed in main three categories of courses:

1.**General Engineering (Engineering Science and Engineering Design)**: These courses are common to most undergraduate engineering students and instruct students in general engineering methods. They provide the introduction to engineering fundamentals and complement the mathematics and basic sciences that precede or are taken concurrently with these courses. The general engineering courses rapidly establish the context of the mathematics and basic sciences that students must take, but have trouble appreciating.

2. **Basic Mathematics and Science**: Students in the undergraduate program are required to complete extensive coursework in MathematicsI, Mathematics II, ChemistryI,

Chemistry II, Physics, Computer Science , Mathematics III, Mathematics IV, Physical Chemistry I, Physical Chemistry II, Statistics, Numerical Analysis, and Optimization.

3. **General Education**: These are largely university requirements, but also support engineering student outcomes. These courses provide the student with the knowledge and skills required to appreciate the global perspective of engineering and to be prepared in technical communications. They also include courses to broaden the horizons of the student and provide opportunities for service learning.

The courses that comprise the topic requirements are listed in Table (1.1, 1.2,1.3).

The CodeCredit"units" are arrangedas the theory 1 hour per semester = 1 Credit, practical 2-3 hours per semester = 1 Credit, and the tutorial hoursCredit = 0. Prerequisites, if any, are indicated at the course description. These have been established to assure an adequate and uniform background for students in advanced classes.

Course code is presented according to three requirements:

1- University Requirement
2- Engineering College Requirement
3- Department or ProgramRequirement

Course code started by capital letters **CES** then latter represent the programandfollowed bynumber of 3-digits as following:

1st digit represents the class number
2nd digit represents the courserequirement
3rd digit represents the course number

The code for three programs
CES.P…. Chemical Processing Engineering
CES.R…. Chemical and Petroleum Refinery Engineering
CES.E…. Chemical Engineering and Oil Pollution

Example: -

CES.P.223	Computer Programming, I	1st digit represents the 2ndclass, 2nd digit represents collagerequirement, 3rd digit represents the course number
CES.P.431	Unit Operations II	1st digit represents the 4edclass, 2nd digit represents program requirement, 3rd digit represents the course number

Table (1.1) Courses Comprising the Topic Requirements for **Chemical Processing Engineering**

Categories	Subject	L	P	T	Crds	Total Crds
General Education(Humanities and Social Sciences)	Technical English I	2	0	0	2	6
	Technical English II	2	0	0	2	
	Human Rights & Democracy	2	0	0	2	
Math & Basic Sciences	Mathematics I	2	0	1	2	30
	Mathematics II	2	0	1	2	
	Chemistry I	2	2	0	3	
	ChemistryII	2	2	0	3	
	Physics	2	0	1	2	
	Computer Science	1	2	0	2	
	Mathematics III	2	0	1	2	
	Mathematics IV	2	0	1	2	
	Physical Chemistry I	2	2	0	3	
	Physical Chemistry II	2	0	0	2	
	Statistics	2	0	1	2	
	Numerical Analysis	2	2	1	3	
	Optimization	2	0	1	2	
Engineering	Engineering Drawing	1	2	0	2	94
	Engineering Mechanics &Strength of Materials	2	0	1	2	
	AutoCAD	1	2	0	2	
	Computer Programming I	1	2	1	2	
	Computer Programming II	1	2	1	2	
	Materials Eng. I	2	0	1	2	
	Materials Eng. II	2	2	1	3	
	Chemical Engineering Principles I	3	0	1	3	
	Chemical Eng. Principle II	2	0	1	2	
	Chemical Eng. Principles III	2	0	1	2	
	Fluid FlowI	2	2	1	3	
	Fluid FlowII	2	2	1	3	
	Fuel's & Energy Eng.	2	2	0	3	
	Thermodynamics I	2	0	1	2	
	Thermodynamics I I	2	2	1	3	
	Applied Mathematics in chemical Engineering	2	0	1	2	
	Mass Transfer	2	2	1	3	
	Unit Operation I	3	0	1	3	
	Heat Transfer I	2	0	1	2	
	Heat Transfer II	2	2	1	3	
	Chemical Reaction Kinetics	2	0	1	2	
	Reactor Design	2	0	1	2	
	Equipment Design	2	0	1	2	
	Equipment Design Using CAD	2	2	1	3	
	Environment Eng. & Industrial Safety	2	0	1	2	
	Particles& Nanotechnology	2	0	0	2	
	Bio Chemical Engineering	2	0	0	2	
	Project I	1	2	0	2	
	Project II	1	2	0	2	
	Unit Operations II	2	2	1	3	
	Unit Operations III	3	0	1	3	
	Process dynamics	2	0	1	2	
	Heterogeneous Reactor &Catalysis	2	0	1	2	
	Process Control	2	2	1	3	
	Petroleum Refinery Processing	2	0	1	2	
	Petrochemical Industries	2	0	1	2	
	Industrial Management and Ethics	2	0	1	2	
	Corrosion Eng.	2	0	0	2	
	Chemical Process IndustriesI	2	3	0	3	
	Chemical Process Industries II	2	0	0	2	
	Workshop I	0	6	0	-	
	WorkshopII	0	6	0	-	
						130

Table (1.2) Courses Comprising the Topic Requirements for Chemical and Petroleum Refinery Engineering

Categories	Subject	L	P	T	Crds	Total Crds
General Education(Humanities and Social Sciences)	Technical English I	2	0	0	2	6
	Technical English II	2	0	0	2	
	Human Rights & Democracy	2	0	0	2	
Math & Basic Sciences	Mathematics I	2	0	1	2	30
	Mathematics II	2	0	1	2	
	Chemistry	2	2	0	3	
	Chemistryof Petroleum	2	2	1	3	
	Physics	2	0	0	2	
	Computer Science	1	2	0	2	
	Mathematics III	2	0	1	2	
	Mathematics IV	2	0	1	2	
	Physical Chemistry I	2	2	0	3	
	Physical Chemistry II	2	0	0	2	
	Statistics	2	0	1	2	
	Numerical Analysis	2	2	1	3	
	Optimization	2	0	1	2	
Engineering	Engineering Drawing	1	2	0	2	94
	Engineering Mechanics &Strength of Materials	2	0	1	2	
	AutoCAD	1	2	0	2	
	Computer Programming I	1	2	1	2	
	Computer Programming II	1	2	1	2	
	Materials Eng. I	2	0	1	2	
	Materials Eng. II	2	2	1	3	
	Chemical Engineering Principles I	3	0	1	3	
	Chemical Eng. Principle II	2	0	1	2	
	Chemical Eng. Principles III	2	0	1	2	
	Fluid FlowI	2	2	1	3	
	Fluid FlowII	2	2	1	3	
	Fuels Technology	2	2	0	3	
	Thermodynamics I	2	0	1	2	
	Thermodynamics I I	2	2	1	3	
	Applied Mathematics in chemical Engineering	2	0	1	2	
	Mass Transfer	2	2	1	3	
	Unit Operation I	3	0	1	3	
	Heat Transfer I	2	0	1	2	
	Heat Transfer II	2	2	1	3	
	Chemical Reaction Kinetics	2	0	1	2	
	Reactor Design	2	0	1	2	
	Equipment Design	2	0	1	2	
	Equipment Design Using CAD	2	2	1	3	
	Petroleum and Gas FieldProcessing	2	0	0	2	
	Combustion	2	0	0	2	
	Chemicals from petroleum	2	0	1	2	
	Project I	1	2	0	2	
	Project II	1	2	0	2	
	Unit Operations II	2	2	1	3	
	Unit Operations III	3	0	1	3	
	Process dynamics	2	0	1	2	
	Heterogeneous Reactor &Catalysis	2	0	1	2	
	Process Control	2	2	1	3	
	Environment Pollution & Safety in Petroleum Refineries	2	0	1	2	
	Petroleum Refinery Economics	2	0	0	2	
	Corrosion Eng.In PetroleumRefinery	2	0	0	2	
	Refinery Management and Ethics	2	0	1	2	
	Petroleum Refinery Eng. I	2	2	1	3	
	Petroleum Refinery Eng. II	2	0	1	2	
	Workshop I	0	6	0	-	
	Workshop I I	0	6	0	-	
						130

Table (1.3) Courses Comprising the Topic Requirements for Chemical Engineering and Oil Pollution

Categories	Subject	L	P	T	Crds	Total Crds
General Education(Humanities and Social Sciences)	Technical English I	2	0	0	2	6
	Technical English II	2	0	0	2	
	Human Rights & Democracy	2	0	0	2	
Math & Basic Sciences	Mathematics I	2	0	1	2	30
	Mathematics II	2	0	1	2	
	Chemistry	2	2	0	3	
	Bio-Chemistry	2	2	0	3	
	Physicsfor Environmental Engineering	2	0	1	2	
	Computer Science	1	2	0	2	
	Mathematics III	2	0	1	2	
	Mathematics IV	2	0	1	2	
	Physical Chemistry I	2	2	0	3	
	Physical Chemistry II	2	0	0	2	
	Statistics	2	0	1	2	
	Numerical Analysis	2	2	1	3	
	Optimization	2	0	1	2	
Engineering	Engineering Drawing	1	2	0	2	94
	Engineering Mechanics &Strength of Materials	2	0	1	2	
	AutoCAD	1	2	0	2	
	Computer Programming I	1	2	1	2	
	Computer Programming II	1	2	1	2	
	Materials Eng.	2	2	1	3	
	Chemical Engineering Principles I	3	0	1	3	
	Chemical Eng. Principle II	2	0	1	2	
	Chemical Eng. Principles III	2	0	1	2	
	Fluid FlowI	2	2	1	3	
	Fluid FlowII	2	2	1	3	
	Fuel's and Clean Eng.	2	2	0	3	
	Thermodynamics I	2	0	1	2	
	Thermodynamics I I	2	2	1	3	
	Applied Mathematics in chemical Engineering	2	0	1	2	
	Mass Transfer	2	2	1	3	
	Unit Operation I	3	0	1	3	
	Heat Transfer I	2	0	1	2	
	Heat Transfer II	2	2	1	3	
	Chemical Reaction Kinetics	2	0	1	2	
	Biochemical Reactor Design	2	0	1	2	
	Equipment Design	2	0	1	2	
	Equipment Designin Environmental Engineering Using CAD	2	2	1	3	
	Principles of Sustainability	2	0	1	2	
	Air Pollution Control Engineering	2	0	1	2	
	Solid Waste Treatment	2	0	0	2	
	Project I	1	2	0	2	
	Project II	1	2	0	2	
	Unit Operations II	2	2	1	3	
	Unit Operations III	3	0	1	3	
	Process dynamics	2	0	1	2	
	Catalysis and Catalytic Eng.	2	0	1	2	
	Process Control	2	2	1	3	
	Industrial & Petroleum Pollution Control	2	0	1	2	
	Industrial Safety	2	0	0	2	
	Petroleum Refinery Processing	2	0	1	2	
	Corrosion and degradation	2	0	0	2	
	Environmental EngineeringManagement and Ethics	2	0	1	2	
	Water and Wastewater Treatment Engineering I	2	2	1	3	
	Water and Wastewater Treatment Engineering II	2	0	0	2	
	Workshop I	0	6	0	-	
	Workshop I I	0	6	0	-	
						130

1.5.2.Graduation Requirements: for Chemical Processing Engineering

1-University Requirement						
No.	Code Course	Subject	L	P	T	Credits
1	CES.P.111	Technical EnglishI	2	0	0	2
2	CES.P.112	Technical English II	2	0	0	2
3	CES.P.113	Computer Science	1	2	0	2
4	CES.P.114	Workshop I	0	6	0	-
5	CES.P.115	Workshop II	0	6	0	-
6	CES.P.116	Human Rights& Democracy	2	0	0	2

2-Collage Requirement						
No.	Code Course	Subject	L	P	T	Credits
1	CES.P.121	Mathematics I	2	0	1	2
2	CES.P.122	Mathematics II	2	0	1	2
3	CES.P.123	Chemistry I	2	2	0	3
4	CES.P.124	Chemistry II	2	2	0	3
5	CES.P.125	Physics	2	0	1	2
6	CES.P.126	Engineering Drawing	1	2	0	2
7	CES.P.127	AutoCAD	1	2	0	2
8	CES.P.128	Engineering Mechanics &Strength of Materials	2	0	1	2
9	CES.P.221	Mathematics III	2	0	1	2
10	CES.P.222	Mathematics IV	2	0	1	2
11	CES.P.223	Computer Programming I	1	2	1	2
12	CES.P.224	Computer Programming II	1	2	1	2
13	CES.P.225	Materials Eng. I	2	0	1	2
14	CES.P.226	Materials Eng. II	2	2	1	3
15	CES.P.227	Statistics	2	0	1	2
16	CES.P.321	Numerical Analysis	2	2	1	3
17	CES.P.322	Applied Mathematics in chemical Engineering	2	0	1	2
18	CES.P.421	Project I	1	2	0	2
19	CES.P.422	Project II	1	2	0	2
20	CES.P.423	Industrial Management &Ethics	2	0	1	2
21	CES.P.424	Optimization	2	0	1	2

3-Program Requirement						
No.	Code Course	Subject	L	P	T	Credits
1	CES.P.131	Chemical Engineering Principles I	3	0	1	3
2	CES.P.231	Chemical Engineering Principles II	2	0	1	2
3	CES.P.232	Chemical Engineering Principle III	2	0	1	2
4	CES.P.233	Fluid FlowI	2	2	1	3
5	CES.P.234	Fluid FlowII	2	2	1	3
6	CES.P.235	Physical Chemistry I	2	2	0	3
7	CES.P.236	Physical Chemistry II	2	0	0	2
8	CES.P.237	Fuel's & Energy Eng.	2	2	0	3
9	CES.P.331	Thermodynamics I	2	0	1	2
10	CES.P.332	Thermodynamics II	2	2	1	3
11	CES.P.333	Mass Transfer	2	2	1	3
12	CES.P.334	Unit Operation I	3	0	1	3
13	CES.P.335	Chemical Reaction Kinetics	2	0	1	2
14	CES.P.336	Reactor Design	2	0	1	2
15	CES.P.337	Heat Transfer I	2	0	1	2
16	CES.P.338	Heat TransferII	2	2	1	3
17	CES.P.339	Environment Eng. & Industrial Safety	2	0	1	2
18	CES.P.3310	Bio Chemical Engineering	2	0	0	2
19	CES.P.3311	Equipment Design	2	0	1	2
20	CES.P.3312	Equipment Design using CAD	2	2	1	3
21	CES.P.3313	Particles& Nanotechnology	2	0	0	2
22	CES.P.431	Unit Operation II	2	2	1	3
23	CES.P.432	Unit Operation III	3	0	1	3
24	CES.P.433	Process Dynamics	2	0	1	2
25	CES.P.434	Process Control	2	2	1	3
26	CES.P.435	Petroleum Refinery Processing	2	0	1	2
27	CES.P.436	Heterogeneous Reactor &Catalysis	2	0	1	2
28	CES.P.437	Chemical Process Industries I	2	3	0	3
29	CES.P.438	Chemical Process Industries II	2	0	0	2
30	CES.P.439	Corrosion Eng.	2	0	0	2
31	CES.P.4310	Petrochemical Industries	2	0	1	2

1.5.3.Graduation Requirements: for Chemical and Petroleum Refinery Engineering

1-University Requirement						
No.	Code Course	Subject	L	P	T	Credits
1	CES.R.111	Technical EnglishI	2	0	0	2
2	CES.R.112	Technical English II	2	0	0	2
3	CES.R.113	Computer Science	1	2	0	2
4	CES.R.114	Workshop I	0	6	0	-
5	CES.R.115	Workshop II	0	6	0	-
6	CES.R.116	Human Rights& Democracy	2	0	0	2

2- Collage Requirement						
No.	Code Course	Subject	L	P	T	Credits
1	CES.R.121	Mathematics I	2	0	1	2
2	CES.R.122	Mathematics II	2	0	1	2
3	CES.R.123	Chemistry	2	2	0	3
4	CES.R.124	Chemistry of Petroleum	2	2	0	3
5	CES.R.125	Physics	2	0	1	2
6	CES.R.126	Engineering Drawing	1	2	0	2
7	CES.R.127	AutoCAD	1	2	0	2
8	CES.R.128	Engineering Mechanics &Strength of Materials	2	0	1	2
9	CES.R.221	Mathematics III	2	0	1	2
10	CES.R.222	Mathematics IV	2	0	1	2
11	CES.R.223	Computer Programming I	1	2	1	2
12	CES.R.224	Computer Programming II	1	2	1	2
13	CES.R.225	Materials Eng. I	2	0	1	2
14	CES.R.226	Materials Eng. II	2	2	1	3
15	CES.R.227	Statistics	2	0	1	2
16	CES.R.321	Numerical Analysis	2	2	1	3
17	CES.R.322	Applied Mathematics in chemical Engineering	2	0	1	2
18	CES.R.421	Project I	1	2	0	2
19	CES.R.422	Project II	1	2	0	2
20	CES.R.423	Refinery Management &Ethics	2	0	1	2
21	CES.R.424	Optimization	2	0	1	2

3-Program Requirement						
No.	Code Course	Subject	L	P	T	Credits
1	CES.R.131	Chemical Engineering Principles I	3	0	1	3
2	CES.R.231	Chemical Engineering Principles II	2	0	1	2
3	CES.R.232	Chemical Engineering Principle III	2	0	1	2
4	CES.R.233	Fluid FlowI	2	2	1	3
5	CES.R.234	Fluid FlowII	2	2	1	3
6	CES.R.235	Physical Chemistry I	2	2	0	3
7	CES.R.236	Physical Chemistry II	2	0	0	2
8	CES.R.237	Fuel's Technology	2	2	0	3
9	CES.R.331	Thermodynamics I	2	0	1	2
10	CES.R.332	Thermodynamics II	2	2	1	3
11	CES.R.333	Mass Transfer	2	2	1	3
12	CES.R.334	Unit Operation I	2	2	1	3
13	CES.R.335	Chemical Reaction Kinetics	2	0	1	2
14	CES.R.336	Reactor Design	2	0	1	2
15	CES.R.337	Heat Transfer I	2	0	1	2
16	CES.R.338	Heat Transfer II	2	2	1	3
17	CES.R.339	Combustion	2	0	0	2
18	CES.R.3310	Chemicals from Petroleum	2	0	1	2
19	CES.R.3311	Equipment Design	2	0	1	2
20	CES.R.3312	Equipment Design using CAD	2	2	1	3
21	CES.R.3313	Petroleum and Gas Field Processing	2	0	0	2
22	CES.R.431	Unit Operation II	2	2	1	3
23	CES.R.432	Unit Operation III	3	0	1	3
24	CES.R.433	Process Dynamics	2	0	1	2
25	CES.R.434	Process Control	2	2	1	3
26	CES.R.435	Petroleum Refinery Eng. I	2	2	1	3
27	CES.R.436	Petroleum Refinery Eng. II	2	0	1	2
28	CES.R.437	Heterogeneous Reactor &Catalysis	2	0	1	2
29	CES.R.438	Enviromental Pollution and Safty in Petroleum Refinery	2	0	1	2
30	CES.R.439	Corrosion Eng. In Petroleum Refinery	2	0	0	2
31	CES.R.4310	Petroleum Refinery Economics	2	0	0	2

1.5.4.Graduation Requirements: for **Chemical Engineering and Oil Pollution**

1-University Requirement						
No.	Code Course	Subject	L	P	T	Credits
1	CES.E.111	Technical English I	2	0	0	2
2	CES.E.112	Technical English II	2	0	0	2
3	CES.E.113	Computer Science	1	2	0	2
4	CES.E.114	Workshop I	0	6	0	-
5	CES.E.115	Workshop II	0	6	0	-
6	CES.E.116	Human Rights& Democracy	2	0	0	2

2- Collage Requirement						
No.	Code Course	Subject	L	P	T	Credits
1	CES.E.121	Mathematics Ⅰ	2	0	1	2
2	CES.E.122	Mathematics II	2	0	1	2
3	CES.E.123	Chemistry	2	2	0	3
4	CES.E.124	Bio-Chemistry	2	2	0	3
5	CES.E.125	Physics for Enviromental Engineering	2	0	1	2
6	CES.E.126	Engineering Drawing	1	2	0	2
7	CES.E.127	AutoCAD	1	2	0	2
8	CES.E.128	Engineering Mechanics &Strength of Materials	2	0	1	2
9	CES.E.221	Mathematics III	2	0	1	2
10	CES.E.222	Mathematics IV	2	0	1	2
11	CES.E.223	Computer Programming I	1	2	1	2
12	CES.E.224	Computer Programming II	1	2	1	2
13	CES.E.225	Materials Eng.	2	2	1	3
14	CES.E.226	Statistics	2	0	1	2
15	CES.E.321	Numerical Analysis	2	2	1	3
16	CES.E.322	Applied Mathematics in chemical Engineering	2	0	1	2
17	CES.E.421	Project I	1	2	0	2
18	CES.E.422	Project II	1	2	0	2
19	CES.E.423	Enviromental Engineering Management &Ethics	2	0	1	2
20	CES.E.424	Optimization	2	0	1	2

3-Program Requirement						
No.	Code Course	Subject	L	P	T	Credits
1	CES.E.131	Chemical Engineering Principles I	3	0	1	3
2	CES.E.231	Chemical Engineering Principles II	2	0	1	2
3	CES.E.232	Chemical Engineering Principle III	2	0	1	2
4	CES.E.233	Fluid FlowI	2	2	1	3
5	CES.E.234	Fluid FlowII	2	2	1	3
6	CES.E.235	Physical Chemistry I	2	2	0	3
7	CES.E.236	Physical Chemistry II	2	0	0	2
8	CES.E.237	Priciples of Sustainability	2	0	1	2
9	CES.E.238	Fuel's and Clean Engineering	2	2	0	3
10	CES.E.331	Thermodynamics I	2	0	1	2
11	CES.E.332	Thermodynamics II	2	2	1	3
12	CES.E.333	Mass Transfer	2	2	1	3
13	CES.E.334	Unit Operation I	3	0	1	3
14	CES.E.335	Chemical Reaction Kinetics	2	0	1	2
15	CES.E.336	Biochemical Reactor Design	2	0	1	2
16	CES.E.337	Heat Transfer I	2	0	1	2
17	CES.E.338	Heat Transfer II	2	2	1	3
18	CES.E.339	Air Pollution Contorl Engineering	2	0	1	2
19	CES.E.3310	Industrial Safty	2	0	0	2
20	CES.E.3311	Equipment Design	2	0	1	2
21	CES.E.3312	Equipment Design using CAD	2	2	1	3
22	CES.E.3313	Solid Waste Treatment	2	0	0	2
23	CES.E.431	Unit Operation II	2	2	1	3
24	CES.E.432	Unit Operation III	3	0	1	3
25	CES.E.433	Process Dynamics	2	0	1	2
26	CES.E.434	Process Control	2	2	1	3
27	CES.E.435	Water and Wastewater Treatment Engineering I	2	2	1	3
28	CES.E.436	Water and Wastewater Treatment Engineering II	2	0	1	2
29	CES.E.437	Industrail and Petroleum Pollution Control	2	0	1	2
30	CES.E.438	Catalyis and Catalysit Eng.	2	0	1	2
31	CES.E.439	Petroleum Refinery Processing	2	0	0	2
32	CES.E.4310	Corrosion and Degradation	2	0	0	2

First Year

Chemical Processing Engineering

No.	First Semester					
	Code Course	Subject	L	P	T	Credits
1	CES.P.111	Technical English I	2	0	0	2
2	CES.P.121	Mathematics I	2	0	1	2
3	CES.P.123	Chemistry I	2	2	0	3
4	CES.P.125	Physics	2	0	1	2
5	CES.P.126	Engineering Drawing	1	2	0	2
6	CES.P.113	Computer Science	1	2	0	2
7	CES.P.114	Workshop I	0	6	0	-
		Total	10	12	2	**13**
		Hours/week		**24**		

No.	Second Semester					
	Code Course	Subject	L	P	T	Credits
1	CES.P.112	Technical EnglishII	2	0	0	2
2	CES.P.122	Mathematics II	2	0	1	2
3	CES.P.131	Chemical Engineering Principles I	3	0	1	3
4	CES.P.124	Chemistry II	2	2	0	3
5	CES.P.127	AutoCAD	1	2	0	2
6	CES.P.128	Engineering Mechanics & Strength of Materials	2	0	1	2
7	CES.P.115	Workshop II	0	6	0	-
8	CES.P.116	Human Rights & Democracy	2	0	0	2
		Total	14	10	3	16
		Hours/week		**27**		

Second Year

Chemical Processing Engineering

No.	First Semester					
	Code Course	Subject	L	P	T	Credits
1	CES.P.221	Mathematics III	2	0	1	2
2	CES.P.231	Chemical Eng. Principles II	2	0	1	2
3	CES.P.233	Fluid Flow I	2	2	1	3
4	CES.P.235	Physical Chemistry I	2	2	0	3
5	CES.P.223	Computer Programming I	1	2	1	2
6	CES.P.225	Materials Eng. I	2	0	1	2
7	CES.P.237	Fuel's & Energy Eng.	2	2	0	3
		Total	13	8	5	17
		Hours/week		26		

Second Semester						
No.	Code Course	Subject	L	P	T	Credits
1	CES.P.222	Mathematics IV	2	0	1	2
2	CES.P.232	Chemical Eng. Principles III	2	0	1	2
3	CES.P.234	Fluid Flow II	2	2	1	3
4	CES.P.236	Physical Chemistry II	2	0	0	2
5	CES.P.224	Computer Programming II	1	2	1	2
6	CES.P.226	Materials Eng. II	2	2	1	3
7	CES.P.227	Statistics	2	0	1	2
		Total	13	6	6	16
		Hours/week		**25**		

Third Year

Chemical Processing Engineering

	First Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.P.331	Thermodynamics I	2	0	1	2
2	CES.P.321	Numerical Analysis	2	2	1	3
3	CES.P.333	Mass Transfer	2	2	1	3
4	CES.P.335	Chemical Reaction Kinetics	2	0	1	2
5	CES.P.337	Heat Transfer I	2	0	1	2
6	CES.P.339	Environment Eng. & Industrial Safety	2	0	1	2
7	CES.P.3310	Bio Chemical Engineering	2	0	0	2
8	CES.P.3311	Equipment Design	2	0	1	2
		Total	16	4	7	**18**
		Hours/week		**27**		

	Second Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.P.332	Thermodynamics II	2	**2**	1	3
2	CES.P.322	Applied Mathematics in Chemical Engineering	2	0	1	2
3	CES.P.334	Unit Operation I	3	0	1	3
4	CES.P.336	Reactor Design	2	0	1	2
5	CES.P.338	Heat Transfer II	2	2	1	3
6	CES.P.3312	Equipment Design Using CAD	2	2	1	3
7	CES.P.3313	Particles& Nanotechnology	2	0	0	2
		Total	15	6	6	18
		Hours/week		**27**		

Fourth Year

Chemical Processing Engineering

	First Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.P.421	Project I	1	2	0	2
2	CES.P.431	Unit Operations II	2	2	1	3
3	CES.P.433	Process Dynamics	2	0	1	2
4	CES.P.435	Petroleum Refinery Processing	2	0	1	2
5	CES.P.436	Heterogeneous Reactor &Catalyst	2	0	1	2
6	CES.P.423	Industrial Management &Ethics	2	0	1	2
7	CES.P.437	Chemical Process Industries I	2	3	0	3
		Total	13	7	5	**16**
		Hours/week		**25**		

	Second Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.P.422	Project II	1	2	0	2
2	CES.P.432	Unit Operations III	3	0	1	3
3	CES.P.434	Process Control	2	2	1	3
4	CES.P.438	Chemical Process Industries II	2	0	0	2
5	CES.P.424	Optimization	2	0	1	2
6	CES.P.439	Corrosion Eng.	2	0	0	2
7	CES.P.4310	Petrochemical Industries	2	0	1	2
		Total	14	4	4	16
		Hours/week		**22**		

First Year

Chemical and Petroleum Refinery Engineering

	First Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.R.111	Technical English I	2	0	0	2
2	CES.R.121	Mathematics I	2	0	1	2
3	CES.R.123	Chemistry	2	2	0	3
4	CES.R.125	Physics	2	0	1	2
5	CES.R.126	Engineering Drawing	1	2	0	2
6	CES.R.113	Computer Science	1	2	0	2
7	CES.R.114	Workshop I	0	6	0	-
		Total	10	12	2	13
		Hours/week		**24**		

	Second Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.R.112	Technical English II	2	0	0	2
2	CES.R.122	Mathematics II	2	0	1	2
3	CES.R.131	Chemical Engineering PrinciplesI	3	0	1	3
4	CES.R.124	Chemistry of Petroleum	2	2	0	3
5	CES.R.127	AutoCAD	1	2	0	2
6	CES.R.128	Engineering Mechanics &Strength of Materials	2	0	1	2
7	CES.R.115	Workshop II	0	6	0	-
8	CES.R.116	Human Rights & Democracy	2	0	0	2
		Total	14	10	3	16
		Hours/week		**27**		

Second Year
Chemical and Petroleum Refinery Engineering

	First Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.R.221	Mathematics III	2	0	1	2
2	CES.R.231	Chemical Eng. Principles. II	2	0	1	2
3	CES.R.233	Fluid Flow I	2	2	1	3
4	CES.R.235	Physical Chemistry I	2	2	0	3
5	CES.R.223	Computer Programming I	1	2	1	2
6	CES.R.225	Materials Eng. I	2	0	1	2
7	CES.R.237	Fuels Technology	2	2	0	3
8		**Total**	13	8	5	17
		Hours/week	**26**			

Second Semester						
No.	Code Course	Subject	L	P	T	Credits
1	CES.R.222	Mathematics IV	2	0	1	2
2	CES.R.232	Chemical Eng. Principles III	2	0	1	2
3	CES.R.234	Fluid Flow II	2	2	1	3
4	CES.R.236	Physical Chemistry II	2	0	0	2
5	CES.R.224	Computer Programming II	1	2	1	2
6	CES.R.226	Materials Eng. II	2	2	1	3
7	CES.R.227	Statistics	2	0	1	2
		Total	13	6	6	16
		Hours/week	**25**			

Third Year

Chemical and Petroleum Refinery Engineering

	First Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.R.331	Thermodynamics I	2	0	1	2
2	CES.R.321	Numerical Analysis	2	2	1	3
3	CES.R.333	Mass Transfer	2	2	1	3
4	CES.R.335	Chemical Reaction Kinetics	2	0	1	2
5	CES.R.337	Heat Transfer I	2	0	1	2
6	CES.R.339	Combustion	2	0	0	2
7	CES.R.3310	Chemicals from Petroleum	2	0	1	2
8	CES.R.3311	Equipment Design	2	0	1	2
		Total	16	4	7	**18**
		Hours/week		**27**		

	Second Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.R.332	Thermodynamics II	2	2	1	3
2	CES.R.322	Applied Mathematics in Chemical Engineering	2	0	1	2
3	CES.R.334	Unit Operation I	3	0	1	3
4	CES.R.336	Reactor Design	2	0	1	2
5	CES.R.338	Heat Transfer II	2	2	1	3
6	CES.R.3312	Equipment Design Using CAD	2	2	1	3
7	CES.R.3313	Petroleum and Gas Field Processing	2	0	0	2
		Total	15	6	6	18
		Hours/week		**27**		

Fourth Year

Chemical and Petroleum Refinery Engineering

	First Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.R.421	Project I	1	2	0	2
2	CES.R.431	Unit Operations II	2	2	1	3
3	CES.R.433	Process Dynamics	2	0	1	2
4	CES.R.435	Petroleum Refinery Eng. I	2	2	1	3
5	CES.R.423	Refinery Management & Ethics	2	0	1	2
6	CES.R.437	Heterogeneous Reactor &Catalyst	2	0	1	2
7	CES.R.438	Environment Pollution & Safety in Petroleum Refineries	2	0	1	2
		Total	13	6	6	**16**
		Hours/week		**25**		

	Second Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.R.422	Project II	1	2	0	2
2	CES.R.432	Unit Operations III	3	0	1	3
3	CES.R.434	Process Control	2	2	1	3
4	CES.R.436	Petroleum Refinery Eng. II	2	0	1	2
5	CES.R.424	Optimization	2	0	1	2
6	CES.R.439	Corrosion Eng. In Petroleum Refinery	2	0	0	2
7	CES.R.4310	Petroleum Refinery Economics	2	0	0	2
		Total	14	4	4	16
		Hours/week		**22**		

First Year

Chemical Engineering and Oil Pollution

	First Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.E.111	Technical English **I**	2	0	0	2
2	CES.E.121	Mathematics **I**	2	0	1	2
3	CES.E.123	Chemistry	2	2	0	3
4	CES.E.125	Physics for Environmental Engineering	2	0	1	2
5	CES.E.126	Engineering Drawing	1	2	0	2
6	CES.E.113	Computer Science	1	2	0	2
7	CES.E.114	Workshop **I**	0	6	0	-
		Total	10	12	2	13
		Hours/week	**24**			

Second Semester						
No.	Code Course	Subject	L	P	T	Credits
1	CES.E.112	Technical English **II**	2	0	0	2
2	CES.E.122	Mathematics **II**	2	0	1	2
3	CES.E.131	Chemical Engineering Principles **I**	3	0	1	3
4	CES.E.124	Bio-Chemistry	2	2	0	3
5	CES.E.127	AutoCAD	1	2	0	2
6	CES.E.128	Engineering Mechanics &Strength of Materials	2	0	1	2
7	CES.E.115	Workshop **II**	0	6	0	-
8	CES.E.116	Human Rights & Democracy	2	0	0	2
		Total	14	10	3	16
		Hours/week	**27**			

Second Year

Chemical Engineering and Oil Pollution

	First Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.E.221	Mathematics III	2	0	1	2
2	CES.E.231	Chemical Eng. Principles II	2	0	1	2
3	CES.E.233	Fluid FlowI	2	2	1	3
4	CES.E.235	Physical Chemistry I	2	2	0	3
5	CES.E.223	Computer Programming I	1	2	1	2
6	CES.E.237	Princibles and Sustainability	2	0	1	2
7	CES.E.238	Fuel's and Clean Eng.	2	2	0	3
		Total	13	8	5	17
		Hours/week	**26**			

	Second Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.E.222	Mathematics IV	2	0	1	2
2	CES.E.232	Chemical Eng. Principles III	2	0	1	2
3	CES.E.234	Fluid Flow II	2	2	1	3
4	CES.E.236	Physical Chemistry II	2	0	0	2
5	CES.E.224	Computer Programming II	1	2	1	2
6	CES.E.225	Materials Eng.	2	2	1	3
7	CES.E.226	Statistics	2	0	1	2
		Total	13	6	6	16
		Hours/week	**25**			

Third Year

Chemical Engineering and Oil Pollution

	First Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.E.331	Thermodynamics I	2	0	1	2
2	CES.E.321	Numerical Analysis	2	2	1	3
3	CES.E.333	Mass Transfer	2	2	1	3
4	CES.E.335	Chemical Reaction Kinetics	2	0	1	2
5	CES.E.337	Heat Transfer I	2	0	1	2
6	CES.E.339	Air Pollution Control Engineering	2	0	1	2
7	CES.E.3310	Industrial Safety	2	0	0	2
8	CES.E.3311	Equipment Design	2	0	1	2
		Total	16	4	7	**18**
		Hours/week		**27**		

.	***Second Semester***					
No	Code Course	Subject	L	P	T	Credits
1	CES.E.332	Thermodynamics I I	2	2	1	3
2	CES.E.322	Applied Mathematics in chemical Engineering	2	0	1	2
3	CES.E.334	Unit Operation I	3	0	1	3
4	CES.E.336	Biochemical Reactor Design	2	0	1	2
5	CES.E.338	Heat Transfer II	2	2	1	3
6	CES.E.3312	Equipment Design in Environmental Engineering Using CAD	2	2	1	3
7	CES.E.3313	Solid Waste Managment	2	0	0	2
		Total	15	6	6	18
		Hours/week		**27**		

Fourth Year

Chemical Engineering and Oil Pollution

	First Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.E.421	Project I	1	2	0	2
2	CES.E.431	Unit Operations II	2	2	1	3
3	CES.E.433	Process Dynamics	2	0	1	2
4	CES.E.435	Water and Wastewater Treatment Engineering I	2	2	1	3
5	CES.E.437	Industrial & Petroleum Pollution Control	2	0	1	2
6	CES.E.438	Catalysis and Catalytic Eng.	2	0	1	2
7	CES.E.423	Environmental Engineering Management & Ethics	2	0	1	2
		Total	13	6	6	**16**
		Hours/week		**25**		

	Second Semester					
No.	Code Course	Subject	L	P	T	Credits
1	CES.E.422	Project II	1	2	0	2
2	CES.E.432	Unit Operations III	3	0	1	3
3	CES.E.434	Process Control	2	2	1	3
4	CES.E.436	Water and Wastewater Treatment Engineering II	2	0	0	2
5	CES.E.424	Optimization	2	0	1	2
6	CES.E.439	Petroleum Refinery Processing	2	0	1	2
7	CES.E.4310	Corrosion and degradation	2	0	0	2
		Total	14	4	4	16
		Hours/week		**22**		

<table>
<tr><td>Program</td><td colspan="6">Chemical Processing Engineering</td></tr>
<tr><td>Course Code</td><td>CES.P.111</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Technical English I</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Basic principles in English language (grammars and vocabularies)</td><td>2</td><td>-</td><td>-</td><td>2</td><td>2</td></tr>
</table>

Course Description

Define a specialknowledge and basic concepts in English language, review of (words, terms and phrases commonly utilized)with practical everyday language that students need, the fundamental principles of grammars used in English language such as question and answer, the negative, the tail questions, the singular and plural, the numbers, nouns, pronouns, the verb (to be, to have, and to do), adjectives, regular and irregular verbs, using so & neither, and adverbs, degrees of comparison, conjunctions and interjections, kinds of letter (S) with general exercises. Also, accurate description of the nature of vocabularies and idioms used by the chemical engineers and that the student needs in his/her academic and/or in his/her professional career by means of applying two reading passages focus mainly on studying the chemical engineer work in the factories as well as equipment, tools and materials used.

Course Text

1- The language of chemical engineering in English, Roy V. Hughson (1979), Regents publishing company, Inc.
2- New headway plus (English Course), Liz & John Soars (2014), Oxford University press.

Other support books :-

1- Life Lines workbook (Pre-intermediate and Intermediate level), Tom Hutchinson (2007), Oxford University press.
2- English in a simplified way, Tahir Al- Bayati (1991), Baghdad.

Course Objectives: at the end of the semester the student should be able to :-

The objective of this course focuses on:

1-in-depth understanding and comprehension of the essential grammars in the English language that usually used in writing and/or speaking with choosing the correct way of speaking and/or listening the vocabulary (phonetics and spelling) by the use of common phrases and words.

2-Also, focus on the use of technical English(reading passages) as a heart of chemical engineer work, such as what chemical engineers do, research and development.

3- The development of the student's ability to apply and arrange knowledge in English language

and thus become able to employ them appropriately in his/her daily dealing without the complexity. 4- As well, encourage students to develop their capabilities in the field of English language through participation by the training on the use and improve their language.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Academic Comprehension: (Reading passages related to chemical engineering)** The first reading passage (What chemical engineers do) (Special terms or definitions, vocabulary practice - the word and its meaning, paragraphs - read and explanation, review, and discussion)	8 hr
2	**Academic Comprehension: (Reading passages related to chemical engineering)** The second reading passage (Research and development). (Special terms or definitions, vocabulary practice - the word and its meaning, paragraphs - read and explanation, review, and discussion).	8 hr
3	**English Grammar:** A general introduction to the English language and its importance as a means of communication between different peoples around the world, Review of the words, terms and phrases commonly used, Review of the simple grammars in English language, such as question and answer, the negative, the tail questions, the singular and plural, the numbers, telling the date, and telling the time, Nouns, pronouns, the verb to be, the verb to have, the verb to do, Adjectives and regular and irregular verbs, Reading and writing grammars that include short forms and words with two different meanings, The use of so & neither, and adverbs, Degrees of comparison,Conjunctions and interjections with general exercises, Kinds of letter (S) with general exercises.	14 hr

Program	***Chemical Processing Engineering***					
Course Code	**CES.P.121**	Credits hr				Units
Course Title	Mathematics I					
Term	1^{st} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematic of secondary school	**2**	**-**	**1**	**3**	**2**

Course Description

Introduction to functions, limits, Special functions, Derivatives, Chain rule, and their applications. Introduction to integral calculus, Methods of integration.

Course Text

1- Thomas Calculus, by George B.Thomas,Jr,Elevnth Edition Media Upgrade 2018"

Other support books:-

2- Engineering Mathematics for Semesters I and II, by C.B. Gupta, S.R. Singh, M. Kumar, 2015.

3- Advanced Engineering Mathematics, Fifth Edition, by C.Raywylie,LouisC.Barrett, 1982.

4- Mathematical Methods in chemical Engineering, Second Edition, by V.G.Jenson and G.V. Jeffreys, 1977.

Course Objectives: at the end of the semester the student should be able to :-

1.To develop an understanding with the concepts of calculus and analytic geometry and the applications of these concepts to the solution of engineering problems.

2.Provide practice at developing critical thinking skills, solving open ended problems and to work in teams.

3. Develop a deep understanding of issues related to the basic principles of calculus, and how to solve problems in chemical engineering

Topics Covered (Syllabus)/ Mathematics I

No.	Contents	Duration
1	**Functions** • Absolute value, • Coordinates of the plane, • Slope of lines and angle of inclination, • Functions and graph of the functions, • Domain and range, • Identifying functions, sum, differences, products and quotients, • Composite functions, • Shifting a graph of a function, • Scaling and reflecting a graph of a function,	**9 hr**
2	**Transcendental functions** • Logarithmic and exponential functions, • Trigonometric functions, • Inverse trigonometric functions.	**6 hr**
3	**Derivatives** • Definition, • Chain rule, • Derivative of inverse trigonometric functions, • Derivative of exponential and logarithmic functions, • L, hopitals rule, • Partial derivative, • Function of two or more variables.	**9 hr**
4	**Determinates and Matrices** • Definition, • Determinate evaluation, • Solution of system of linear equation by matrix; (Inverse of matrix, Gauss elimination), • Rank of matrix, • Eigen value and Eigen vectors.	**6 hr**

University of Technology
Department of Chemical Engineering

Program	*Chemical Processing Engineering*					
Course Code	**CES.P.123**	Credits hr				Units
Course Title	Chemistry I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemistry of Secondary School	**2**	**2**	**0**	**4**	**3**

Course Description

Fundamentals of atoms, molecules , Quantitative analysis , Environmental , Transition Metal Chemistry and Spectroscopic Techniques which are mostly used in all other chemical engineering courses

Course Text

1- Skoog, D.A., West D.M., Holler F.J., and Crouch S.R. "Fundamentals of analytical chemistry", 8ed edition, brooks/Cole Cengage Learning. 2004

Other support books :-

2- Harrison, R.M," Understanding Our Environment An Introduction to Environmental Chemistry and Pollution",3ed edition, The Royal Society of Chemistry 1999

3- Atkins, P., de Paula, J."Physical Chemistry and Collide Science"8ed edition, W. H. Freeman and Company. 2006

4- Huheey, J. E. "Inorganic Chemistry: Principles of Structure and Reactivity", 4ed edition, Prentice Hall. 1997

Course Objectives: at the end of the semester the student should be able to:-

1- Students will learn to use the language of chemistry: symbolic representation, nomenclature, and terminology.
2- Students will learn to think about chemical reactions and chemical and physical properties at the particulate level and will be able to visualize and depict the structure of matter and its reactions at the microscopic (atomic and molecular) level.
3- Students will gain a conceptual understanding of and will be able to perform quantitative problem-solving skills in atomic structure, Stoichiometry, chemical equilibria, and electrochemistry.
4- Students will be able to use their knowledge to analyze and construct solutions by instruments
5- Students will learn to use theories of bonding in coordination compounds

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Atoms and Molecules:** Mechanical picture of atomic structure, Derivation of Schrodinger wave equation, Chemical Bonding- Orbital concepts in bonding, V.B. and M.O. theory, M.O. diagrams, Intermolecular interactions.	3 hr
2	**Quantitative analysis:** Atomic weight , Molecular formula, Chemical equations, Mole concept, Chemical, equilibrium, equilibrium constants, Preparation and properties, Molarity, Normality, ppm, pH, pOH, Buffers, Solubility Ksp, Gravimetric Analysis, Precipitation reaction, Potentiometric Titration, Complex titration.	6 hr
3	**Electrochemistry:** Arrhenius theory of electrolytic dissociation, Transport number, Kohlrausch's law, Solubility product, Redox reaction, Electrochemical and concentration cells	4 hr
4	**Photochemistry and Spectroscopic Techniques:** Photoexcitation of organic molecules, Jablonski diagram, Laws of photochemistry and quantum yield, Some examples of photochemical reactions, Chemistry of vision and other applications of photochemistry. General introduction to UV, IR, NMR and Chromatography	7 hr
5	**Transition Metal Chemistry:** Structure of coordination compounds corresponding to coordination number up to 6, Types of ligands, Isomerism [geometrical, optical, ionization, linkage and coordination], Theories of bonding in coordination compounds- crystal field theory, Valence bond theory, Chelation	6 hr
6	**Environmental:** Introduction, Water, air, soil pollution	4 hr

Practical: (Chem. lab.)

No.	Experiment Name
1	Introduction and chemical safety basic rules
2	Equipment and how to use it
3	Preparation of standard solution (primary and secondary)
4	Direct Titration
5	Quantitative determination of a carbonate and hydroxide in mixture
6	Back titration
7	Titration Curves
8	Determination of Chloride Ions in Water
9	Standardization of $KMnO_4$ and the determination of ferrous sulfate (Redox reaction)
10	Determination of Hardness of Water
11	Paper Chromatography
12	Qualitative analysis silver group

Program	***Chemical processes Engineering***					
Course Code	**CES.P.125**	Credits hr				Units
Course Title	Physics					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Physics of secondary school	**2**	**-**	**1**	**3**	**2**

Course Description

This course aims to help students acquire the knowledge and understand concepts, fundamental laws, principles, and processes in physics necessary for students who intend to complete their bachelor's degree in the chemical engineering department.

Course Textbooks

1. Shipman, James, Jerry D. Wilson, Charles A. Higgins, and Bo Lou. An introduction to physical science. Cengage Learning, 2013.
2. Principle of Physics, Kinetic Books Company, 2007.

Course Objectives: at the end of the semester, the student should be able to understanding:-

1. Determine the components of linear motion (displacement, velocity, and acceleration).
2. Solve problems involving forces and work.
3. Apply Newton's laws to physical problems.
4. Identify the different types of energy.
5. Solve problems using principles of conservation of energy.
6. Define the principles of momentum and collisions.
7. Use principles of momentum to solve problems.
8. Problems solving ability, e.g., analyzing a situation or data, establishing a relationship between cause and effects.

Topics Covered (Syllabus)/ Physics

No.	Contents	Duration
1	**Motion in One Dimension** • Position • Displacement • Velocity • Acceleration • Derivation: creating new equations • Motion equations for constant acceleration • Free-fall acceleration	2 hr

2	**Properties of matter** • Elasticity • Surface Tension • Viscosity	**2 hr**
3	**Force and Newton's Laws:** • Force • Newton's first law • Gravitational force: weight • Newton's second law • Newton's third law • Normal force • Tension • Newton's second and third laws • Free body diagram • Static and kinetic friction • Hooke's law and spring force • Air resistance	**6 hr**
4	**Applications of Newton's Laws** • Presenting and solving on Newton's Laws	**2 hr**
5	**Work, Energy, and Power:** • Energy • Kinetic energy • Work-kinetic energy theorem • Power • potential energy • Work and gravitational potential energy • Conservation of energy	**4 hr**
6	**Momentum** • Linear momentum • Conservation of momentum • Collisions	**2 hr**
7	**Thermodynamics** • Temperature and Heat • Temperature and thermometers • Temperature scales • Temperature scale conversions • Heat • Zeroth law of thermodynamics • Internal energy	**4 hr**

	• Thermal expansion and its types • Specific capacity • Phase changes • Latent heat • Modes of heat transfer • Global warming and the greenhouse effect	
8	**Modern Physics** • Electron, thermionic, emission, photoelectric emission, • X-ray • The nucleus • Structure of nucleus and atom • Radioactivity • Nuclear energy • Ionizing radiation • Health hazards	**4 hr**
9	**Introduction to IS units and DC circuit:** Materialuseinelectriccomponent,ohmslaw,temperatureCoefficient,Review of Kirchhoff's Laws, Series and Parallel circuit, Resistance and resistivity	**2 hr**
12	**Chemical Effect of Electricity:** Electrolysis, Electroplating, Electrical Cells	**2 hr**

Program	***Chemical Processing Engineering***					
Course Code	**CES.P.126**	Credits hr				Units
Course Title	Engineering Drawing					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	None	**1**	**2**	**---**	**3**	**2**

Course Description

Introduction inEngineering drawing, engineering drawing applications, engineeringprocess , analysis model to view and study the full and half Sections , conclusion of the third projection ,Draw isometric and Oblique.

Course Text

1. الرسم الهندسي،تاليف (عبد الرسول الخفاف) الطبعة الثانية،1993
2. R.P Hoelscher and C.H Springer "Engineering Drawing and Geometry ".2nd edition

Course Objectives: at the end of the semester the student should be able to :-

1. The students can be use Tools Drawing in draw and analyze geometric shapes
2. Enable students to draw devices, equipment & PFD in chemical engineering.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	Introduction	**3 hr**
2	Planning of Drawing paper	**3 hr**
3	Types of line	**3 hr**
4	Engineering operation	**3 hr**
5	Projection Drawing	**3 hr**
6	First angle projection	**3 hr**
7	Third angle projection	**3 hr**
8	Full section	**3 hr**
9	Half section	**3 hr**
10	The finding of third view	**3 hr**
11	Application Example	**3 hr**
12	Pictorial Drawing (Isometric and Oblique)	**3 hr**
13	Application Example	**3 hr**
14	Dimensions	**3 hr**
15	Examples of chemicalengineering drawing and exercises.	**3 hr**

University of Technology
Department of Chemical Engineering

Program	***Chemical Process Engineering***					
Course Code	**CES.P.113**	Credits hr				Units
Course Title	**Computer Science**					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	None	**1**	**2**	**---**	**3**	**2**

Course Description

This course provides an overview of the Operating Systems, Types Of Operating Systems, Computer Operating Systems, Smartphone Operating Systems, operating system Windows 7, Windows 7 is a series of personal computer operating systems produced by Microsoft as part of its Windows NT family of operating systems. It is the successor to Windows 8.1, and was released to manufacturing on July 15, 2009, and broadly released for retail sale on July 29, 2010and the program of Microsoft Office 2010, Microsoft Office 2010, Microsoft Excel 2010. we an overview the Visual Basic and includes the operation of Visual Basic and describe the elements of the design environment and user interface design and the difference between the project and the program and introduce students to the philosophy of programming using visual Basic and a programming process events Event-Driven Programming and programming objects Object Oriented Programming and gives the student an introduction to object-oriented programming and introduce students to the fundamental differences between the concept of the programming language BASIC visual and languages BASIC traditional and explain the steps to design and program planning.

Course Text

1- David a. "How computer hardware and software work " 2009.
2- Introduction to windows 7
3- Sabgayyeshi " basic networking tutorial",2011
4- IC3"Key applications using Microsoft office 2010
5- “Visual Basic: Crash Course - The Ultimate Beginner's Course to Learning Visual Basic Programming”, 3rd Edition, A. Tannenbaum, Prentice-Hall, 1996.
6-" Beginning Visual Basic " by Bryan Newsome Worx, USL Press, | December 2003 | ISBN-10: 1119092116 |
7- “Course Notes for Learn Visual Basic 6.0”, 4th Edition, F. Halsall, Addison-Wesley, 2000.

Course Objectives: at the end of the semester the student should be able to :-

1- Learn how to turn on the Windows operating system windows
2- Start Microsoft Office applications and work with the Microsoft Office interface Create documents in Microsoft Word. Create workbooks in Microsoft Excel.
3- Learn how to deal with the web and how to navigate

4- Define and modify the properties and methods associated with an object
5- Load, modify, and save changes made to forms and projects in the Visual Basic environment
6- Define and implement form objects including data arrays, control arrays, text boxes, message boxes, dialog boxes, labels, controls, menus, frames, picture boxes, pull-down menus, and combo boxes

Topics Covered (Syllabus)/ Computer Programming (I)

No.	Contents	Duration
1	**Operating Systems:** Types Of Operating Systems, Computer Operating Systems, Smartphone Operating Systems	1 hr
2	**Windows 7:** the operating system Windows 7, Computer Fundamentals: (Computer components, types, operations, Computer Fundamentals: (hardware units, software types), numeric systems, Introduction to Windows, Desktop, Desktop icons, change desktop properties, taskbar and toolbars, start menu basics, context menu, operation in window, control panel features.	1 hr
3	**Microsoft office World 2010:** Introduction to the office system, Microsoft World, Microsoft World, Program Interface and how to write scripts, Microsoft World, Text Processing and typesetting	1 hr
4	**Microsoft Excel 2010:** Program Interface, how statistical tables and graphs work, Microsoft Excel 2010, How to use mathematical and statistical functions	1 hr
5	**Introduction to Visual Basic Programming** Menu bar, Tools bar, Project explorer, Tool box, Properties windows, Form, Code, Controls, Command Buttons, Label, Textbox, Pointers, Picture box, frame, Naming Controls, Properties for controls: Height, Width, Left, Top, Font, Forecolor, Backcolor , Name, Caption, Text, and Visible, Events, Saving Visual Basic Project, Examples, Chemical Engineering Applications.	1 hr
6	**Mathematics** Arithmetic Operations: +, , *, /, \, mod, ^. (Using Simple Example for each Operation), Logical Operations. AND, OR, NOT. And the Truth Table for each Operation, (Using Simple Example for each Operation), Relational Operation: >, <, >=, <=, <>, =, String Concatenation (&), Operation Precedence. For all arithmetic, logical, relational operators, Print statement and Formatting. Illustrate (colon, comma, and semicolon), Examples: Chemical Engineering Applications **Built in Functions:**	1 hr

	Built-in math functions, Abs(x), Int(x), Rnd(x), sgn(x), sqr(x), str(x), val(x), round(x,n),CInt(x),Fix(x),String Functions, InputBox, MsgBox, Examples: Chemical Engineering Applications.	
7	**Selection Structure** Single Selection: If/Then structure, Double Selection: If/Then/Else structure, Nested If/Then/Else structure, Select Case Multiple Selection Structure, Examples: Chemical Engineering Applications.	1 hr
8	**Reputation Structure:** For ... Next Loop, while ... Wend, Do .... While Loop, Do ... Loop Until, Exit Do, Exit For Examples: Chemical Engineering Applications.	1 hr
9	**Variables** Data Types: Boolean, Integer, Long, Single, Double, String, Valid Naming of Variables, Initial Value for each Type of the Variables (Initial Value for each Data Type), Size of each Variable Type in Bytes, How to Declare Variables. (Dim statement).	1 hr
10	Using: Dim variable name As Data type, Using Suffix: Integer, Long, Single, Double, String, Constant Variable. Examples: Chemical Engineering Applications.	1 hr
11	**Arrays** Introduction: Defining Arrays, Array Declaration Statement, Assigning Values for Arrays (i.e., Filling array's element value either by loop or by direct assignment statement), Re Dim Statement, Using Loops with Arrays. (i.e. writing an application on array using loops), Two Dimensional Arrays, Operations on Arrays,	2 hr
12	Fill Array Elements with Random Numbers using and Function, Sorting, Searching. (i.e., Linear search), Swapping Two Elements. Examples: Chemical Engineering Applications.	1 hr
13	**Graphics in Visual Basic:** Graphics control, Picture box, Image box, Coordinate system, Pixel,	1 hr
14	Graphics methods (Line, Circle, pset) Examples: Chemical Engineering Applications.	1 hr

Practical :(Comp.Sci.Lab)

No.	Contents
1	**Windows 7:** the operating system Windows 7 , Computer Fundamentals: (Computer components, types, operations,Computer Fundamentals: (hardware units, software types), numeric systems. **I**ntroduction to Windows, Desktop, Desktop icons, change desktop properties, taskbar and toolbars, start menu basics, context menu, operation in window, control panel features.
2	Microsoft office, Introduction to the office system, Microsoft World, Program Interface and how to write scripts, Text Processing and type setting
3	Microsoft Excel 2010, Program Interface, How statistical tables and graphs work
4	Microsoft Excel 2010, How to use mathematical and statistical functions
5	Operating Systems, Types Of Operating Systems
6	Computer Operating Systems, Smartphone Operating Systems
7	**Introduction to Visual Basic Programming:** Menu bar, Tools bar, Project explorer, Tool box, Properties windows, Form, Code, Controls, Command Buttons, Label, Textbox, Pointers, Picture box, frame, Naming Controls, Properties for controls: Height, Width, Left, Top, Font, Forecolor, Backcolor, Name, Caption, Text, and Visible, Events, Saving Visual Basic Project, Examples, Chemical Engineering Applications.
8	Mathematics Arithmetic Operations: +, , *, /, \, mod, ^. (Using Simple Example for each Operation), Logical Operations. AND, OR, NOT. And the Truth Table for each Operation, (Using Simple Example for each Operation), Relational Operation: >, <, >=, <=, <>, =, String Concatenation (&), Operation Precedence. For all arithmetic, logical, relational operators, Print statement and Formatting. Illustrate (colon, comma, and semicolon), Examples: Chemical Engineering Applications
9	**Built in Functions:** Built-in math functions, Abs(x), Int(x), Rnd(x), sgn(x), sqr(x), str(x), Val(x), round(x,n),CInt(x),Fix(x),String Functions, InputBox, MsgBox, Examples: Chemical Engineering Applications.
10	**Selection Structure:** Single Selection: If/Then structure, Double Selection: If/Then/Else structure, Nested If/Then/Else structure, Select Case Multiple Selection Structure, Examples: Chemical Engineering Applications.

11	For ... Next Loop, while ... Wend, Do .... While ... Loop, Do ... Loop Until, Exit Do, Exit For Examples: Chemical Engineering Applications.
12	**Variables** Data Types: Boolean, Integer, Long, Single, Double, String, Valid Naming of Variables, Initial Value for each Type of the Variables (Initial Value for each Data Type), Size of each Variable Type in Bytes, How to Declare Variables. (Dim statement), Using: Dim variable name As Data type, Using Suffix: Integer, Long, Single, Double, String, ConstantVariable. Examples: Chemical Engineering Applications.
13	**Arrays:** Introduction: Defining Arrays, Array Declaration Statement, Assigning Values for Arrays (i.e., Filling array's element value either by loop or by direct assignment statement), Re Dim Statement, Using Loops with Arrays. (i.e., writing an application on array using loops), Two Dimensional Arrays, Operations on Arrays, Fill Array Elements with Random Numbers using and Function, Sorting, Searching. (i.e., Linear search), Swapping Two Elements. Examples: Chemical Engineering Applications
14	**Graphics in Visual Basic:** Graphics control, Picture box, Image box, Coordinate system, Pixel, Graphicsmethods (Line, Circle, pset) Examples: Chemical Engineering Applications.

Program	***Chemical Processing Engineering***					
Course Code	**CES.P.112**	Credits hr				Units
Course Title	Technical English II					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Technical English I	**2**	**-**	**-**	**2**	**2**

Course Description

Define a special knowledge and basic concepts in English language, review of phonetics and spellingwith words and sounds that need attention in understanding the meaning and pronunciation, the fundamental principles of grammars utilized in English language such as the use of the prefixes (un, im, in, and dis), the use of since & for, the definite and indefinite articles. As well as simple, continuous and perfect tenses (present, past, and future), the punctuation, active voice and passive voice, direct and indirect speech, finite and non-finite verbs, analyses and kinds of sentences. Also, accurate description of the nature of vocabularies and idioms used by the chemical engineers and that the student needs in his/her academic and/or in his/her professional career by means of applying two reading passages focus mainly on studying the chemical engineer work in the factories as well as equipment, tools and materials used.

Course Text

1- The language of chemical engineering in English, Roy V. Hughson (1979), Regents publishing company, Inc.
2- New headway plus (English Course), Liz & John Soars (2014), Oxford University press.

Other support books :-

1- Life Lines workbook (Pre-intermediate and Intermediate level), Tom Hutchinson (2007), Oxford University press.
2- English in a simplified way, Tahir Al- Bayati (1991), Baghdad.

Course Objectives: at the end of the semester the student should be able to :-

The objective of this course focuses on:

1- Study and conception of the advance grammars in the English language that usually employed in academic writing and also explain the use of grammars correctlyin speaking and/or listening the vocabulary (phonetics and spelling) via increasing the ability to rapid recognize the words that have two different meanings depending on their presence in the context of speech

2- Accurate description of the nature of vocabulary and idioms used by the chemical engineers in dealing with their respective fields in addition to the vocabulary of daily dealing. Also, focus on the use of reading passages such as process design and plant operation, which are related to student competence and his/her profession as an engineer in the chemical companies.

3- Enhancement of student's ability by applying modern information in English language about the characteristics of the chemical engineer job and then try to the simulation that in writing the scientific report, expression, and formulate of simple sentences and complex ones without the difficulty.

4- Finally, promote the qualifications of students in the field of English language by training on the use and the progress of their language in order to allow them to easily use it in his/her future academic study in chemical engineering.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Academic Comprehension: (Reading passages related to chemical engineering):** The third reading passage (Process design) (Special terms or definitions, vocabulary practice - the word and its meaning, paragraphs - read and explanation, review, and discussion)	8 hr
2	**Academic Comprehension: (Reading passages related to chemical engineering):** The fourth reading passage (Plant operation). (Special terms or definitions, vocabulary practice - the word and its meaning, paragraphs - read and explanation, review, and discussion).	8 hr
3	**English Grammar:** Phonetics & Spelling (consonant sounds & vowel sounds), Words and sounds that need attention in understanding the meaning and pronunciation, as well as the use of the prefixes (un, im, in, and dis),The use of since & for, as well as the definite and indefinite articles,Punctuation (such as the use of the capital letter, the question mark, and the comma….etc), Simple tenses (present, past, and future), Continuous and perfect tenses (present, past, and future), Active voice and passive voice,Direct and indirect speech, Finite and non-finite verbs, Analyses of sentences, and kinds of sentences (either according to form or to number of statements).	14 hr

University of Technology
Department of Chemical Engineering

Program	*Chemical Processing Engineering*					
Course Code	**CES.P.122**	Credits hr				Units
Course Title	Mathematics II					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematics I	**2**	**-**	**1**	**3**	**2**

Course Description

Definite integral and applications, Polar coordinates, Vector analysis, Determinant and matrices

Course Text

1- Thomas' Calculus, by George B. Thomas, Jr., Fourteenth Edition, Media Upgrade 2018.

Other support books: -

2- Engineering Mathematics for Semesters I and II, by C.B. Gupta, S.R. Singh, M. Kumar, 2015.
3- Advanced Engineering Mathematics, Fifth Edition, by C.Raywylie,LouisC.Barrett, 1982.
4- Mathematical Methods in chemical Engineering, Second Edition, by V.G.Jenson and G.V. Jeffreys, 1977.

Course Objectives : at the end of the semester the student should be able to :-

1. To understand these concepts of applications and how to evaluate volumes, surface area, and to understand analytic geometry.
2. Provide practice at developing critical thinking skills, solving open ended problems and to work in teams.
3. Develop a deep understanding of issues related to the basic principles of polar coordinates, vector analysis, determinants, and how to solve problems in chemical engineering

Topics Covered (Syllabus)/ Mathematics II

No.	Contents	Duration
1	**Integration** • Indefinite integration, • Integration of inverse trigonometric functions, • Integration methods; (substitution, by part, trigonometric substitution, partial fraction).	12 hr
2	**Definite integration and Applications** • Double integrals, • Reverse order of integration, • Length of curves, • Surface area, • Volumes	9 hr
3	**Vector Analysis** • Definitions, • Properties, • Vector in space, • Scalar and cross product of vector, • Product of three vectors.	9 hr

Universityof Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical Processes Engineering</td></tr>
<tr><td>Course Code-</td><td>CES.P.131</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course title</td><td>Chemical Engineering Principles I</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Mathematic I; Chemistry I</td><td>3</td><td>–</td><td>1</td><td>4</td><td>3</td></tr>
</table>

Course Description

Understanding the basic concepts and expressions in chemical engineering and learning calculations related to chemical reactions, material balance, gases and vapours.

Course Text

- D.M.Himmelblau and J.B.Riggs ,Basic Principles and Calculations in Chemical Engineering ,7th Edition , 2004 .
- R.M.Felder and R.W.Rousseau ,Elementary Principles of Chemical Processes ,3rd Edition ,2005 .

Other support books :-

Skogestad, S. (2008). Chemical and energy process engineering. CRC press.

Course Objectives: at the end of the semester the student should be able to:-

1- Have a deep knowledge, wide scope and improved understanding of the mechanisms in heat balance as well as a better insight into analytical and empirical methods applied in analysis of material balance related problems.
2- Gain knowledge for applying the material (equation) balance in chemical engineering problems.
3- To provide experience for students to solve material balance for different process

Topics Covered (Syllabus)

No.	Contents	Duration
1	**General Knowledge of Chemical Engineering** ➢ Definition of chemical engineering. ➢ Chemical process industries (CPI). ➢ Generalized chemical process.	**6 hr**

	➢ flow sheet and block diagram of a chemical process ➢ The difference between the chemist and the chemical engineer.	
2	**Physical and Chemical Principles** ➢ Units and Dimensions ➢ Operations with Units ➢ Addition, Subtraction, Equality ➢ Multiplication and Division ➢ Conversion of Units and Conversion Factors ➢ Dimensional Consistency (Homogeneity) ➢ Nondimensional Groups:	**12 hr**
3	**Concepts of flow rates, density, specific gravity, temperature and pressure** ➢ Four types of temperature ➢ Temperature Conversion ➢ Heat capacity ➢ Pressure and Its Units ➢ Types of pressures ➢ Measurement of Pressure	**15 hr**
4	**Introduction to Material Balances** ➢ The Concept of a Material Balance ➢ Open and Closed Systems ➢ Steady-State and Unsteady-State Systems ➢ Multiple Component Systems	**12 hr**

Program	Chemical Processing Engineering					
Course Code	**CES.P.124**	Credits hr				Units
Course Title	Chemistry II					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemistry I	**2**	**2**	**0**	**4**	**3**

Course Description

An Introduction to Organic Compounds, preparation, reaction including carbohydrate, polymers and dyes

Course Text

1- Ghatak,k.l,” Textbook of organic chemistry and problem analysis”,PHL Learning.2014.

Other support books :-

2- Morrison, Thornton R.; Boyd, Neilson,R."Organic Chemistry". 6th edition, J. Chem. Educ. 1992

3- Bruice,P.Y.,J.M “Organic chemistry”,7th edition ,. Books a la Carte Edition, 2014

Course Objectives: at the end of the semester the student should be able to :-

1- Students will learn the basic concepts of organic chemistry
2- understanding the concepts of organic reactions for analysis of unit processes
3- Students will learn the polymeric chemistry
4- Students will learn the basic concepts of dyes
5- Students will learn the basic concepts of carbohydrates

Topics Covered (Syllabus)/ Chemistry II

No.	Contents	Duration
1	**An Introduction to Organic Compounds:** Nomenclature, Physical Properties, and Representation of Structure	**3 hr**
2	**Preparation and Reactions:** Alkanes, Alkenes, Dienes, Alkynes, aromatic hydrocarbon	**4 hr**
3	**Preparation and Reactions:** Alkanes derivative (RX, ROH, RCOOH, RCOH‹RCOR,)….etc. Organometallic	**8 hr**
4	**Mechanisms of organic reactions:** (Elimination, substation, addition)	**2 hr**
5	**Petroleum:** Origin of petroleum, Composition, Refining, Kerosene, Naphtha	**6 hr**

6	**Heterocyclic compounds:** Isolation and reactions of furan, pyrrole, pyridine Terpenes	**3 hr**
7	**Chemistry of polymeric materials:** Polymerization, methods of polymerization - bulk, solution, suspension and emulsion polymerization. Glass transition temperature (Tg), Conducting polymers	**3 hr**
8	**Dyes:** Classification, nomenclature, synthesis	**1 hr**

Practical: (Chem. lab.)

No.	Experiment Name
1.	**Boiling point determination**
2.	**Melting point determination**
3.	**3. Simple Distillation**
4.	**Preparation of aspirin**
5.	**Preparation of ester**
6.	**Identification of functional groups-I**
7.	**Identification of functional groups-II**
8.	**Saponification reaction**
9.	**Polymerization of vinyl monomer**

Program	*Chemical ProcessingEngineering*					
Course Code	**CES.P.127**	Credits hr				Units
Course Title	AutoCAD					
Term	2st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Computer Science -Eng. Drawing	**1**	**2**	**---**	**3**	**2**

Course Description

Introduction , AutoCAD program components and how to use it , knowing AutoCAD commands like point , lines, Rectangle, Polygon, Poly line , Arc with their option to draw 2D engineering drawing, learning Hatching, text, mtext , Dimension creation and editing , Modify command and Layers for 2D engineering drawing.
3D drawing methods: Surfaces, Solids and Composite solid.
Render, background, lights for drawing.

Course Text

1-Terry T. Wohler, applying AutoCAD 2002 fundamentals, Glencoe /McGraw-Hill
2-James A. Leach, AutoCAD 2002 Companion Essentials of AutoCAD plus Solid modeling ,2003 , McGraw-Hill, Boston
3- Terry T. Wohler, applying AutoCAD a step by step approach for AutoCAD release 13, 1996, Glencoe McGraw-Hill
4- James A. Leach, AutoCAD 14 Companion Essentials of AutoCAD plus Solid modeling ,1999,WCB / McGraw-Hill, Boston
Other support books :-
David Byrnes and Mark Middlebrook, AutoCAD® 2007 For Dummies , Wiley Publishing, Inc
5-2001 الرسم بمساعدة الحاسوب أ.م علي حسين علي م. فادي جنان جبرائيل م. وليد يوسف شهاب

Course Objectives : at the end of the semester the student should be able to :-

1- The students can use AutoCAD program and produce 2D and 3D chemical engineering drawings.
2- Enable students to draw designed equipment in AutoCAD program.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	Introduction, Drawing program screen components, Setting drawing limits, Units, Grid and snap, Zoom, Orthogonal, Osnap, UCS. 2D drafting: Cartesian system coordinate, AutoCAD drawing command:	**1 hr**
2	Point, Line: line, multi-line, construction line, drawing line by using: absolute coordinate, polar coordinate, relative coordinate, Example	**1 hr**
3	Continuous line drawing: Rectangle, Polygon, Poly line with their options, Example	**1 hr**
4	Curves drawing: Arc, Circle, point –SP line, Ellipse with their options,	**1 hr**

	Example.	
5	Hatching, text command: text, mtext, Example	**1 hr**
6	Dimension creation and editing, Example	**1 hr**
7	Region, block, insert block, Example	**1 hr**
8	Modify command: 1-coy tool: copy, mirror, offset, array. 2- Erase tool: erase, trim, break .3- move tool: move, rotate .4- Change tool: stretch, Lengthen, Extend, Scale, Chamfer, and Fillet .5-Explode, Example	**1 hr**
9	Layers: Create a new layer ,rename layer, active layer, run and extinguishing layers ,Freezing layers, Lock and open layers, the color ,Font type ,Line width, Example	**1 hr**
10	3D drawing methods: Surfaces drawing: box, Wedge, Pyramid, Dome, Sphere, Cone, Torus, Dish, Example	**1 hr**
11	3D drawing methods: Solids: box, Cylinder, Sphere, Cone, Wedge, Torus, Example	**1 hr**
12	Composite solid: Union, Subtraction, Intersection, Example	**1 hr**
13	Examples of chemical engineering drawing and exercises	**1 hr**
14	Examples of chemical engineering drawing and exercises	**1 hr**
15	Examples of chemical engineering drawing and exercises	**1 hr**

Practical: (AutoCAD. lab.)

No.	**Experiments Name.**
1-	Drawing rectangular using lines in absolute coordinate, polar coordinate, relative coordinate
2-	Drawing line, rectangular, polygon
3-	Drawing Arc, Circle, point –SP line, Ellipse
4-	Drawing of geometry shape and applied Hatching, text command
5-	Drawing simple 2D shape and applying Modify commands such as copy, mirror, offset, array , trim, move, rotate , stretch, Lengthen, Extend, Scale, Chamfer, and Fillet
6-	Drawing a simple 2D chemical engineering drawing and applied layers.
7-	Drawing chemical engineering Applications
8-	Drawing chemical engineering Applications

Universityof Technology
Department of Chemical Engineering

Program	***Chemical ProcessingEngineering***					
Course Code	**CES.P.128**	Credits hr				Units
Course Title	Engineering Mechanics and Strength of Materials					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Physics	**2**	**-**	**1**	**3**	**2**

Course Description

This class focuses on the following topics, including principles of equilibrium of a force system, Moment of a force, Centroid and center of gravity, Analysis of internal force, Strain, Stress-strain diagram, Hook's law, Shearing deformation, Poisson's ratio, Volumetric strain, Thin-walled cylinders, Thermal stress, Shear and bending moment in the beam.

Course Text

1- Engineering Mechanic-Statics and Dynamics volume 1; Higdon, A. and Stiles, W.B., 3ed Edition, Prentice-Hall, India, (1968).
2- Strength of Materials; Singer, F.L. and Pytel, A., 3ed Edition, Harper and Row, London, (1980).
3. Hibbeler, R. C. (2016). Engineering Mechanics: Statics, 14th SI Edition.

Course Objectives: at the end of the semester, the student should be able to:-

1. This class is designed to study the effects of external forces on a group of solid objects.
2. This class is designed to study the resistance of materials and their applications in chemical engineering.

Topics Covered (Syllabus)/ Engineering Mechanics and Strength of Materials

No.	Contents	Duration
1	Equilibrium of rigid bodies	**3 hr**
2	Moment of a Force Moment about a point, Resultant moment of multiple forces, Moment of Couple	**3 hr**
3	Centroid and Center of Gravity	**3 hr**
4	Introduction Force in Rigid Bodies: Definitions of Stress and Strain, Stress-Strain Diagrams	**2 hr**
5	Proportional Limits: Elastic limit, Stiffness elasticity, Plasticity, Hardness and working stress.	**4 hr**
6	Hook's Law	**3 hr**
7	Poisson Ratio, Composite Stresses: Volumetric Stress, Bulk Modulus, Thin-Walled Cylinders	**4 hr**
8	Thermal Stress	**4 hr**
9	Shear and Bending Moments in Beam	**4 hr**

University of Technology
Department of Chemical Engineering

Program	***Chemical Processing Engineering***					
Course Code	**CES.P.116**	Credits hr				Units
Course Title	Human Rights & Democracy					
Term	2st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	none	**2**	**-**	**-**	**2**	**2**

Course Description

The concept of human rights Characteristics of human rights _ Human rights groups _ The relationship between human rights and other concepts.and
The study of the democracy concept and history and is relationship to religions and relationwith development also the advantages and the disadvantages of democracy

Course Text

1. عبد الكريم خليفة، القانون الدولي لحقوق الإنسان،(بدون طبعة)الإسكند رية: دار الجامعة الجديدة، 2013
2. مبادئ و قواعد عامة في حقوق الأنسان , د. صلاح حسن مطرود
3. د. محمد علي الشجيري ، حقوق الأنسان بين الأسلامي و العالمي
4. د. زكريا أبراهيم ، مشكلة الحرية
5. د. ماهر صلاح الجبوري ، حقوق الأنسان و الديمقراطية
6. د.سعدون هليل. الطبقة الوسطى والتحول الديمقراطي.
7. د.جورج طرابيشي. الديمقراطية والحداثة.

Course Objectives: at the end of the semester the student should be able to :-

1-Define the concept of human rights and their characteristics
2-To promote the culture of human rights in society

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	Introduction to Human Rights Human Rights and Secularism	**2 hr**
2	The concept of human rights Positions of the Arab intellectual currents of human rights	**2 hr**
3	Characteristics of human rights The future of human rights	**2 hr**
4	Human Rights and Islam Human Rights Classification	**2 hr**
5	Human Rights in Ancient Civilizations Human rights between universality and privacy	**2 hr**

6	Human rights sources andHuman Rights and Globalization	**2 hr**
7	Universal Declaration of Human Rights Human rights and political parties	**2 hr**
8	Human Rights and the Constitution of the Republic of Iraq 2005	**2 hr**
9	The concept of democracy. Characteristics and Categories forms of democracy	**2 hr**
10	The historical development of democracy Democratic systems of government	**2 hr**
11	Democracy between challenges and external pressures ideological democracy	**2 hr**
12	Democracy between privacy and universality Pros and cons of democracy	**2 hr**
13	Voting in democracies Democracy and the phenomenon of globalization	**2 hr**
14	Political freedom and the state The role of the middle class in democracies	**2 hr**
15	The relationship between the intellectual and the authority Democracy between capitalism and socialism	**2 hr**

Universityof Technology
Department of Chemical Engineering

Program	*Chemical Processing Engineering*					
Course Code	**CES.P.221**	Credits hr				Units
Course Title	Mathematics III					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematics I, Mathematics II	**2**	**–**	**1**	**3**	**2**

Course Description

This course describes the evaluation of double, triple integrals, area and volume.Provide knowledge and skills in writing a periodic function in its Fourier series form and on their applications. Develop skills for applying this course in the future on various chemical engineering applications.

Course Text

1- Text book:

1. Higher Engineering Mathematics by Dr.B.S.Grewal, Khanna Publishers, 40th Edition, 2007.

2- **Reference book**:

1. Advanced Engineering Mathematics by Erwin Kreyszig, 8th edition, 2007.

Course Objectives: at the end of the semester the student should be able to:-

1- Able to evaluate double, triple integrals and the area, volume by double & triple integrals respectively.

2- Understand the concept of Fourier-series representation of periodic functions and their applications

Topics Covered (Syllabus)/ Mathematics III

No.	Contents	Duration
1	**Multiple Integrals:** Double Integral, Area, Volume, Double Integral in polar coordinates, Triple Integral in rectangular coordinates, physical application of double and triple integration.	**12 hr**
2	**Function and definite Integrals:** The error function, the gamma function, the beta function, factorial function.	**6 hr**
3	**Infi** Sequences, Convergence, Geometric series, nth partial sum, tests of convergence, alternating series, power and Taylor's series.	**6 hr**
4	**Fourier series:** Periodic functions, Fourier series, Even and odd functions, Half range expansion.	**6 hr**

University of Technology
Department of Chemical Engineering

Program	***Chemical Processes Engineering***					
Course Code-	**CES.P.231**	Credits hr				Units
Course title	Chemical Engineering Principles II					
Term	1^{st} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemical Engineering Principles I	**2**	**—**	**1**	**3**	**2**

Course Description

Understanding the basic concepts and expressions in chemical engineering and learning calculations related to chemical reactions, material balance, gases and vapours.

Course Text

- D.M.Himmelblau and J.B.Riggs ,Basic Principles and Calculations in Chemical Engineering ,7th Edition , 2004 .
- R.M.Felder and R.W.Rousseau ,Elementary Principles of Chemical Processes ,3rd Edition ,2005 .

Other support books :-

Skogestad, S. (2008). Chemical and energy process engineering. CRC press.

Course Objectives: at the end of the semester the student should be able to:-

1- Have a deep knowledge, wide scope and improved understanding of the mechanisms in heat balance as well as a better insight into analytical and empirical methods applied in analysis of material balance related problems.
2- Gain knowledge for applying the material (equation) balance in chemical engineering problems.
3- To provide experience for students to solve material balance for different process

Topics Covered (Syllabus)

No.	Contents	Duration
1	**Systematic steps of solving material balance problems:** ➢ Material balances without chemical reactions. ➢ Material balances with chemical reactions. ➢ Species Material Balances ➢ Processes Involving a Single Reaction ➢ Processes Involving Multiple Reactions ➢ Element Material Balances ➢ Material balances on combustion processes	**4 hr**
2	**Material Balances for Processes Involving Chemical Reaction** ➢ Species Material Balances ➢ Processes Involving a Single Reaction ➢ Processes Involving Multiple Reactions ➢ Element Material Balances	**10 hr**
3	**Material Balance Problems Involving Multiple Units, Material balances involving recycle, bypass and purge streams:** ➢ Process flow sheet ➢ Recycle without Chemical Reaction ➢ Recycle with Chemical Reaction ➢ Bypass and Purge	**8 hr**
4	**Gases and Vapors** ➢ Ideal gas law. ➢ Ideal gas mixtures. ➢ Real gas relationships.	**4 hr**
5	**Introduction to Energy Balance**	**4 hr**

Program	*Chemical ProcessingEngineering*					
Course Code	**CES.P.233**	Credits hr				Units
Course Title	Fluid Flow I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematic I &II,Chemical Engineering Principles I	**2**	**2**	**1**	**5**	**3**

Course Description

Define and show the student what about related with fluids statics and dynamics, its types, and flow patterns. Introduction to Fluid Flow. Course material includes an introduction to the concepts and applications of fluid flow and dimensional analysis and static fluid, analysis of engineering applications of incompressible Newtonian and fluid Non-Newtonian fluid flow pipe systems, Pumps and pumping of liquid.

Course Text

1. Coulson, J.M and Richardson J.F. "Chemical Engineering, volume 1", Fifth edition 2002, Elsevier Science, Linacre House, Jordan Hill, Oxford
2. Coulson, J.M and Richardson J.F. "Chemical Engineering, volume 2", Fifth edition 2002, Elsevier Science, Linacre House, Jordan Hill, Oxford
3. F.A. Holland and R. Bragg "Fluid Flow for Chemical Engineers", 2nd Ed. (1995) Elsevier Ltd.

Other support books :-

1. DARBY. R., M. Dekker "Chemical Engineering Fluid Mechanics", 2ndEd. (2001)
2. James O. Wilkes "Fluid Mechanics for Chemical Engineers", Prentice Hall PTR, New Jersey, USA, 1999.
3. De Nevers, N. "Fluid Mechanics for Chemical Engineers", (1991) McGraw-Hill, Singapore.

Streeter and Wylie "Fluid Mechanics", McGraw-Hill, (1981).

Course Objectives: at the end of the semester the student should be able to :-

1. Recognize the incompressible fluid flow, single- and two-phase flow, fluid statics and dynamics, Newtonian and non-Newtonian fluids and essential basic hydrodynamics.
2. Define the problems in fluid dynamics in various engineering applications. Distinguish the energy variation and its applications spatially the frictional energy losses calculations and the required energy for fluid pumping.
3. Define the necessary fluid parameters of full scale projects by performing simple model experiments and share ideas and work in a team in an efficient and effective manner under controlled supervision or independently.

Topics Covered (Syllabus) Fluid Flow I

No.	Contents	Time
1	Introduction Definition of a fluid, and fluid mechanics. Physical properties of fluids: Density, specific gravity, viscosity, kinematic viscosity, surface tension and capillarity, bulk modulus of elasticity, Pressure & Shear stress, Newton's law of viscosity, Types of Fluids, Newtonian, non-Newtonian fluids ideal and real fluids	3 hr
2	Dimensional Analysis Fundamental dimensions, dimensional homogeneity, dimensionless numbers. Methods of dimensional analysis, 1- Rayleigh's method (power series) 2- Buckingham's Π- method / Theorem.	3 hr
3	Fluid Statics Basic concept of fluid statics, Pressure terminology, pressure (head) of liquid. Measurement of pressure: (Piezometer, Manometers, types of Manometers, Mechanical Gauges).	3 hr
4	Fluid Dynamics Fluid kinematics: Types of fluid flow (steady and unsteady flows, uniform and non-uniform flows, one, two, and three dimensional flows, Rotational and irrotational flows, laminar and turbulent, compressible and incompressible flows, Boundary layer, Continuity equation. General energy equation. Bernoulli's equation, equation of motion, derivation of Euler's equation of motion, modified Bernoulli's equation.	6 hr
5	Newtonian's Fluid (Incompressible flow in Pipes and Channels) Reynolds experiment, Pressure drop (head losses) in pipes (Skin friction), Velocity distribution, Hagen-Poiseuille's equation and Darcy equation. Pressure drop (head losses) in fittings, valves and any obstruction, (Form friction). Hydraulic diameter for flow in non-circular pipes, Boundary layer, Unsteady state examples, Two-phase (gas-liquid) flow definitions.	6 hr
6	Non-Newtonian Fluids in Pipes Definition, types of fluid depended on time, calculation of friction and pressure drop for general time independent in laminar and turbulent flow, Velocity profile of power law fluid flow.	3 hr
7	Pumping of Liquids Total and pump heads, Cavitation & NPSH, Horse Power and, Pumping Efficiencies, Pump Characteristics curves, Pump specific speed Types of the pumps, Pumps selection Priming the pump. Centrifugal pump relations, homologous centrifugal pump, centrifugal pumps in series and in parallel	6 hr
Total hours		30

Practical: (Fluid Flow I. lab.)

No.	Experiment Name.
1	Calibration Of Bourdon Tube Pressure Gauge
2	Impact Of Jet
3	Reynolds Experiment
4	Energy Losses In Pipes
5	Friction Losses In Piping Systems
6	Centrifugal Pump Characteristics
7	Gear Pump
8	Non-Newtonion Fluids

Program	Chemical Processing Engineering					
Course Code	CES.P.235	Credits hr				Units
Course Title	Physical Chemistry I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Chemical Engineering Principles I -Chemistry I & II	2	2	-	4	3

Course Description

Physical chemistry is the application of the methods of physical to chemical problems. Itincludes the qualitative and quantitative study. Both experimental and theoretical of the generalprinciples determining the behaviour of matter

Course Text

1. J. Laidler, Physical Chemistry and Collide Science, Bosten; Houghton M, ffl.n company, 1999.
2. G. Mortimer, Physical Chemistry and Collide Science, San Francisco; Altarcourt science and technology company, 2000.

Course Objectives : at the end of the semester the student should be able to :-

1- . Be able to solve problems involving ideal mixture and dilute solutions.

2- Understand the principles govering phase diagrams and be able to interpret phase diagrams for various kinds of systems.

3- . Be able to solve problems involving surface tension.

4- . Be able to solve several simple rate laws and to solve a variety of problems related to these solutions.

5- . Be able to apply experimental techniques to the determination of rate law and rate constant.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Chemical Kinetics:** Rate of consumption and formation, rate of reaction, empirical rate equation, order of reaction (zero, 1st , 2nd , 3ed) , reactions having no order, rate constants and rate coefficients, enzyme reactions kinetics , analysis of kinetic results.	10 hr
2	**Surface chemistry:** Adsorption, adsorption isotherms, surface tension and capillary rise, solid- liquid interfaces, colloidal systems, electrical properties of colloidal systems, gels, emulsions.	10 hr

3	**PhaApplications of the equations of ideal gases:** The PVT behaviour of pure substances, the ideal gas, the constant volume process, the constant pressure process, the adiabatic process, the polytropic process.	**10 hr**

Practical: (phy. Chem. lab.)

No.	Experiment Name.
1	**Hydrolysis of Hydrogen Peroxide at the Presence of Catalyst**
2	**Saponification of Ethyl Acetate**
3	**Surface Chemistry Adsorption by Solid from Solution**
4	**Determination of the Surface Tension for Liquids**
5	**Viscosity**
6	**Three component system**

<table>
<tr><td rowspan="2">Program</td><td colspan="6">Chemical Processing Engineering</td></tr>
<tr><td>CES.P.223</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Computer Programming I</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Basic Principles of Chemical Engineering I.
-Mathematics I.</td><td>1</td><td>2</td><td>1</td><td>4</td><td>2</td></tr>
</table>

Course Description

To introduce chemical engineering students to modern calculating tool used in the practice of engineering by being able to construct plots, fit data, and use built-in functions in MATLAB.

Course Text

1- RudraPratap: Getting started with MATLAB 7, Oxford Press (Indian edition),2006.

2- Desmond J. Higham and Nicolas J. Higham: Matlab Guide, SIAM, 2000.

Other support books: -

1- Duane Hanselman and Bruce Littlefield: Mastering Matlab-6: A Comprehensive Tutorial and Reference, Prentice Hall, 2001.

2- Schilling R. J., Harries S.L., Applied Numerical Methods for Engineers using MATLAB & C, Thomson Books, 2002.

Course Objectives: at the end of the semester the student should be able to :-

1- Develop the confidence necessary to successfully solve Mathematical problems with a computer.
2- Formulate and write structured code in MATLAB.
3- Understand the foundation behind the basic numerical methods for Matrix manipulations.

TopicsCovered (Syllabus)/CourseTitle

No.	Contents	Duration
1	**StartingWithMatlab:** MATLAB windows , Menus and the toolbar, Working in the commandwindow , Arithmetic operations with scalars , Display formats , Elementarymathbuilt-infunctions,Usefulcommandsformanagingvariables,Script filesandtheEditorDebugger,MatlabHelpSystem	2 hr
2	**ALGEBRA:** Symbolicobjects,andsymbolicexpressions,Changingtheformofanexistingsymbolicexpression,Solvingalgebraicequations,Differentiation, Integration, Solving anordinary differential equation.	2 hr
3	**Vector:** Only one row and a column vector has only one column. Entering Vectors and Matrices,ColumnVectors,Transposing,Vectors Addition and subtraction,Vectorsmultiplication,element-wise operation,The Colon Operator,The Colon Operator,Other Operations on Vectors(length,size,find,sum,max,min,mean,sort,all,abs)	2 hr
4	**Interpolation :** One-Dimensional Interpolation(interp1), Two-Dimensional Interpolation(interp2)	1 hr
5	**Polynomials in Matlab :** Roots,PolyVal, Polyfit	2 hr
6	**Matrices:** Entering matrices, Transpose, Matrix operations Addition and subtraction, Matrix multiplication, Matrix division, Element-wise operation, The Colon Operator, Referencing elements, Matrix Inverse, Predefined Matrix, Other Operations on Matrix	2 hr
7	**Matrix Algebra:** Introduction, Solving Linear Equations Using Matrix Algebra.	2 hr
8	**Condition:** If Statement, Loop(For loop, While Loop), Break statement	2 hr

Practical: (Computer Programming. lab.)

No.	Experiment Name
1	StartingWithMatlab
2	ALGEBRA
3	Vector
4	Interpolation
5	Polynomials in Matlab
6	Matrices
7	Matrix Algebra
8	Condition

Program	*Chemical Processing Engineering*					
Course Code	**CES.P.225**	Credits hr				Units
Course Title	Material Eng. I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	1-Eng. Mechanics & Strength of material 2-Chemistry I & II	**2**	**-**	**1**	**3**	**2**

Course Description

Introduction to classification of materials and the atomic structure of it, Study the mechanical, thermal and electrical properties of materials and Crystal structure and imperfection in solid materials.

Course Text

1-Donaled R. Askeland, The science and engineering of materials, international student edition, 2006 .
2-William D. Callister, Jr. , Materials science and engineering, Fifth edition, 2000.
3-Lawrence H. Vanvlack , Elements of materials science and engineering, Fifth edition, 1987.

Course Objectives : at the end of the semester the student should be able to :-

1- Describe and solve problems on atomic arrangement and geometry of imperfections.
2- Describe and solve problems on mechanical, thermal and electrical properties of materials.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Classification of Materials:** Classification of materials, classification of materials based on structure, advanced materials	**4 hr**
2	**Mechanical Properties of Materials:** Stress-strain behavior, ductility, brittleness, toughness, modulus of resilience, poison's ratio, hardness, effect of temperature.	**6 hr**
3	**Atomic structure:** The structure of atom, atomic bonding, bonding energy and inter-atomic spacing	**6 hr**
4	**Atomic order in solids :** Types of atomic or ionic arrangements, crystal structure, lattice, unit cells, metallic crystalstructure, crystal systems, crystal direction and crystal planes, diffraction techniques for crystal structure analysis	**8 hr**
5	**Thermal and electrical properties of materials:** Heat capacity, thermal expansion, thermal conductivity, thermal stresses, Glass transition temperature, Creep resistance, electrical conductivity, electron mobility, electrical resistivity of metals	**6 hr**

Program	*Chemical Processing Engineering*					
Course Code	**CES.P.237**	Credits hr				Units
Course Title	Fuel's and Energy Engineering					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemistry I & II	**2**	**2**	**0**	**4**	**3**

Course Description

Introduction to fuels technology (solid, liquid, and gases).Procedure and characterization in terms of physic-chemical properties of these fuels.

Course Text

1. Speight, J.G, Handbook of petroleum product analysis, John Willey&Sons, 2002.
2. SpeightJ.G.and Ozum, B; Petroleum Refinery processes, MacelDekker, NewYork, 2002.
3. SpeightJ.G. The chemistry and Technology of petroleum, 3rdEdition.Marcel Dekker, NewYork1999.
4. Petroleum Fuels manufacturing handbook; Surinder Parkash, McGraw-Hillcompanies, 2010.
5. Fundamentals of Petroleum and Petrochemical Engineering, Uttam Ray Chaudhuri, Taylor & Francis Group, 2011

Course Objectives: at the end of the semester the student should be able to :-

1- Introduces basic knowledge about solid, liquid and gases fuels, their origin, classification.
2- Knowledge of preparation, procedure and characterization in terms of physic-chemical properties
3- Knowledge in liquid fuel section. Petroleum is the liquid fuel which is elaborated in terms of distillation and secondary processing. Different important gaseous fuels are included in gaseous fuel section.

Topics Covered(Syllabus)/ Fuel and Energy Engineering

No.	Contents	Duration
1	**Introduction**: Historyoffuels,historyofsolidfuel,historyofliquidfuelsandgasesfuels, Fundamentaldefinition, propertiesofliquidandgaseousfuels, variousmeasurement.	**2 hr**
2	**Coal:** Classification, Composition and basis, coalpreparation and washing, combustion of coalandcoke and making, coaltardistillationcoalliquefaction, coal gasification.	**4 hr**

3	**CrudePetroleum:** Exploration of crude Petroleum, Evaluation of crude, distillation cracking, thermalcrackingcatalyticcracking, reforming of naphtha, hydrotreatment, dewaxingdeasphalting, refinery equipment.	6 hr
4	**Natural gas and LPG:** Producergas, watergas, otherfuelgases.	4 hr
5	**CombustionairCalculation:** Calculation ofcalorificvalueoffuels, flameproperties, combustionburners, combustionfurnaces.	6 hr
6	**Energy Engineering:** Past, Present and Future Energy Use Bioenergy, Geothermal Energy and Nuclear Energy, Solar Energy and Solar Photovoltaics, Wind, Ocean Wave, Tide, Current, and Thermal Energy Conversion, and Energy Carriers and Fuel Cells.	8 hr

Practical: (Fuel's & Energy Engg Lab)

No.	Experiment Name.
1	**ASTM distillation exp.**
2	**Density and specific gravity exp**
3	**Viscosity& viscosity index exp.**
4	**Salt content in crude oil**
5	**Gum and gum stability**
6	**Flash & fire point**
7	**Ash content for petroleum products**
8	**Conrad Son Carbon residue of petroleum**

University of Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical Processing Engineering</td></tr>
<tr><td>Course Code</td><td>CES.P.222</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Mathematics IV</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Mathematics I, II, III</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td></tr>
</table>

Course Description

This course describe the providing of knowledge on solving ordinary differential equations and applications of first order ordinary differential equations and chemical engineering applications of the theory portion covered will be emphasized.

Course Text

Text book:

1. Higher Engineering Mathematics by Dr.B.S.Grewal, Khanna Publishers, 40th Edition, 2007.

Reference book:

1. Advanced Engineering Mathematics by Erwin Kreyszig, 8th edition, 2007.

Course Objectives: at the end of the semester the student should be able to:-

1- Understand methods of solving First order and Higher order ordinary differential equations along with some physical applications.
2- Demonstrate the relevance of the mathematical methods learnt to chemical engineering.

Topics Covered (Syllabus)/ Mathematics IV

<table>
<tr><th>No.</th><th>Contents</th><th>Duration</th></tr>
<tr><td>1</td><td>Ordinary Differential Equations:
Introduction,
First Order Ordinary Differential Equations:
Variable Separable Equation
Homogenous Equation
Exact Equation
Linear Equation
Bernoulli, s Equation.
Second Order Ordinary Differential Equations:
Non-Linear Differential Equations
Equations with Dependent Variable Missing
Equations with Independent Variable Missing
Homogenous Equation
Linear Differential Equations
Equations with Constant Coefficient</td><td>10 hr</td></tr>
</table>

	• Equations with Coefficients as a Function of the Independent Variable • **Higher Order Ordinary Differential Equations.** • Simultaneous Differential Equations. • Series Solution of Differential Equations.	
2	**Application of Ordinary Differential Equations:** Representation problems of 1st and 2nd ordinary differential equations (linear and nonlinear, homogeneous …etc.).	**5 hr**
3	**Solution by Series:** • Infinite series by Taylor theorem, • Method of Frobenius (Case I, II, IIIa, and IIIb), • Bessels's and Modified Bessel's Equation, • Properties of Bessel Functions, • Applications in chemical engineering, • Tubular Gas Preheater, • Reaction in axisymmetric Spherical and Cylindrical pellets.	**15 hr**

University of Technology
Department of Chemical Engineering

Program	***Chemical Processing Engineering***					
Course Code-	**CES.P.232**	Credits hr				Units
Course title	Chemical Engineering Principles III					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemical Engineering Principles I, Chemical Engineering Principles II	2	–	1	3	2

Course Description

Understanding the basic concepts and expressions in chemical engineering and learning calculations related to chemical reactions, energy balance,

Course Text

- D.M.Himmelblau and J.B.Riggs ,Basic Principles and Calculations in Chemical Engineering ,7th Edition , 2004 .
- R.M.Felder and R.W.Rousseau ,Elementary Principles of Chemical Processes ,3rd Edition ,2005 .

Other support books :-

Skogestad, S. (2008). Chemical and energy process engineering. CRC press.

Course Objectives: at the end of the semester the student should be able to:-

1- Have a deep knowledge, wide scope and improved understanding of the mechanisms in heat balance as well as a better insight into analytical and empirical methods applied in analysis of energy balance related problems.
2- Gain knowledge for applying the energy (equation) balance in chemical engineering problems.
3- To provide experience for students to solve energy balance for different process

Topics Covered (Syllabus)

No.	Contents	Duration
1	**Introduction, Basic concept and definitions** ➢ First law of thermodynamics ➢ Temperature integral heat capacity (mean heat capacity) ➢ - Latent heat temperature dependence	**2 hr**
2	**General Energy Balance Without Chemical Reaction** ➢ Energy Balance on Closed System ➢ -Energy Balance on open System ➢ -Heat Capacity ➢ -Sensible & latent heat principles	**8 hr**
3	**Calculation of Enthalpy Change** ➢ Enthalpy Change Without Change in Phase ➢ Enthalpy Change Including Phase Transition	**8 hr**
4	**General Energy Balance With Chemical Reaction** ➢ Standard Heat of Formation ➢ Standard Heat of consumption ➢ Standard Heat of Reaction ➢ Heat of reaction temperature dependence ➢ Heat effects of industrial reactions	**12 hr**

University of Technology
Department of Chemical Engineering

Program	***Chemical Processing Engineering***					
Course Code	**CES.P.234**	Credits hr				Units
Course Title	Fluid Flow II					
Term	2^{nd}Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Fluid Flow I, Chemical Engineering Principles II, Physical Chemistry I & II	**2**	**2**	**1**	**5**	**3**

Course Description

Define and show the student what about related with fluid flow measurements types and principles. Course material includes an introduction to the concepts and applications of compressible fluid flow and compressors, analysis of engineering applications of liquid mixing with their power consumption. Fluid flow though packed bed fluidization and transportation of particles.

Course Text

1. Coulson, J.M and Richardson J.F. “Chemical Engineering, volume 1”, Fifth edition 2002, Elsevier Science, Linacre House, Jordan Hill, Oxford
2. Coulson, J.M and Richardson J.F. “Chemical Engineering, volume 2”, Fifth edition 2002, Elsevier Science, Linacre House, Jordan Hill, Oxford
3. F.A. Holland and R. Bragg “Fluid Flow for Chemical Engineers”, 2^{nd} Ed. (1995) Elsevier Ltd.

<u>Other support books :-</u>

1. DARBY. R., M. Dekker “Chemical Engineering Fluid Mechanics”, 2^{nd}Ed. (2001)
2. James O. Wilkes “Fluid Mechanics for Chemical Engineers”, Prentice Hall PTR, New Jersey, USA, 1999.
3. De Nevers, N. “Fluid Mechanics for Chemical Engineers”, (1991) McGraw-Hill, Singapore.

Course Objectives: at the end of the semester the student should be able to :-

1. Recognize the compressible fluid flow, pumping tools of the compressible fluid flow, fluid flow measurements, liquid mixing and its power consumptions, flow through packed columns, fluidization and particles transportation.
2. Define the problems in fluid dynamics in various engineering applications. Distinguish the energy variation and its applications spatially the frictional energy losses calculations and the required energy for fluid pumping.
3. Define the necessary fluid parameters of full scale projects by performing simple model experiments and share ideas and work in a team in an efficient and effective manner under controlled supervision or independently.

Topics Covered (Syllabus)/ Fluid Flow II

No.	Contents	Time
1	Flow Measurement Flow in closed channels: Pitot tubes, Orifice meter, Venturi meter, Nozzle meter, Rotameters, special flow measurements Hot wire and other types of flow meters, Flow in open channels and weirs: Rectangular, Triangular and Trapezoidal notches with unsteady state applications;	6 hr
2	Flow of Compressible Fluid General energy equation, Sonic velocity and Mach No., Isothermal, and Adiabatic flow of an ideal gas in pipes, maximum fluid velocity. Compressible fluid flow through converging-diverging nozzle. Types of gas pumping equipment, Compressors & gas compression cycle (ideal and real, single and multistage) with total work done.	8 hr
3	Liquid Mixing Stirring and mixing types, Stirred vessels (power consumption, power curves, scaled-up), Equation of motion for rotational flow (vortex).	6 hr
4	Motion of Particles in a Fluid Drag force on a particle, terminal falling velocities of fine and coarse particles	4 hr
5	Flow of Fluid through Granular Bed and Packed Columns Pressure drop in granular beds (fixed packed columns): Packings types and specification, Pressure drop relations (Darcy, Kozeny and Kozeny - Carmen equations)	4 hr
6	Fluidization and Particles transportation Minimum fluidization velocity, Pressure, Pressure drop, Ergun equation, bed expansion and transport of particles.	2 hr
Total hours		**30**

Practical: (Fluid Flow Lab)

No.	Experiment Name
1	Bernoulli's Theorem Demonstration
2	Discharge Through An Orifice
3	Flow Through Venturi Meter
4	Open Channel Flow Over Weir
5	Flow Of Compressible Fluid
6	Forced Vortex
7	Fluidization

<table>
<tr><td>Program</td><td colspan="6">Chemical Processing Engineering</td></tr>
<tr><td>Course Code</td><td>CES.P.236</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Physical Chemistry II</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Physical Chemistry I</td><td>2</td><td>-</td><td>-</td><td>2</td><td>2</td></tr>
</table>

Course Description

In this semester deals with the various transformations that can be brought about an ideal gases have played a very important part in the development of thermodynamics. It is include properties of solutions of electrolytes and with processes that occur at electrodes. It concerned with galvanic cells, in which a chemical reaction produce an electric potential difference between two electrodes.

Course Text

1. J. Laidler, Physical Chemistry and Collide Science, Bosten; Houghton M, ffl.n company, 1999.
2. G. Mortimer, Physical Chemistry and Collide Science , San Francisco; Altarcourt science and technology company, 2000.

Course Objectives : at the end of the semester the student should be able to :-

1- 1. Be able to solve problems related to the macroscopic equilibrium properties of gases and liquid.
2- Understand how the thermodynamics of non simple system is applied to electrochemical cells.
3- . Be able to calculate cell voltages for standard conditions and other conditions using standard reduction potentials and the nerst equation.
4- Be able to solve problems relating equilibrium constants and Gibbs energy changes to electrochemically measured quantities.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Phase Equilibria:** Equilibrium between phases, one component systems, binary systems involving vapor, liquid vapor equilibria of two component system, liquid vapor equilibrium in system not obeying Raoults law, temperature composition diagram (boiling point curves), distillation, azeotropes, solubility of gases in liquids.	**10 hr**

2	**Solutions of electrolytes :** Electrical units, Faradays laws of electrolysis, molar conductivity, weak electrolytes, strong electrolytes, activity and ionic strength, determination of activity coefficient from solubility, the Debye-Hackle theory, acid- base catalysis and their dissociation constant.	10 hr
3	**Electrochemical cells:** Electromotive force (EMF) of a cell, measurements of EMF- the potentiometer, the polarity of electrodes, the cell reactions and reversible cells, free energy and reversible cells, typical of half-cell's classification EMF, standard electrode potentials, standard free energy and energy of aqueous ions, calculation of EMF of cell, oxidation reduction reactions, concentrations cells, electrolysis.	10 hr

Universityof Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical Processing Engineering</td></tr>
<tr><td>Course Code</td><td>CES.P.224</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Computer Programming II</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Basic Principles of chemical engineering I.
Mathematics I.
Computer Programming I</td><td>1</td><td>2</td><td>1</td><td>4</td><td>2</td></tr>
</table>

Course Description

To introduce chemical engineering students to modern calculating tool used in the practice of engineering by demonstrating an ability to create small structured programs in a MATLAB programming environment and understanding how user written functions interact with numerical methodsroutines.

Course Text

1. RudraPratap: Getting started with MATLAB 7, Oxford Press (Indian edition),2006.
2. Desmond J. Higham and Nicolas J. Higham: Matlab Guide, SIAM, 2000.

Other support books :-

1. Duane Hanselman and Bruce Littlefield: Mastering Matlab-6: A Comprehensive Tutorial and Reference, Prentice Hall, 2001.
2. Schilling R. J., Harries S.L., Applied Numerical Methods for Engineers using MATLAB & C, Thomson Books, 2002.

Course Objectives: at the end of the semester the student should be able to:-

1- Solve sets of linear and nonlinear equations using numerical methods as well as in-built MATLAB functions.

2- Apply numerical methods and MATLAB functions to differentiate and integrate a function or a set of discrete points.

3- . Apply explicit and implicit numerical methods and MATLAB functions to integrate single and multiple sets of initial value problems

Topics Covered (Syllabus)

No.	Contents	Duration
1	**Two-dimensional plot:** The plot command ,Using the plot Command ,Line styles, Markers, and Colors ,Adding Grids, Labels, Text, or a Legend ,Customizing Axes ,Plotting multiple graphs in the same plot ,Multiple figure windows (subplot command) ,Plots with special graphics ,The fplot , ezplot command ,area, bar,barh, stairs ,semilogx,semilogy,log log, errorbar,stem, plotyy ,Histograms ,Polar ,Pie,erf.	2 hr
2	**Three dimensional plot :** plot3 ,Meshgrid ,mesh ,surf ,ezmesh ,ezplot3 ,ezsurf ,cylinder ,sphere	1 hr
3	**Functions :** Functions types: local function, Nested function, Anonymous function, function Handle ,Creating and calling a local function file ,Structure of a local function file ,Local and global variables in local function ,Saving a local function file ,Examples of simple local function(user-defined functions) ,Comparison between script files and function files ,Add local functions ,Sub-local functions ,Nested functions ,Anonymous Functions ,Multiple Anonymous Functions ,Anonymous Functions with No Inputs ,Anonymous Functions with Multiple Inputs or Outputs ,Function Handle ,What Is a Function Handle? ,Creating Function Handles ,Create handles to anonymous functions ,Saving and Loading Function	4 hr
4	**Introduction to Numerical analysis:** Numerical solution of of Differential Equations ,Ordinary Differential Equation ,Euler's Method	2 hr
5	**Differential Equations:** Numerical solution of multi simultaneous differential equations,Runge-KuttaMethod,Integration two or more coupled first-order ODE's,MATLAB Built-In Routines for solving ODES	2 hr
6	**Partial differential equations:** Numerical solution of partial differential equations,Higher order ode's,Non-Linear Equation Solving MATLABs built-in function: (fsolve).	2 hr
7	**Numerical Analysis applications in Chemical Engineering:** Solving chemical engineering problems	2 hr

Practical: (Computer Programming. lab.)

No.	Experiment Name
1	Two-dimensional plots
2	Three dimensional plots
3	Functions
4	Introduction to Numerical analysis
5	Differential Equations
6	Partial differential equations:
7	Numerical Analysis applications in Chemical Engineering

Universityof Technology
Department of Chemical Engineering

Program	*Chemical Processing Engineering*					
Course Code	**CES.P.226**	Credits hr				Units
Course Title	Materials Eng. II					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Materials Eng. I	**2**	**2**	**1**	**5**	**3**

Course Description

Imperfection in solid. diffusion and atomic movement in solid. Solid solution and phase diagram for different alloys. Ceramic materials and composite materials.

Course Text

1-Donaled R. Askeland, The science and engineering of materials, international student edition, 2006 .
2-William D. Callister, Jr. , Materials science and engineering, Fifth edition, 2000.
3-Lawrence H. Vanvlack , Elements of materials science and engineering, Fifth edition, 1987.

Course Objectives : at the end of the semester the student should be able to :-

1- Describe the geometry of imperfections
2- Calculate the extent of diffusion- driving composition changes based upon composition, time and temperature.
3- Predict the equilibrium microstructure of a material given the binary phase diagram, thermal history of the materials.
4- Describe the types and properties of ceramic and composite materials.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Imperfections in solids:** Point defects, line defects, interfacial imperfections, Macroscopic defects	6 hr
2	**Atomic and ion movements in materials:** Stability of atoms and ions, mechanisms for diffusion, rate of diffusion (Fick's first law), factors affecting diffusion, non-steady state diffusion (Fick's second law) .	6 hr
3	**Solid solutions and phase diagrams:** Basic concepts, solubility and solid solution, phase and phase diagram, unary phase diagram, binary Iso-morphous system, binary eutectic system.	6 hr
4	**The Iron-Carbon system:** The Iron-Iron carbide phase diagram, development of microstructures in Iron-carbon alloys	6 hr
5	**Ceramic materials :** Crystal structure, mechanical properties of ceramic, classification of ceramic materials on the basis of its application	2 hr
6	**Composites**: Material combination, Reinforced composites, structural composites.	4 hr

Practical: (Materials Eng. lab.)

Exp. No.	Exp. Name.
1	Tension test
2	Hardness Testing
3	Bending Test
4	Creep Test
5	Abrasion Test
6	Impact Test
7	Moisture Measurement in Engineering Materials
8	Determination of Linear Thermal Expansion for a Solid
9	Microstructure Examination of pb-Sn alloys using the metallurgical microscope

University of Technology
Department of Chemical Engineering

Program	*Chemical Processing Engineering*					
Course Code	**CES.P.227**	Credits hr				Units
Course Title	Statistics					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematics I, Mathematics II	**2**	**0**	**1**	**3**	**2**

Course Description

The subject is to be given in one semester its consists of organization of data & summarized in a frequency distribution table which is graphically represented, and determination of dispersion & center measurement, study of continuous & discrete probability distribution, curve fitting and least square method & the study of chi square distribution. Use of statistical methods in relation to applications of environmental engineering sciences, analysis of industrial problems and oil pollution

Course Text

1. Statistics, Murray R. Spiegel, 7 Ed. 2009
2. Statistical methods for technologists, C.G. Paradise.2005
3. Statistical Methods in Analytical Chemistry, Peter C. Meier and Richard E. Zund, 2 Ed, A Wily-Intercedence Publication,2000

Course Objectives: at the end of the semester the student should be able to: -

We are teaching students how to use statistical methods.
Application of statistical methods in the description and analysis of data.
Use statistics to solve different problems and comprehend measurement instruments' fundamental principles.

Topics Covered (Syllabus)/ statistics

No.	Contents	Duration
1	Introduction, statistics population, descriptive and inductive statistics. Tutorial	2 hr
2	Frequency distribution table, types of frequency.Tutorial of frequency distribution table. Tutorial	2 hr
3	Graphical representation of frequency distribution table. Tutorial	2 hr
4	Measures of Location, Mode, Median, Arithmetic Mean, and Other Mean Measures.	2 hr
5	First exam Measures of Dispersion, Mean Absolute Deviation, Standard Deviation, Variation, Coefficient of Variation, Properties of Z, Tutorial.	2 hr
6	Probability distribution, Discrete Prob. Distribution, continuous & discrete probability dist., normal dist., table of the area under normal dist., Tutorial	2 hr
7	Tutorial and the binomial distribution, Approximation of binomial dist., normal & Poisson dist., Tutorial.	2 hr
8	The chi-square test, confidence intervals, Test of independence	2 hr
9	degree of a significant test، Test of hypothesis، Chi-square test for goodness of fit, Tutorial	2 hr
10	second exam Curve fitting, least squares method, variance, and correlation coefficient.	2 hr
11	Tutorial of the least square methods.	2 hr
12	Multiple and partial correlations.	2 hr
13	Normal equations for the least square regression, Tutorial.	2 hr
14	Coefficient of correlation. Tutorial in partial correlation.	2 hr
15	Tutorial	2 hr

Program	***Chemical Processing Engineering***					
Course Code	**CES.P.331**	Credits hr				Units
Course Title	Thermodynamics I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemical Engineering Principle II, Physical Chemistryand ,Fluid Flow	**2**	**0**	**1**	**3**	**2**

Course Description

The course of chemical engineering thermodynamics I comprises the study of volumetric properties of pure fluids; Entropy and second law analysis of engineering systems; Thermodynamic properties of fluids; Applications of thermodynamics to flow processes.

Course Text

1- J. M. Smith,H.C.Van Ness, Introduction to chemical engineering thermodynamics, 6th edition (International Edition), Mc-Graw Hall, 2008.

Other support books :-

2- K.V.Narayanan, Atext book of chemical engineering thermodynamics, prentice Hall of India, New Delhi, 2011.

3- B.G.Kyle, Chemical and process thermodynamics, (3rd Edition), prentice Hall Inc.New Jersey, 1984.

4- J. Rayner, Basic engineering thermodynamics inSI units, printed in great Britain,1971.

Course Objectives: at the end of the semester the student should be able to :-

1-To familiarize the students with basic concepts of the first and second laws of thermodynamics and their applications in engineering problems.

2-Develop a practical ability to solveChemical Engineering Principle IIproblems, minimum work.

3- Students will demonstrate basic understanding of basics and definitions of thermodynamics and properties of pure substances.

4-Describe the reversible and irreversible processes (macroscopic description of ideal and real processes).

Topics Covered (Syllabus)/ Course Title

No.	Content	Duration
1	**Introduction** Basic definitions, work, energy, heat, types of systems, extensive and intensive properties, thermodynamic processes, zero law of thermodynamics, 1st law of thermodynamic, energy balance for open and close system	2 hr
2	**Volumetric properties of pure fluids** Review on virile equation of state, cubic equation of state, generalized correlations for gases and for liquids.	6 hr
3	**The 2nd law of thermodynamics** Review on the 2nd law and Carnot heat engine, entropy balance for open system, calculation of ideal work, lost work.	6 hr
4	**Heat capacity** Heat effect, heat capacity calculations, sensible heat, latent heat, standard heat of reaction, heat effect of industrial reactions.	4 hr
5	**Thermodynamic properties of fluids** Review on the property relations (ΔH, ΔS, ΔUandΔG□ residual properties, two phase systems, thermodynamic diagrams and tables, generalized Property correlations for gases.	6 hr
6	**Applications of thermodynamics to flow processes** Duct flow of compressible fluids, pipe flow, nozzles, throttling process, turbines, compression processes compressors, ejectors	6 hr

University of Technology
Department of Chemical Engineering

Program	*Chemical Processing Engineering*					
Course Code	**CES.P.321**	Credits hr				Units
Course Title	Numerical Analysis					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Computer Programming I, II	**2**	**2**	**1**	**5**	**3**

Course Description

This course introduces students to: Error analysis; Finding roots of a non-linear function; Approximation and interpolation; Numerical integration and differentiation; direct and indirect solution of systems of linear equations; Solution of systems of nonlinear equation; solving ordinary differential equations and partial differential equations. All examples within the course concerning with principles of chemical engineering.

Course Text

1. "Numerical Methods for Engineers", Steven C. Chapra, Raymond P. Canale, McGraw Hill, 6th edition, 2010.
2. "Numerical Methods for Engineers and Scientists", Joe Hoffman, McGraw-Hill Book Company,1993.
3. "Applied Numerical Analysis", Gerald,C.F. and Wheatley, P.O., 6th Edition, Pearson Education, 2006.
4. "Numerical Methods for Chemical Engineers with MATLAB Applications", AlkisConstantinides, NavidMostoufi, Prentice Hall, 1999.

Course Objectives: at the end of the semester the student should be able to:-

To solve chemical engineering problems with numerical analysis techniques.

Topics Covered (Syllabus)/Numerical Analysis

No.	Contents	Duration
1	**Introduction to Numerical Analysis:** • Numerical Solution, type of errors; relative error, absolute error, percentage error, truncation error, round off error. Floating point.	2 hr
2	**Interpolation and Polynomials Approximation:** • Lagrangian Polynomials (Linear, Quadratic, and General Form). • Newton's Divided differences (Linear, Quadratic, and General Form). • Cubic spline interpolating polynomials.	3 hr
3	**Curve Fitting**	2 hr

	• Linear regression, Polynomial Models, Nonlinear Data.	
4	**Root Finding:** • Roots of polynomials, Bisection method, Secant method, Newton-Raphson method.	**3 hr**
5	**Numerical Differentiation and Numerical Integration:** Forward, backward and central difference approximation. Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rules. Double integrals using trapezoidal and Simpson's rules.	**6 hr**
6	**Solving System of Equations:** Solution of linear system of equations by direct methods (Gaussian elimination and Gauss-Jordon). Solution of linear system of equations by Iterative methods (Jacobi and Gauss-Seidel). Solution of non-linear system of equations by Newton-raphson.	**4 hr**
7	**Solution of ordinary Differential Equations:** Initial value problems. Solution of first-order ordinary differential equations using Taylor', Eular, Runge-Kutta and Predictor-corrector methods. Solution of simultaneous ordinary differential equations.	**4 hr**
8	**Solution of Partial Differential Equations:** Types of Partial Differential Equations: Elliptic (Poisson) equation, Parabolic (heat) equation, Hyperbolic (wave) equation. Finite difference solution of Partial Differential Equations. Numerical solution of partial differential equations using explicit, implicit and Crank-Nicolson methods elliptic (Laplace) equation.	**6 hr**

Practical: (Numerical Analysis. lab.)

No.	Contents
1	**Review of properties of Matlab programming language.**
2	**Bisection method and Secant method.**
3	**Newton-raphson method.**
4	**Lagrange interpolation.**
5	**Newton’s forward and backward difference formulas.**
6	**Trapezoidal rule.**
7	**Simpson’s 1/3 and 3/8 rules.**
8	**Solution of linear system of equations by direct methods (Gaussian elimination and Gauss-Jordon).**
9	**Solution of linear system of equations by Iterative methods (Gauss-Seidel and Jacobi).**

10	**Solution of differential equation using Euler's method.**
11	**Solution of differential equation using Runge-Kutta method.**
12	**Solution of partial differential equations using explicit and implicit methods.**
13	**Solution of partial differential equations using Crank-Nicolson method.**
14	**Solution of steady state diffusion through catalyst**
15	**Solution of un-steady state diffusion through catalyst**

University of Technology
Department of Chemical Engineering

Program	*Chemical Processes Engineering*					
Course Code	**CES.P.333**	Credits hr				Units
Course Title	Mass Transfer					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemical engineering principles II &III, fluid flow I & II	**2**	**2**	**1**	**5**	**3**

Course Description

This course covers diffusion and mass transfer in binary& multi-components, molecular diffusion in fluids, convective mass transfer, mass transfer coefficients, mass transfer correlations, interphase mass transfer, mass transfer theories.

Course Text

1- Coulson, J. M & Richardson J. F. (2006). "Chemical engineering, Volume 1", 3rd Edition, Robert Maxwell. M. C.

2- Dutta Binary K. (2007), "Principles of Mass Transfer & Separation Process", Bvt. Ltd. Prentice Hall, ISPN 8-1203-2990-2.

Other support books:-

1- Treybal Robert E. (1975), "Mass transfer Operation" 2ed Edition, Mc-Graw-Hill Book.

2- McCabe, W., Smith, J., Harriott, P. (2004), "Unit Operations of Chemical Engineering", M Graw-Hill Co., 7th Edition, ISBN0072848235.

Course Objectives: at the end of the semester the student should be able to:-

1- Understand the basics of diffusion as applicable to mass transfer phenomena.
2- Estimate Molar fluxes in convective and inter phase mass transfer.
3- Explain the concept of diffusion theories.
4- Applying the convective mass transfer correlations to calculate mass transfer rates in many units operation.

Topics Covered (Syllabus)/ Mass transfer

No.	Contents	Duration
1	**Introduction :** Fundamentals of mass transfer processes, concentrations, velocities, mass & molar fluxes.	**2 hr**

2	**Diffusion in binary gaseous :** Fick's first law of diffusion. Diffusion in gas mixtures, Equimolecular diffusion, diffusion in stationary layer. Correlations to calculate diffusivity, correcting diffusivity	6 hr
3	**Diffusion in multi component mixtures:** Multi-component gas phase systems, effective diffusivity. Maxwell's law of diffusion	4 hr
4	**Diffusion in liquids.**	2 hr
5	**Diffusion in solids.**	2 hr
6	**Diffusion theories**: Diffusion across phase boundary, Film theory, two film theory, Mass transfer coefficients (individual & overall) in laminar and turbulent flow.	4 hr
7	**Diffusion resistances:** Calculating the resistance to mass transfer in both phases. Calculating intermediate concentrations.	4 hr
8	**Unsteady state mass transfer:** Introduction to unsteady state mass transfer, mass transfer accompanied by a chemical reaction.	6 hr

Practical: (Mass Transfer. lab.)

No.	Experiment Name
1	Liquid-Liquid diffusion
2	Absorption
3	Batch Distillation Column
4	Fluid Mechanics of Packed Bed
5	Sieve Analysis
6	Gas - Solid Fluidization

<table>
<tr><td>Program</td><td colspan="6">Chemical Processing Engineering</td></tr>
<tr><td>Course Code</td><td>CES.P.335</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Chemical Reaction Kinetics</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Physical Chemistry II</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td></tr>
</table>

Course Description

Theory,Kinetic parameters and rate law, multiple reactions, yield and selectivity, stoichiometric considerationsand collection and analysis of rate data
.

Course Text

1-Octave Levenspiel (1999), Chemical Reactor Engineering, 3rd edition, John Wiley & Sons Inc., USA ISBN: 9780471254249.

2-J.M. Smith (1987), Chemical Engineering Kinetics, 3rd edition, McGraw-Hill International Editions, Singapore. ISBN: 9780070587106

Other support books :-

1- Ronald W. Missen; Charles A. Mims; Bradley A. Saville (1999), Introduction To Chemical Reaction Engineering And Kinetics, 1stedition, John Wiley & Sons Inc.,USA.

Course Objectives : at the end of the semester the student should be able to :-

This course aims to establish fundamental knowledge for the students in chemical reaction kinetics. At the end of this course, students should be able to:-

(i) Interpret and analysechemical reaction kinetics data.
(ii) Apply reaction kinetics principles in chemical reaction.
(iii) Identify and formulate problems in chemical reaction kinetics and find appropriate solutions.

Topics Covered (Syllabus)/ Chemical Reaction Kinetics

No.	Contents	Duration
1	**Introduction to reactor design:** L1: Interpretation of rate data, scale-up, and design L2: Classification of reactors.	**2 hr**
2	**Kinetic parameters and rate law:** L3: Definition in terms of reacting compounds and reaction extent; irreversible and reversible reactions, homogeneous catalyticreactions, conversion, yield. L4: Rate laws, stoichiometry, reaction order and elementary reactions. L5: Reaction rate constants, Arrhenius equation andvan't Hoff equation and Heat of reaction. L6: Temperature and pressure effects on reaction rates.	**8 hr**

3	**Reactors design and Stoichiometry:** L7: Mole Balances. L8: Batch Reactor Design Equations. L9: Design of Continuous Stirred-Tank Reactor. L10: Design of Plug Flow Reactor. L11: Stoichiometry in batch systems. L12: Stoichiometry in flow systems. L13: Reversible Reactions and EquilibriumConversion.	10 hr
4	**Multiple reactions, yield and selectivity:** L14: Types of multiple reactions. L15: Definitions of yield and selectivity. L16: Analysis of parallel, series, consecutive reactions. L17: Effect of pressure and temperature on multiple reactions. L18: The Denbigh reaction and its special cases.	10 hr

Universityof Technology
Department of Chemical Engineering

Program	*Chemical ProcessingEngineering*					
Course Code	**CES.P.337**	Credits hr				Units
Course Title	Heat transfer I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Fluid Flow II & Math III & IV	**2**	**0**	**1**	**3**	**2**

Course Description

The course will introduce the fundamental concepts of various modes of heat transfer. Additionally, it will elaborate these concepts with theories and applications to solve practically relevant chemical engineering problems. Moreover, this course will help students formulate the models necessary to study, analyze and design heat transfer systems by applying these principles. Furthermore, this course will focus on developing problem-solving skills, which are essential to good heat transfer engineering practice in real-world applications.

Course Text

1- - Holman, J.P. (2009) Heat Transfer. 10th Edition, McGraw-Hill, New York.

Other support books: -

2- Harker, J. H., J. R. Backhurst, and J. F. Richardson. Chemical Engineering Volume 1. Vol. 1. Elsevier, 2013

3- Incropera, Frank P., David P. DeWitt, Theodore L. Bergman, and Adrienne S. Lavine. Fundamentals of heat and mass transfer. Vol. 6. New York: Wiley, 1996.

Course Objectives: at the end of the semester the student should be able to:-

1. Understand the fundamental laws of heat transfer.
2. Account for the consequence of heat transfer in thermal analyses of engineering systems.
3. Analyze problems involving steady-state heat conduction in simple geometries.
4. Develop solutions for transient heat conduction in simple geometries.
5. Understand the fundamentals of the convective heat transfer process.
6. Evaluate heat transfer coefficients for forced convection over exterior surfaces.
7. Evaluate heat transfer coefficients for forced convection inside tubes and ducts.
8. Contribute to the ability of the student to identify, formulate, and solve engineering problems.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction** • Cover syllabus and introduction to class • Temperature scales • Conduction Heat Transfer • Thermal Conductivity • Convection Heat Transfer • Radiation Heat Transfer	**4 hr**

2	**Steady State Heat Conduction in One Dimension:** • The Plane Wall • Heat conduction through a composite wall • Radial Systems • The Overall Heat-Transfer Coefficient • Critical Thickness of Insulation • Heat-Source Systems • Cylinder with Heat Sources • Conduction-Convection Systems • Extended surfaces (Fins)	**10 hr**
3	**Unsteady-State Conduction** • Introduction • Lumped-Heat-Capacity System	**4 hr**
4	**Principles of Convection:** • Viscous Flow • Inviscid Flow • Laminar Boundary Layer on a Flat Plate • Energy Equation of the Boundary Layer • The Thermal Boundary Layer • Calculation of the heat transfer coefficient for flow over a flat plate • The Relation Between Fluid Friction and Heat Transfer	**8 hr**
5	**Empirical and Practical Relations for Forced-Convection Heat Transfer** • Introduction • Empirical Relations for Pipe and Tube Flow • Flow Across Tube Banks	**4 hr**

Universityof Technology
Department of Chemical Engineering

Program	*Chemical ProcessingEngineering*					
Course Code	**CES.P. 339**	Credits hr				Units
Course Title	Environmental Eng. & Industrial Safety					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemistry I & II	**2**	**0**	**1**	**3**	**2**

Course Description

Environment; Environmental Engineering: Pollution; Classification of air pollutants, Sources and type of air pollution, Particulate and air born particulate. Air pollution control equipment: types of equipment, its operation and its advantages and disadvantages. Design of settling chamber and cyclones. Source of water, Utilization, and classification. Type of water pollutants and its effect, Wastewater treatment. Oxygen demanding wastewater: Dissolved Oxygen DO, BOD, Oxygen sage curve and the related equations.
Industrial safety

Course Text

1- C.S.Rao, "Environmental Pollution Control Engineering", 2nd Edition, New Age International(P) Limited, Published, 2006, Reprint 2007.
2- M. Grawford, "Air Pollution Control Theory", McGraw-Hill, New York, 1976.
3- S.C.Bhatia, "Environmental Pollution and Control in Chemical Process Industries" 2nd Edition, 2009, KHANNA PUBLISHERS,New Delhi.

Course Objectives: at the end of the semester the student should be able to:-

1- Understand the concept of the environment and environmental pollution.
2- Provide solutions to environmental problems.
3- Concerned with local and worldwide environmental issues.
4- Design devices that are used in the control of air pollution.
5- Environmental engineers conduct hazardous-waste management studies in which they evaluate the significance of the hazard, offer analysis on treatment and containment.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction:** Definition: Environment, Environmental engineering, Pollution and Pollutants.	2 hr
2	**Water and Waste Water Treatment:** Source of water, Utilization of water. Types of water pollutants and their effects. Classification of wastewater. Wastewater treatment process.	10 hr

3	**Air Pollution Control:** Classification of air pollution. Source of air pollutants. Air pollutants and their effects. Case study treatment of gaseous effluent in typical industry.	**8 hr**
4	**Solid and Hazardous Wastes Law:** Solid Wastes Characterization, Nonhazardous and Hazardous solid waste, Solid wastes treatment.	**4 hr**
5	**Industrial Safety**: Hazards: Toxicity, Flammability, Explosions, Sources of ignition, Ionizing radiation, Pressure, Temperature deviations and Noise. Dow fire and explosion index. Fire and protection, Biological effects. Designing for safety, Personal protective equipment.	**6 hr**

Universityof Technology
Department of Chemical Engineering

Program	Chemical ProcessingEngineering					
Course Code	**CES.P.3310**	Credits hr				Units
Course Title	Biochemical Engineering					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	—	**2**	**0**	**0**	**2**	**2**

Course Description

General definitions, Enzymes, Bioreactors (batch and continuous), Models of enzymes kinetics, inhibition of enzyme, Mass transfer in biological reactors, classical growth curve, Fermenters, Heat transfer in biological reactors, wastewater treatment, Aerobic fermentation process.

Course Text

1-Rajiv Dutta , "Fundamentals of Biochemical Engineering",India,2007
2-Nukesh Double, "Biochemical Engineering" ,India 2007
3- James E.Bailey , David F. Oils, "Biochemical Engineering Fundamentals",2nd ,1986.

Course Objectives: at the end of the semester the student should be able to :-

1. Introduce and understanding of microorganisms.
2. Introduce the types of biochemical reactors and fermenters.
3. Introduce biochemical wastewater treatment.
4. Introduce biochemical industries.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Definitions:** Principles definitions to know the principles of bioscience	**2 hr**
2	**Classification of enzymes:** Types of enzymes and the role in bio reactors	**2 hr**
3	**Michaelies model:** Know how to calculate the reaction rate	**2 hr**
4	**Briggs model:** Know how to calculate the reaction rate	**2 hr**
5	**Calculate the parameters:** How calculate the parameters of this models	**2 hr**
6	**Mods of bioreactors:** Understand the types of bioreactors	**2 hr**

7	**Batch reactor:** Know how to calculate the reaction time	2 hr
8	**Continuous reactor:** Know how to calculate the volume of reactor	2 hr
9	**Immobilized of enzymes:** Know the advantages and disadvantages	2 hr
10	**Fermenters:** General explanation	2 hr
11	**Types of fermenters:** Know the types and choose the best depending the process	2 hr
12	**The division rate:** Know how to calculate the division rate	2 hr
13	**Heat transfer in bioreactors:** Know the basic principles of heat transfer in bioreactor	2 hr
14	**Wastewater treatment:** Know the main biological wastewater treatment	2 hr
15	**Biological industries:** Explain some biological processes	2 hr

Universityof Technology
Department of Chemical Engineering

Program	Chemical Processing Engineering					
Course Code	**CES.P.3311**	Credits hr				Units
Course Title	Equipment Design					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Fluid Flow I & II, Principles of Chemical Eng. I, II, III.,	**2**	**0**	**1**	**3**	**2**

Course Description

The course content process planning, piping and pumps network , gas-gad separation ,solid handling, hear and mass transfer equipments

Course Text

1- -Sinnott R. and Towler C; 2013 " chemical Engineering Design" 5th edition Butterworth-Heinemann
2- -Coke,A.K ;2007"Ludwig s Applied Process Design of Chemical and petrochemical Plant" vol. 1 4th edition Gulf professional Publisher

Course Objectives : at the end of the semester the student should be able to :-

The ability to apply the design equation and equipments specifications as practical

To prepare students to be able to read and understand chemical engineering plants drawing

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Process planning:** Introduction, Nature of design ,the organization of a chemical engineering projects Scheduling .Standards and codes. Flow sheet design, flow sheet types and designation .Block diagram .Process flow sheet .Piping and instrumentation diagram .Utilities, Computer aided drafting ,process simulation programs .Layout and plot plan .Project evaluation and cost estimation	**10 hr**
2	**Piping network and Pumps:** Valves selection . Piping design standards and codes . Pipe size selection .Mechanical design of piping system. Pump type, pump specifications, and pump data sheet	**6 hr**
3	**Vessels and tanks:** Types of vessels. Criteria in vessel design, stress considerations. Materials of construction commonly used in vessels tanks. Design of tall vertical vessels . Pressure vessels Design. Vessels supports and foundations	**10 hr**
4	**Solid Handling**: Screenin Classification with Streams of Air or Water Air Classifiers. Size Reduction. Equipment for Size Reduction Particle Size Enlargement Extrusion Processes	**4 hr**

University of Technology
Department of Chemical Engineering

Program	***Chemical Processing Engineering***					
Course Code	**CES.P.332**	Credits hr				Units
Course Title	Thermodynamics II					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mass Transfer,Thermodynamics I	**2**	**0**	**1**	**3**	**2**

Course Description

The course discuss the study of Power cycles; Refrigeration and liquefaction process; Theory and application of solution thermodynamics ;Vapor/liquid equilibrium in both: binary and multi-components; Ideal and non-ideal solutions are discussed using Raoult's and modified Raoult's law; Fugacity and fugacity coefficient definitions; Chemical reaction equilibrium and Thermodynamic analysis of processes.

Course Text

1- J. M.Smith,H.C.Van Ness, Introduction to chemical engineering thermodynamics, 6th edition (International Edition), Mc-Graw Hall, 2008.

Other support books :-

1-K.V.Narayanan, Atext book of chemical engineering thermodynamics, prentice Hall of India, New Delhi, 2011.

2- B.G.Kyle, Chemical and process thermodynamics ,(3rd Edition), prentice Hall Inc.New Jersey, 1984.

3-J. Rayner, Basic engineering thermodynamicsinSIunits, printed in great Britain,1971.

Course Objectives : at the end of the semester the student should be able to :-

1-Apply the laws of thermodynamics to power, refrigeration and liquefaction cycle.

2-Establish thermodynamic constraint that apply to VLE, and explain qualitatively the VLE diagram.

3. Apply thermodynamics to VLE of pure components and solutions in terms of fugacity and fugacity coefficients.

4. Apply equilibrium criteria to chemical reactions and evaluate the effect of temperature.

5. Revision for thermodynamic analysis of processes.

Topics Covered (Syllabus)/ Course Title

No.	Content	Duration
1	**Solution thermodynamics: theory** Fundamental property relations, the chemical potential and phase Equilibrium, ideal gas mixtures, fugacity and fugacity coefficient, the Fundamental residual property relations, the ideal solutions.	**4 hr**
2	**Vapor\liquid equilibrium; introduction :** The nature of equilibrium, the phase rule, Duhem,s theorem, diagrams for vapor liquid equilibrium, simple models for VL equilibrium: Rault,s law, dew point and bubble point calculations, Henrys law, VLE by modified Raults law, VLE from K value correlations, flash calculations.	**8 hr**

3	**Chemical Reaction equilibrium:** The reaction coordinate, standard Gibbs energy change and equilibrium constant, effect of temperature on equilibrium constant, evaluation of equilibrium constant, liquid phase reactions, equilibrium conversion forsingle reactions.	8 hr
4	**Production of power from heat**: The steam power plant, Rankin cycle, the regenerative cycle, internal combustion engines Otto engine, diesel engine, gas turbine engine.	4 hr
5	**Refrigeration and liquefaction:** The Carnot refrigerator, the vapor compression cycle, the choice of refrigerant, absorption refrigeration, the heat pump, liquefaction processes	4 hr
6	**Thermodynamic analysis of processes:** Second law relation for steady state flow processes, calculation of ideal work, thermodynamic analysis of steady state flow processes.	2 hr

Practical: (Thermodynamics lab.)

No	Name of Experiment
1	**Pressure and Temperature relationship for steam**
2	**Liquid -vapor equilibrium Isotropic Mixtures**
3	**Boyles' law**
4	**Refrigeration**
5	**Hydrolysis of methyl acetate**
6	**Regulating and charging battery**
7	**Measurement of the solar irradiation**
8	**Alternating current solar installation**

University of Technology
Department of Chemical Engineering

Program	***Chemical Processing Engineering***					
Course Code	**CES.P.322**	Credits hr				Units
Course Title	Applied Mathematicsin Chemical Engineering					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematics III and IV, Numerical Analysis	**2**	**-**	**1**	**3**	**2**

Course Description

This course introduces students to: Solve ordinary differential equations: apply Laplace transform to solve various systems of ordinary differential equations: Solve different types of partial differential equations. At the end of the course students should be able to apply these methods to tackle all kinds of problems that appear in chemical engineering.

Course Text

1. “Mathematical Methods in Chemical Engineering”, Jenson. V.J. and Jeffereys, G.V, 2nd Edition, Academic Press New York, 1977.
2. “Applied Mathematics and Modeling for Chemical Engineers”,Rice R G. and. Do, D. D., John Wiley and Sons, New York, 1995.
3. “Applied Mathematical Methods for Chemical Engineers”,Loney, Norman W., 2^{nd} edition, CRC Press – Taylor & Francis Group, Boca Raton, 2007.

Course Objectives: at the end of the semester the student should be able to:-

Apply different analytical methods to solve chemical engineering problems.

Topics Covered (Syllabus)/ Applied Mathematics in chemical Engineering

No.	Contents	Duration
1	**Review: (Ordinary Differential Equations):** L1: First Order Ordinary Differential Equations. L2: Second Order Ordinary Differential Equations. L3: Higher Order Ordinary Differential Equations.	**6hr**
2	**Partial Differential Equations:** L1: Method of Direct Integration. L2: Separation of Variables (Forier Transforms). L3: Combination of Variables (Variation of Parameters). L4: Laplace Transforms.	**8 hr**

3	**Laplace Transforms** L1: Definitions (Laplace Transforms of Some Elementary Functions, Rules of Laplace Transforms). L2: The First Shifting Theorem, Multiplicity by X or X^n. L3: The Inverse of Laplace Transforms (Completing the Square in the Denominator, By Partial Fractions, By Convolution Integral, By Conversion Integral) L4: Laplace Transform of Derivatives L5: Solution of Ordinary Differential Equations (Ordinary Differential Equations with Constant Coefficient, Ordinary Differential Equations with Variable Coefficient). L6: Partial Differential Equations. L7: The Unit Step Function, The Unit Impulse Function. L8: The Second Shifting Theorem	8 hr
4	**Formulation of Chemical Engineering Problems (Modeling):** L1: Storage Tanks. L2: Mixing Tanks. L3: Chemical Reaction Vessels. L4: Heat Transfer Problems. L5: Mass Transfer Problems. L6: Momentum Transfer Problems. L7: Process Control System. L8: Another Problems.	8 hr

Program	*Chemical ProcessingEngineering*					
Course Code	**CES.P.334**	Credits hr				Units
Course Title	Unit Operations I					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemical Engineering Principles I, II&Mass transfer	**3**	**0**	**1**	**4**	**3**

Course Description

This course covers three main operations, gas absorption, stripping, distillation for binary and multi component mixtures and boundary layer. Concepts to design mass transfer equipment.The course aims to provide deeper knowledge, a wide scope and improved understanding of the mechanisms in mass transfer as well as a better insight into analytical and empirical methods applied in analysis and synthesis of mass transfer related problems.

Course Text

1- Coulson, J. M & Richardson J. F. (2006). "Chemical engineering", Volume 2, 3rd Edition, Robert Maxwell. M. C.
2- Dutta Binary K. (2007), "Principles of Mass Transfer & Separation Process", Bvt. Ltd. Prentice Hall, ISPN 8-1203-2990-2.

Other support books:-

1- Treybal Robert E. (1975), "Mass transfer Operation" 2nd Edition, Mc-Graw-Hill Book.
2- McCabe, W., Smith, J., Harriott, P. (2004), "Unit Operations of Chemical Engineering",Mc-Graw-Hi Co., 7th Edition, ISBN0072848235.

Course Objectives: at the end of the semester the student should be able to:-

1- Understand the basics of gas absorption, stripping and distillation.
2- Design absorbers, strippers and distillation columns.
3- Find Operating lines, feed line and No. of trays or amounts of packing required.
4- Calculate columns efficiency.
5- Derive basic momentum equation models from first principles for the boundary layer.

Topics Covered (Syllabus)/ Unit Operation I

No.	Contents	Duration
1	**Introduction to separation processes:** General separation techniques. The mechanism of absorption and stripping processes. Flow regimes.	3 hr
2	**Absorption in packed bed columns**: Constructions, mass transfer coefficients & specific area, capacity, height of columns based on gas film, liquid film, and based on overall conditions, operating line, the transfer units, the importance of gas and liquid flow rates.	6 hr
3	**Absorption in Tray towers :** Types of trays, number of trays analytically and graphically. How to calculate the tray and column efficiency.	6 hr
4	**Introduction to distillation process:** Partial pressure, Dalton's, Raoult's& Henry's laws. Relative volatility, non ideal systems. Method of diffusion, binary mixtures, batch distillation, flash distillation, steam distillation. Fractionating column.	6 hr
5	**Fractionating process**: Number of plates required importance of reflux ratio, location of feed point, multiple feeds and side streams.	3 hr
6	**Multi-component Distillation :** Key components. Components distributions, equilibrium data, feed & product compositions, minimum reflux ratio, calculation number of trays required, relation between reflux ratio & number of plates.	9 hr
7	**Plate & packed distillation columns:** General designed methods, column efficiency	3 hr
8	**Reynolds Analogy**: Mass transfer with bulk flow, flow over a plane surface, flow in a pipe.	9 hr

Universityof Technology
Department of Chemical Engineering

Program	***Chemical ProcessingEngineering***					
Course Code	**CES.P.336**	Credits hr				Units
Course Title	Reactor Design					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemical Reaction Kinetics	**2**	**–**	**1**	**3**	**2**

Course Description

Theory, design fundamentals and mass conservation equations for ideal reactors, isothermal reactors for homogeneous reactions, non-isothermal reactors, multiple reactor System.

Course Text

1. Octave Levenspiel (1999), Chemical Reactor Engineering, 3rd edition, John Wiley & Sons Inc., USA ISBN: 9780471254249.
2. J.M. Smith (1987), Chemical Engineering Kinetics, 3rd edition, McGraw-Hill International Editions, Singapore. ISBN: 9780070587106

Other support books :-

2- Ronald W. Missen; Charles A. Mims; Bradley A. Saville (1999), Introduction To Chemical Reaction Engineering And Kinetics, 1stedition, John Wiley & Sons Inc.,USA.

3- . H. S. Fogler, Elements of Chemical Reaction Engineering, 4th Ed (2006), Prentice Hall,NewYorK.

Course Objectives: at the end of the semester the student should be able to :-

This course aims to establish fundamental knowledge for the students in chemical reactor engineering. At the end of this course, students should be able to:

(i) Apply reaction kinetics principles in chemical reactor engineering.

(ii) Identify and formulate problems in chemical reactor engineering and find appropriate solutions.

(iii) Specify and size the most common industrial chemical reactors to achieve production goals for processes involving homogeneous reaction systems.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction to reactor design:** L1: Interpretation of rate data, scale-up, and design L2: Classification of reactors.	2 hr
2	**Design fundamentals and mass conservation equations for ideal reactors:** L1: Conservation of mass in reactors. L2: The ideal stirred-tank reactor (Batch and steady-state flow) L3: The ideal tubular flow reactor (PFR) L4: Space time and space velocity	4 hr
3	**Isothermal reactors for homogeneous reactions:** L5: Design procedure: Batch reactor (constant volume and constant pressure) L6: Design procedure: Continuous stirred-tank reactors (Single and multiple reactions) L7: Design procedure: Tubular-flow reactors L8: Comparison of stirred-tank and tubular-flow reactors. L9: Flow recycle reactors L10: Non-steady flow (semi-batch) reactors	8 hr
4	**Non-isothermal reactors:** L11: Energy conservation equations L12: Batch stirred-tank reactors L13: Continuous stirred-tank reactors	8 hr
5	**Multiple reactor System:** L14: Plug flow reactors in series and/or parallel L15: Equal- size mixed flow reactors in series (first order and second order reactions) L16: Mixed Flow Reactors of different sizes in series. L17: Best arrangement of a set of ideal reactors	8 hr

Universityof Technology
Department of Chemical Engineering

Program	*Chemical ProcessingEngineering*					
Course Code	**CES.P.338**	Credits hr				Units
Course Title	Heat transfer II					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Heat transfer I	**2**	**2**	**1**	**5**	**3**

Course Description

This course will focus on the following topics:

- Learning about the heat exchanger and its types.
- Presenting the methods of predicting heat-exchanger performance.
- Discussing the methods that may be used to estimate the heat exchanger size and type
- Necessary to accomplish a particular task.
- Understanding the phenomena of boiling and condensation process.
- Estimating the heat transfer for pool boiling and condensation process.
- Introducing the industrial furnaces and their types, and what are the design
- Considerations.
- Learn about the different types of renewable energies.

Course Text

- Holman, J.P. (2009) Heat Transfer. 10th Edition, McGraw-Hill, New York.

Other support books: -

2- Harker, J. H., J. R. Backhurst, and J. F. Richardson. Chemical Engineering Volume 1. Vol. 1. Elsevier, 2013.

3- Incropera, Frank P., David P. DeWitt, Theodore L. Bergman, and Adrienne S. Lavine. Fundamentals of heat and mass transfer. Vol. 6. New York: Wiley, 1996.

Course Objectives: at the end of the semester the student should be able to:-

- Process principles of heat transfer in chemical process industry.

2- Practical heat exchanger design.

3- The students must understand the processes involved in boiling and condensation to design the appropriate heat-transfer equipment.

4- Define and solve problems in boiling and condensation heat transfer.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Heat Exchangers:** • Introduction • Types of Heat Exchangers • The Overall Heat-Transfer Coefficient • Fouling Factors • The Log Mean Temperature Difference • Design of heat exchanger by the conventional and Effectiveness-NTU • methods • Heat-Exchanger Design Considerations	**10 hr**

2	**Shell and Tube Exchanger:** • Presenting a complete design of shell and tube heat exchanger. • Types and various specifications, design calculations by conventional and by effectiveness (NTU) methods and optimum design calculation.	6 hr
3	**Condensation and Boiling Heat Transfer:** • Introduction • Condensation Heat-Transfer Phenomena • The Condensation Number • Film Condensation Inside Horizontal Tubes • Boiling Heat Transfer • Simplified Relations for Boiling Heat Transfer with Water.	6 hr
4	**Radiation and Furnace design:** • Radiation properties, shape factor, heat exchange for nonblack bodies, parallel planes, shields, gas tradition. • Introduction about the types of furnaces	4 hr
5	**Renewable Energy:** • Solar radiation • Solar water heater • Solar air heaters • Heat exchangers for ocean thermal energy • Heat storage and transmits	4 hr

Practical: (Heat transfer lab.)

No.	Experiment Name
1	**Conductive Heat Transfer in Steady State.**
2	**Coil Heat Exchanger.**
3	**Determination of overall Heat Transfer Coefficient under different Air Velocity conditions**
4	**Heat transfer in fluidized bed reactor**
5	**Graphite Heat Exchanger**
6	**Extended Surface Heat Transfer**
7	**Film and dropwise condensation experiment**

University of Technology
Department of Chemical Engineering

Program	***Chemical Processing Engineering***					
Course Code	**CES.P.3312**	Credits hr				Units
Course Title	Equipment Design Using CAD					
Term	2 nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Thermodynamics, heat and mass transfer	**2**	**2**	**1**	**5**	**3**

Course Description

The aim of the subject is to engaged students with chemical plants by explain the main items of plants design by computer software ,and also supervise students design of heat exchangers and gas-liquids column by traditional design procedures

Course Text

1- Sinnott R. and Towler C; 2013 " chemical Engineering Design" 5th edition Butterworth-Heinemann
2- Coke,A.K ;2007"Ludwig s Applied Process Design of Chemical and petrochemical Plant" vol. 1 4th edition Gulf professional Publisher

Course Objectives : at the end of the semester the student should be able to :-

1-Provide practice at developing critical thinking skills, solving open ended problems and to work in teams.
2- The student be able to use computer software packages to perform design activity beside the conventional methods

3- The student should have the necessary skills to design equipments

Topics Covered (Syllabus)/Equipment Design Using CAD

No.	Contents	Duration
1	Applied Design for Pressure vessels ,pumps and compressors flash drum, gas-liquid separator, liquid-liquid separator, gas movers and compressors manually and with computer aided	**6 hr**
2	Applied Design for heat equipments (shell And tube heat exchanger, plate heat exchanger , coil type exchanger, condenser, vaporizer, air cooler …….etc) manually and with computer aided	**12 hr**
3	Applied Design for mass transfer equipments (distillation column, absorber column, leaching equipment, scrubber…………..etc) manually and with computer aided	**12hr**

Practical: (Equipment Design lab.)

No.	Contents
1	**Introduction**
2	**Equation of state & stream**
3	**Rotating Equipment (3.1 Compressor, 3.2 Expander, 3.3 pump)**
4	**Separation Operations (Separator , 3-Phases Separator , 4.3 Tank)**
5	**Heat Transfer Equipment (Heater & Cooler, Heat Exchanger, LNG,Air Cooler)**
6	**Column distillation** **(Column Installation, Column Property View, Column-Specific Operations and Running the Column)**
7	**Reactors(CSTR, General Reactor, Gibbs, Equilibrium, conversion)**
8	**Logical Operations (Adjust, Balance, Recycle, Set)**
9	**process plant involving reaction and separation**
10	**Examination lab**

University of Technology
Department of Chemical Engineering

Program	***Chemical Processing Engineering***					
Course Code	**CES.P.3313**	Credits hr				Units
Course Title	Particles& Nanotechnology					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemistry I &II Physics	**2**	**-**	**-**	**2**	**2**

Course Description

Particle technology, particle size and properties, size reduction particle size reduction, Nanotechnology, synthesis of nanomaterial, investigation methods and application.

Course Text

1- Hiroaki, Mosuda, " Powder Technology Hand book" 2006

Course Objectives : at the end of the semester the student should be able to :-

1-The student an understanding of the fundamental principle of particle and nanotechnology
2-Particle size measurements methods, particle reduction size, particle distribution, Nanotechnology, nanoparticles, Synthesis methods, nano particles and measurement techniques, application of nanotechnology in different fields.

Topics Covered (Syllabus)/ Particles& Nanotechnology

No.	Contents	Duration
1	**Particle Technology** Particle, particle shape, measurement of particle size	**5 hr**
2	**Size reduction** Methods of size reduction, energy required for size reduction, particle size distribution, crystal structure and crystalin structure of materials	**5 hr**
3	**Nanotechnology** Nanotechnology, Nanoscience, Nanomaterials, Synthesis of nanomaterials from various industrial and chemical materials, Synthesis of nanomaterials from green and renewable sources.	**5 hr**
4	**Synthesis of nanomaterial Methods** Mechanical, physical, chemical, sol-gel, CVD, Carbon nanotubes properties and production	**5 hr**
5	Nanoparticals investigation methods, Membrane characterization(XRD, FTIR, SEM, TEM, AFM)	**5 hr**
6	Application of Nanotechnology Polymers Nano Composites and Nano Fluids	**5 hr**

University of Technology
Department of Chemical Engineering

Program	*Chemical Processing Engineering*					
Course Code	**CES.P.421**	Credits hr				Units
Course Title	Project I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Basic Principles of chemical engineering I Basic Principles of chemical engineering II Material &Chemical Engineering Principle II. Thermodynamics I & II	**1**	**2**	**---**	**3**	**2**

Course Description

The course includes the design aspects and design considerations for plant of chemical industry.

Course Text

Sinnott R.K. "Chemical Engineering Design", Coulson and Richardson's. Chemical Engineering, Volume 6, Fourth edition, (2005).

Other support books :-

1. Peters M. S.,Timmerhaus K.D. and West R.E. Plant Design and Economics for Chemical Engineering, Fifth edition, (2003).

Course Objectives: at the end of the semester the student should be able to:-

To learn the students the basic information's of designing the chemical plants and the economic and engineering aspects

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction to Design:** The anatomy of chemical manufacturing process, general overall design considerations, development of design data base, process creation, types of process design.	**5 hr**
2	**Design Information and Data :** Source of information of physical properties , predication of physical properties (density, viscosity, thermal conductivity , etc)	**5 hr**
3	**Material andChemical Engineering Principle II**: Review of material andChemical Engineering Principle II, flow sheet symbols, PFD information in flow diagram	**5 hr**

Project Requirements

No.	Contents	Duration
1	**Chapter One:** Introduction, Historical Profile, Physical and Chemical Properties, Applications for chemical material production.	4 hr
2	**Chapter Two:** Production Methods, Comparison between Processes, Selected the optimum Process, Physical properties of raw materials and by products, Production Capacity.	4 hr
3	**Chapter Three:** Material balance for the plant process.	10 hr
4	**Chapter Four:** Chemical Engineering Principle II for the plant process, Process flow diagram (PFD).	10 hr
5	**Poster and Oral Presentation**	2 hr

Program	***Chemical Process Engineering***					
Course Code-	**CES.P. 431**	Credits hr				Units
Course title	Unit Operation II					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemical Engineering Principle II &III, Fluid FlowI, II, Thermodynamics I, II, Unit operation I, Heat Treansfear I &II,	**2**	**2**	**1**	**5**	**3**

Course Description

Theory, applications and design of unit operations which are mostly employed in the chemical industry, drying of solid, humidification, dehumidification and cooling tower and liquid evaporation and crystallization.

Course Text

- Coulson ,J.M and Richardson J.F. “Chemical Engineering , Volume 1, 3rd edition ,Robert Maxwell.M.C.
- Coulson J.M, and Richardson J.F. “Chemical Engineering, Volume 2, 3rd edition, Robert Maxwell.M.C.

Other support books :-

- Perry,J.H, “Chemical engineering handbook ”,Mc-Graw –Hill Bookcom.1975.
- Binay.K.Dutta “Mass transfer and separation process” 2007.
- Trebal Robert E., “Mass transfer operation”2nd edition, Mc-Graw –Hill Book com.1975.

Course Objectives: at the end of the semester the student should be able to:-

1-To provide an understanding of the general principles of separation processes to allow students to make sensible options given a separation task (Humidification, Dehumidification and Cooling tower, Evaporation, crystallization, and Wet Solid Drying).

2-A comprehensive understanding of the transport processes related to chemical engineering operations, with focus on both theory and applications.

3-Ability to select of appropriate equipment for the separation of materials in process plant.

4-Provide practice at developing critical thinking skills, solving open ended problems and to work in teams.

Topics Covered (Syllabus)

No.	Contents	Duration
1	**Drying of Solids:** Introduction Drying of Solids....General Principles. Wet Solid Group.Terminology and Definitions. Humidity Measurement. Humidity Data for Air – Water system. Temperature –Humidity Chart (Psychometric Chart). Uses of Humidity Chart. Rate of Drying. Calculation method of Drying Rate and Time. Drying Rate. Drying Time. Mechanism of Moisture Movement in Wet Solid.	6 hr
2	**Humidification, dehumidification and Cooling towers:** Introduction. Humidification Operations. Adiabatic Operations. Non-Adiabatic Operations. Mixing of Humid Streams. Mixing of Two Stream of Humid Gas. Addition of Liquid or Vapor to a Gas. Humidification Processes Theory. Cooling Tower Principles and Operations. Cooling Tower Classification. Design Cooling Tower. Adiabatic Humidification — Cooling. Dehumidification Tower	9 hr
3	**Evaporation:** Introduction, Types of Evaporations, Evaporation Equipment, Heat transfer in Evaporation Process, single, double and Multi effect Evaporators, Design of evaporators, Comparison of Forward, backward and Parallel effect evaporators, boiling Point rise.	9 hr
4	**Crystallization :** Crystallization fundamentals, cooling crystallizer, Evaporating crystallizer, Batch and continuous crystallization Crystallizer selection.	6 hr

Practical: (Unit Operation lab.)

No.	Experiment Name
1	**Tray Dryer**
2	**Plate and Frame Filtration**
3	**Rotary Drum Filtration**
4	**Design of Cooling Tower**
5	**Sedimentation**
6	**Liquid - Liquid Extraction**

Universityof Technology
Department of Chemical Engineering

Program	***Chemical Processing Engineering***					
Course Code	**CES.P. 433**	Credits hr				Units
Course Title	Process Dynamics					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemical Engineering Principles II & III Applied Mathmatics in Chem. Eng	**2**	**-**	**1**	**3**	**2**

Course Description

Study of dynamics characteristics of open-loop Chemical Engineering processes to formulate transfer function and analysis response of the system to design and select closed-loop controlscheme.

Course Text

1. D.R. Coughanowr and S. LeBlanc, Process Systems Analysis and Control, McGraw-Hill, 3rd edition, 2008.
2. Stephanopoulos G., “Chemical Process Control-An Introduction to Theory and Practice, ”Prentice -Hall, New Jersey, 1984.

Other support books :-

1-Luyben W. L., “Process Modeling, Simulation and Control for Chemical Engineers,” McGraw-Hill, New York, 2nd Ed., 1990 .

2-Process Dynamics: Modeling, Analysis and Simulation, by Wayne Bequette.

Course Objectives: at the end of the semester the student should be able to :-

1- Study of dynamic analysis of chemical processes to allow students to identify the system under different operating conditions.

2- Understanding of formulate transfer function of the system.

3- Testing and selecting of critical process variables.

4- Developing of skills, solving open ended problems and to work in teams.

Topics Covered (Syllabus)/ Process Dynamic

No.	Contents	Duration
1	Linear Open-Loop Systems: Transfer function**,** Transient Response,Forcing Functions:Step Response **,**Impulse Response Ramp Response Sinusoidal Response.	10 hr
2	Applications of First Order Systems: Liquid –level system, heating system, Mass transfer system, Reactors, absorber, pressure vessel, Linearization.	8 hr
3	Response of First-Order Systems in Series Non-interacting System, Interacting System.	4 hr
4	Higher-Order Systems: Second-Order: Under-damped, Critical and over-damped, Transportation Lag	8 hr

University of Technology
Department of Chemical Engineering

Program	***Chemical Processing Engineering***					
Course Code	**CES.P. 435**	Credits hr				Units
Course Title	Petroleum Refinery Processing					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Fuel's & Energy Eng., Chemistry II	**2**	**0**	**1**	**3**	**2**

Course Description

An introduction to petroleum feedstocks, refining processes, and how refined products are made. Design of atmospheric and vacuum columns for petroleum fractionation will be explained. Refinery processes will be explained in terms of their objectives, feedstocks, products and catalysts.

Course Text

1. W.L..Nelson" Petroleum Refining Engineering " 4th Edition. McGraw Hill, New York, 1985
2. M.A. Fahim, T.A. Al-Sahhaf, and A.S. Elkilani," Fundamentals of Petroleum Refining", Elsevier, 2010.
3. J.H. Gary and G. E. Handwerk and M.J. Kaiser, "Petroleum Refining Technology and Economics", 5th Ed. CRC Press, 2007.

Course Objectives: at the end of the semester the student should be able to :-

1. Become knowledgeable in composition, properties and classification of crude oil or petroleum.
2. Become familiar with the overall refinery processes including physical separation operations and chemical conversion processes.
3. Become knowledgeable about impurities in crude oil and how to remove them from products.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Petroleum Processing Overview** : History of Petroleum Production, What is Petroleum, History of Petroleum Processing, Modern Petroleum Processing. Refinery Feed-stocks and Products.	2 hr
2	**Thermo-physical Properties of Petroleum Fractions and Crude Oils:** Specific Gravity, Boiling Point Curves, Breakup of TBP Curve into Pseudo-components, Thermo-physical Properties Calculation.	4 hr
3	**Heating of Crude oil :** Types of pipe still heaters **,** calculations of radiant absorption rates	4 hr
4	**Crude Distillation :** Desalting Crude Oils, Atmospheric distillation tower: types of refluxes.Chemical Engineering Principle II in a topping tower and calculations involve estimation of top, side, bottom draw tray temperatures	6 hr

5	**Thermal and Catalytic Cracking :** Coking, Visbreaking, Fluid Catalytic Cracking, Hydrotreating and Hydrocracking.	4 hr
6	**Catalytic Reforming:** Objectives, process, Reactions, catalysts and effect of process variables.	2hr
7	**Isomerization, Alkylation and Polymerization:** Objectives, process, Reactions, catalysts and effect of process variables.	2 hr
8	**Products blending :** Reid Vapor Pressure, Octane Blending.	4 hr
9	**Supporting Processes:** Hydrogen Production, Gas Processing Unit, Acid Gas Removal, Sulfur Recovery Processes.	2 hr

University of Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical Processing Engineering</td></tr>
<tr><td>Course Code</td><td>CES.P. 436</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Heterogeneous Reactor &Catalyst</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Mass- and Heat- Transfer, Fluid Flow I and Thermodynamics II</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td></tr>
</table>

Course Description

Definition, classification of catalysts, properties of heterogeneous catalysts (activity, acidity, selectivity, and porosity), effectiveness of presence the catalysts on kinetic and thermodynamic properties, mechanism of chemical interactions occurring within the catalysts, applications of catalysts in catalytic processes, movement of the reactant molecules around and throughout the body of a catalyst in different types of reactors (fixed-, fluidized-, slurry-, and tricklebed), intra-particle and diffusivities inside porous catalysts, and modern characterization techniques.

Course Text

1- J. M. Smith (2014), Chemical Engineering Kinetics, 3rd edition, Mc Grow – Hill, Singapore, Amazon.
2- H. V. Bekkum, E. M. Flanigen, P. A. Jacobs, and J. C. Jansen (2001), Introduction to zeolite science and practice, 2nd edition, Amsterdam: Elsevier.

Other support books :-

1- J.F. Lepage, J. Cosyns&P.Couty, (1987), Applied heterogeneous catalysis. Paris: Editions Technip.
2- R. W. Missen, C. A. Mims, and B. A. Saville (1999), Chemical reaction engineering and kinetics, John Wiley & sons.
3- Daniel Decroocq (1984), Catalytic cracking of heavy petroleum fractions, Paris: Editions Technip

Course Objectives: at the end of the semester the student should be able to :-

The objective of this course focuses on in-depth understanding of the catalyst and its impact on either chemical reactions kinetics or thermodynamics and comprehension the principle of diffusion on the internal and external surfaces of the porous catalyst particles with their impact on the nature of reaction products in terms of increasing the quantity and quality and reducing the operating cost. As well as the utilize of the operating equations for various kinds of reactors containing the catalyst particles as a key parameter in their work, also to discover the theoretical knowledge about the equipments and characterization techniques used in catalyst and catalysis science. Inaddition, identify scientific and engineering information about the performance of acatalyst in enhancing the reaction mechanisms and the rate of reaction, problem solving, and other related issues.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction:** Definition, classification of catalysts, mechanisms of catalysis, properties of porous catalysts (i.e. mechanical strength, stability, activity, and selectivity), morphology, pore size, solid density and porosity calculations, pore volume distribution, developing the support, promoters and inhibitors, coke formation on the catalyst surface, catalyst deactivation and reactivation.	6 hr
2	**Applications of catalysts in catalytic processes:** History of the catalysts in catalytic processes, such as direct oxidation of materials, hydrogenation in a packed bed reactor.	4 hr
3	**Surface area and kinetic parameters determinations:** Determination the surface area of catalyst, calculations of pressure drop and void fraction in a solid catalyst within a packed bed, calculations both the reaction rate and the activation energy over a solid catalyst, operating condition (i.e. temperature, pressure, residence time; *W/F*) and catalyst performance	4 hr
4	**Diffusion of bulk fluid over a solid catalyst within a packed bed:** Fixed-bed reactors: mass and heat-transfer coefficients (fluid-particle), fluidized-bed reactors: particle-fluid mass and heat transfer, slurry-bed reactors: mass-transfer coefficients: gas bubble to liquid (k_L), and liquid to catalyst particle (k_c), trickle-bed reactors: mass-transfer coefficients: gas to liquid ($k_L a_g$), and liquid to particle (kcac) with calculation of global rate.	8 hr
5	**Intra-particle and diffusivities estimation** inside porous catalysts: Diffusion coefficient of Knudsen and Bulk diffusion, Gaseous diffusion in the micro- and macro- cylindrical pores, Diffusion in liquids, Diffusion within porous catalysts (effective diffusivity), pore models (parallel-pore model and random-pore model), surface diffusion, effectiveness factors.	6 hr
6	**Characterisation techniques** of **industrial catalysts:** Developing of catalysts and catalytic cost, characterisation of catalyst framework structure.	2 hr

University of Technology
Department of Chemical Engineering

Program	*Chemical Processing Engineering*					
Course Code	**CES.P- 423**	Credits hr.				Units
Course Title	Industrial Management & Ethics					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	—	**2**	**--**	**1**	**3**	**2**

Course Description

Theory and applications, of Industrial Engineering Management which are mostly employed in The chemical industry Industrial Engineering Management; ,Industrial organization, Maintenance Work Measurement Techniques, Costing, Quality Control, ISO and Engineering Ethics.

Course Text

T.R. Banga and S.C. Sharma "Industrial Engineering Management" including Production Management, Eleventh Edition:2008.
M.S. Peters, K.D. Timmerhaus and R.E. West "Plant Design and Economics for Chemical Engineers" Fifth Edition: 2003.

Course Objectives: at the end of the semester the student should be able to:-

To helps and learn in the optimum use of plant, equipment, efforts towards productivity improvement, establishing the most efficient and effective utilization of human effort and synchronizing various resources like men, machine and material as well as Engineering Ethics.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Management** Principle of management, types and classifications, management responsibility, organization responsibility.	**4 hr**
2	**Industrial organization** Site, Feasibility study, Development of efficient work method (plant layout, flow of material, material handling), Work stations, Inputs and Outputs, Production planning (types of Productions).	**3 hr**
3	**Maintenance** Classification, Cost, Machine replacements, Case studies and examples.	**3 hr**
4	**Network Analysis** Principles and applications, Critical path method (CMP), Gant Chart, Pert techniques (examples and case studies).	**2 hr**
5	**Work Measurement Techniques**	**2hr**

	Time and Motion study.	
6	**Costing:** Framework of management, Cost of production (row material cost, labor cost, machinery cost).	**2 hr**
7	**Quality Control:** Standardization, Specification, Sampling techniques, Inspection- analysis of results. Quality costs (preventive cost, appraisal cost and failure cost). Application of quality control chart-examples, Reliability.	**2 hr**
8	**ISO:** Requirements, applications, ISO series, Quality management system (QMS), Total Quality management (TQM), Requirements and applications.	**2 hr**
9	**Engineering Ethics:** Engineering has a direct and vital impact on the quality of life for all people. Engineering is an important and learned job. Engineers are expected to exhibit the highest standards of honesty and integrity. Accordingly, the services provided by engineers require honesty, impartiality, fairness, and equity, and must be dedicated to the protection of the public health, safety, and welfare. Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct.	**10 hr**

Universityof Technology
Department of Chemical Engineering

Program	*Chemical Processing Engineering*					
Course Code	**CES.P.437**	Credits hr				Units
Course Title	Chemical Process Industries I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemistry II, Unit Operation I	**2**	**3**	**0**	**5**	**3**

Course Description

The syllabus deals with Industrial Chemistry. Which includes manufacture of sulfuric acid, nitric acid, ammonia, nitrogenous fertilizers, phosphoric acid, phosphate fertilizers, electrolytic industries, and industrial salts?

Course Text

1.Shreves chemical process industries, Austin , G. T. , 5thed , McGraw- Hill ,1984
2.N. Naderpour ,Petrochemical production process,1st reprint, sbspublication,New Delhi,2009
3. Hydrocarbon processing ,Petrochemical processes,2005

Course Objectives: at the end of the semester the student should be able to :-

1- Chemical process definition and its applications on an industrial scale.
2- Introduction to natural or primary raw materials and their potential use.
3- Introduction to the use of chemical agents in industry.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Chemical processing:** Process classification,Process types,Operating conditions, Flowcharts, Industrials toichiometry,control system, research and development	**2 hr**
2	**Sulfur and Sulfuric acid:** Raw materials,Mining and manufacture of sulfur, Manufacture of sulfuric acid, Manufacture of oleum	**6 hr**
3	**Ammonia and Nitric acid:** Raw materials, manufacture procedure of ammonia, Nitric acid production,	**6 hr**
4	**Nitrogenous fertilizers:** Types of chemical l fertilizers,Manufacture processes of $(NH_4)SO_4$, Manufacture process of NH_4NO_3, Manufacture process of Urea	**4 hr**
5	**Phosphatefertilizers:** Raw materials, Manufacture process of super phosphate,Manufacture process of triple super phosphate,Phosphorous,Phosphoric acid manufacture process, Nitrophosphate	**4 hr**

6	**Electrolytic industries:** Chloro-Alkali industries	4 hr
7	**Industrial salts**	4 hr

Practical :(Chem. Proc. Ind.Lab.)

No.	Experiment Name
1	Water treatment by ionic exchange
2	Extraction of vegetable oils
3	Production of fatty acid
4	Production of soap
5	Sulfonation of detergent –Alkylates
6	Production of Urea Formaldehyde
7	Biodiesel production
8	Chloroform production
9	Ethanol production
10	Ethyl acetate production

University of Technology
Department of Chemical Engineering

Program	*Chemical Processing Engineering*					
Course Code	**CES.P. 422**	Credits hr				Units
Course Title	Project II					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Mass Transfer -Unit OperationI & II -Heat Transfer I & II -Equipment Design -Catalysis Eng and Reactor Design	**1**	**2**	**---**	**3**	**2**

Course Description

The course includes the design aspects and design considerations for plant of chemical industry.

Course Text

Sinnott R.K. "Chemical Engineering Design", Coulson and Richardson's. Chemical Engineering, Volume 6, Fourth edition, (2005).

Other support books :-

1. Peters M. S., Timmerhaus K.D. and West R.E. Plant Design and Economics for Chemical Engineering, Fifth edition, (2003).

Course Objectives: at the end of the semester the student should be able to:-

To learn the students the basic information's of designing the chemical plants and the economic and engineering aspects

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Choice of Plant Location and Layout Standard**	**3 hr**
2	**Piping and Instrumentation:** Pipes, valves, Pumps, Mechanical design and control	**4 hr**
3	**Cost and Project Evaluation**	**3 hr**
4	**Safety and Loss Prevention**	**2 hr**
5	**Design with Computer Aided**	**3 hr**

Project Requirements

No.	Contents	Duration
1	**Chapter Five:** Design main equipment by design equation with mechanical design, cost evaluation, control andcomputeraided using Hysyssoftware	14 hr
2	Design supported equipment with mechanical design, cost evaluation and control.	6 hr
3	**Chapter Six:** Environmental effect for raw materials, products and by products	6 hr
4	**Poster and Oral Presentation**	4 hr

Program	*Chemical Process Engineering*					
Course Code-	**CES.P. 432**	Credits hr				Units
Course title	Unit Operation III					
Term	2 nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemical Engineering Principle II & III, Fluid FlowI, II, Thermodynamics I, II, Mass Transfer, unit operation I , II, Heat treansfearI, II,	**3**	**0**	**1**	**4**	**3**

Course Description

A comprehensive understanding of the transport processes related to chemical engineering operations with focus on theory, design and applications ofSolid–liquid filtration, Sedimentation, liquid - liquid extraction, Leaching and Washing.

Course Text

1- Coulson ,J.M and Richardson J.F. “Chemical Engineering” , Volume 1, 3rd edition, Robert Maxwell.M.C.
2- Coulson,J.M and Richardson J.F. “Chemical Engineering” , Volume 2, 3rd edition , Robert Maxwell.M.C.

Other support books :-

1- De Sinha and Parameswar De “Mass Transfer: Principles and Operations”, ParameswarDe , New Delhi, 2012
2- Binay.K.Dutta “Mass transfer and separation process” 2007.
3- Trebal Robert E., “Mass transfer operation”2nd edition, Mc-Graw –Hill Book com.1975.

Course Objectives: at the end of the semester the student should be able to :-

1- Basic information, concepts and terminology of the general principles of separation processes of Solid –liquid filtration, Sedimentation, liquid - liquid extraction, Leaching and Washing.
2- Demonstrating a broad and integrated knowledge and a deep understanding of issues related to separation processes in a chemical process and important role it plays in the success of the process both economically and environmentally.
3- Ability to select of appropriate equipment for the separation of materials in process plant.
4- An ability to apply effective, creative and innovative solutions, both independently and cooperatively, to current and future problems in separation processes and transport phenomena.

Topics Covered (Syllabus)

No.	Contents	Duration
1	**Filtration:** Type of Filters, Filtration theory, Plate and frame filter press, leaf filter, filtration at Constant ΔP, Filtration at Constant rate, washing Time.	12 hr
2	**Sedimentation:** Introduction, Settling and Sedimentation in particle fluid separation, Sedimentation and thickening design, equipment for settling and Sedimentation.	9 hr
3	**Liquid - Liquid Extraction and Leaching:** Definition, Extraction process, Equilateral Triangular coordinates (Ternary Diagram), system of three liquid _ one pair partially soluble, choice of solvent, Equipment in extraction cross _ current extraction, multi stage Cross Current extracting cross current for insoluble Liquid , Continuous Counter current extraction , Continuous Counter Current in Soluble , Liquid , Minimum Solvent . General principles, Equipment for leaching	18 hr
4	**Membrane** Introduction , classification of membrane processes , general membrane equation , liquid permeation membrane processes , gas permeation membrane processes reverse osmosis , reverse osmosis with water treatment plant , ultra filtration membrane processes , micro filtration membrane processes	6 hr

University of Technology
Department of Chemical Engineering

Program	*Chemical Processing Engineering*					
Course Code	**CES.P. 434**	Credits hr				Units
Course Title	Process Control					
Term	2st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Process Dynamic	**2**	**2**	**1**	**5**	**3**

Course Description

Analysis ofclosed-loop Chemical Engineering processes system to design and select closed-loop controlscheme that will operate the plant with stable conditions.

Course Text

1. D.R. Coughanowr and S. LeBlanc, Process Systems Analysis and Control, McGraw-Hill, 3rd edition, 2008.
2. Stephanopoulos G., "Chemical Process Control-An Introduction to Theory and Practice, "Prentice -Hall, New Jersey, 1984.

Other support books :-

1. Luyben W. L., "Process Modeling, Simulation and Control for Chemical Engineers," McGraw-Hill, New York, 2nd Ed., 1990.
2. Process Dynamics: Modeling, Analysis and Simulation, by Wayne Bequette.

Course Objectives: at the end of the semester the student should be able to :-

1. To enhancement the ability of students for the analysis of closed-loop system and response of controlled system under different operating conditions.
2. Construction of transfer functions of the closed system for different schemes.
3. Provide practice of tuning of controller parameters and limiting of stable operating conditions.
4. Motivation and encourage the students for solving open ended problems.

Topics Covered (Syllabus)/ Process Control

No.	Contents	Duration
1	Instrumentation Sensors: pressure, temperature, level, flow and concentration. Control valve. Dynamics characteristics of Instruments.	6 hr
2	Linear Closed-Loop Systems The Control System, Controllers and Final Control Elements, Block Diagram of Controlled System, Overall Closed-Loop Transfer Functions.	4 hr
3	Characteristics of the Closed Loop System Transient Response of Simple Control Systems, Stability	7 hr
4	Frequency Response Methods Introduction to Frequency Response Bode Diagrams, Control System Design by Frequency Response, Ziegler-Nichols Controller Settings.	7 hr
5	Computer Control of Chemical process Analog Computer, Digital Computer, Computer Control Loops.	3 hr
6	Control of Complex Processes Distillation Column, Absorber, Chemical Reactor.	3 hr

Practical: (Process Control Lab)

No.	Experiment Name
1	**Feedback Control**
2	**Dynamic Behavior of Second order under Damped System (Orifice)**
3	**Flow rate Control**
4	**Level Control in the Tank**
5	**Pressure Control**
6	**Dynamic Behavior of Second order over Damped System (Stirred Tanks)**
7	**Dynamic Behavior of Second order over Damped System (Stirred Tanks Heater)**
8	**Temperature Control**
9	**PH Control**
10	**Control of Water Treatment Unit**

Universityof Technology
Department of Chemical Engineering

Program	*Chemical ProcessingEngineering*					
Course Code	**CES.P.438**	Credits hr				Units
Course Title	Chemical Process Industries II					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemical Process Industries I	**2**	**0**	**0**	**2**	**2**

Course Description

The syllabus deals with Industrial Chemistry,which includes manufacture of ceramic,cement, glass, oil and fats, soap and detergents, sugar, and production of liquid biofuels from renewable resources.

Course Text

1.Shreves chemical process industries, Austin , G. T. , 5thed , McGraw- Hill ,1984
2.N. Naderpour ,Petrochemical production process,1st reprint, sbspublication,New Delhi,2009
3.Hydrocarbon processing ,Petrochemical processes,2005

Course Objectives : at the end of the semester the student should be able to :-

To provide an understanding of the synthesis, industrial manufacture, flow diagram, properties and uses of important chemical industries such as ceramic, oil and fats, soap and detergents.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Ceramic industries:** Raw materials, Classification of ceramic products, White ware, Refractories	**6 hr**
2	**Cement industries:** Raw materials, Classification of cement, Manufacture of Portland cement	**4 hr**
3	**Glass industries:** Raw materials, Glass fabrication, Types of Glass	**4 hr**
4	**Oil and fats:** Oil and fats sources and properties, Chemical compositions, Manufacture steps of oil	**4 hr**
5	**Soap and detergents:** Detergent groups, Manufacture of fatty acids, Manufacture of fatty alcohols, Manufacture of detergents, Manufacture of soap	**4 hr**
6	**Sugar industries:** Cane sugar, Beet sugar	**4 hr**
7	**Production of liquid biofuels from renewable resources**	**4 hr**

Program	***Chemical Processing Engineering***					
Course Code	**CES.P. 424**	Credits hr				Units
Course Title	Optimization					
Term	2^{st} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Numerical Analysis Mathematics III, IV Unit Operation.	**2**	**-**	**1**	**3**	**2**

Course Description

The subject is to be given in one semester. studying the formulation of objective the theory of optimization of single variable using analytical and numerical methods. Determination in the solution of multi variables problems .studying and solving the linear programming problems (LP).

Course Text

1) Optimization, Greirg D.M. Longmangroup limited London.
2) Optimization, converse A.O ,Holt, Reinhart, and Winston.

Other support books :-

1) Numerical methods for unconstrained optimization, Murrayw. Academic press.
2) Constrained optimization by direct search Swann, W.H. Gill and Murray.

Course Objectives : at the end of the semester the student should be able to :-

1. To formulate many problems arising in widely different situations.
2. Ability for finding optimum. Minimum, or maximum in unconstrained or constrained single or multi variables functions..
3. Deals with the special case of linear programming (functions and constraints are linear).
4. Provide practice to deal with industrial optimization problems.

Topics Covered (Syllabus)/ Optimization

No.	Contents	Duration
1	**Introduction to optimization.**	**2 hr**
2	**Recognizing an optimization problem and their solution.** - Formulation of optimization problems. - Unconstrained and constrained problems.	**4 hr**
3	**Optimization methods for single variable problems.** - Analytical methods; constrained and unconstrained. - Graphical method. - Numerical methods. Unconstrained functions; fixed step method, DSC method, Newton method. Constrained functions; sequential search, Dichotomous search; Fibonacci search, Golden ratio search.	**6 hr**

4	**Determining the solution to multivariable optimization problems.** Unconstrained minimization and maximization strategy. - Solving linear and non-linear equations using matrices. - Optimality conditions for unconstrained problems. - Lagrangian criteria. - Simplex method direction step length calculation. Solution of constrained multivariable problems. - Analytical solution. - Lagrangian duality. - Linearization of nonlinear optimization problems. - Simplex method. - Pivot table formulation. Linear programming (LP) formulation. - Solving linear system. - Basic solution of an (LP) problems. - Graphical interpretation.	**6 hr**
5	**Applications of Optimization**: - Heat Transfer and Energy Conservation. - Separation Processes. - Fluid Flow Systems. - Chemical Reactor Design and Operation. - Optimization in Large-Scale Plant. Design and Operations. - Integrated Planning. Scheduling. And Control in The Process Industries.	**8 hr**
6	**Introduction to:** - Machine learning. - Deep learning - Neural network. - Artificial Intelligence.	**4 hr**

Program	***Chemical Processing Engineering***					
Course Code	**CES.P. 439**	Credits hr				Units
Course Title	Corrosion Engineering					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Material Eng. I & II	**2**	**-**	**-**	**2**	**2**

Course Description

Introduction, Classification of Corrosion, Kinetics of aqueous corrosion, Thermodynamics, Determining Passivity, Reference Electrode, Corrosion prevention, Protection methods.

Course Text

1- Zaki Ahmed, "Principle of Corrosion Engineering and Corrosion Control″,1ST Edition, ,IChemE,ELSEVIER, 2006.
2- Denny A. Jones, "Principle and Prevention of Corrosion″, 2nd Edition, Prentice Hall, 1996.
3- Herbert H. UHLIG, ″ Corrosion and Corrosion Control″ John WILEY, 2008.
4- Fontana, M.G and Greene, N.D, "Corrosion Engineering", 3rd Edition, McGraw-HILL, 1986.

Course Objectives : at the end of the semester the student should be able to :-

1- Understanding the concept of corrosion. The form of corrosion, How the material destroyed by corrosion.
2- Determine the corrosion rates and electrochemical behavior of the metals and the thermodynamics of corrosion reactions.
3- Applying the corrosion prevention technology.
4- Selection of materials involved in applying the corrosion prevention technology.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction :** Definitions, Corrosive environment, Consequences of corrosion, Cost of corrosion, Why metals corrode, Basic concepts on corrosion, Anodic and Cathodic reactions, Types of cells.	**2 hr**
2	**Classification of corrosion:** Wet corrosion, Dry corrosion, Forms of corrosion	**4 hr**
3	**Kinetics of aqueous corrosion:** Faraday's laws of electrolysis and its application in determining the corrosion rate, reversibility and exchange current density, polarization, Activation polarization, Concentration polarization, Resistance Polarization, Combined polarization.	**4 hr**

4	**Thermodynamics and its application on corrosion:** Free energy, Cell potential, Reversible electrode potential, Nernst equation	4 hr
5	**Determining the corrosion rate** Corrosion rate measurement units, methods determining corrosion rate: 1- Immersion test 2- Electrochemical technique a) Tafel extrapolation b) Linear polarization	4 hr
6	**Passivity:** Active passive metal and conditions for passivity, Kinetics of passivity table passivity, Unstable Passivity	2 hr
7	**Reference electrodes:** Hydrogen electrode, Ag/AgCl electrode, $Zn/ZnCl_2$ electrode, $Pb/PbCl_2$ electrode	2 hr
8	**Corrosion prevention in Oil Industry:** Materials selection, Alteration of Environment, Design, Coating, Anodic protection, Inhibitors	2 hr
9	**Pourbaix diagram:** Equilibrium Diagram, Advantage and Disadvantage of Pourbaix Diagram	2 hr
10	**Cathodic Protection:** Sacrificial anode corrosion protection, Impressed current anode corrosion protection, Major impressed current anodes, Galvanic systems anode, Design parameters in cathodic protection, Stray current corrosion	4 hr

University of Technology
Department of Chemical Engineering

Program	Chemical Processing Engineering					
Course Code	**CES.P. 4310**	Credits hr				Units
Course Title	Petrochemical Industries					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemistry II, Unit Operation I	**2**	**–**	**1**	**3**	**2**

Course Description

Basic PCs (1st PCs generation) raw materials, processes and uses, Intermediate of most basic PCs (2nd generation), Final products: involve polymers.

Course Text

1. Sami Matar, Lewis F. Hatch, Chemistry of Petrochemical Process, 2nd edition.
2. William D. Callister, David G. RETHWISC, Materials Science and Engineering.

Course Objectives : at the end of the semester the student should be able to :-

1. To introduce and develop an understanding of raw materials of petrochemicals. Petrochemical.
2. To introduce petrochemical generation first: Basic petrochemicals, second: Intermediates and third: final products: polymers.
3. To give the learner the skills necessary to accommodate considered what has been studied.
4. To provide the student with confidence and study the skills to enable them to progress.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction:** Raw material, characterization	3 hr
2	**Basic Petrochemical Materials :** a-low Olefins: Ethylene production by steam Cracking processes b-butylenes: conversion process for production of olefins, Isobutylene production. C-Diolefin:, Butadiene Separation.d- Higher Olefins: production methods.e-. Linear: Alkyl benzene Complex (LAB), f-Aromatics: Sources, Separation of benzene Toluene Xylene.g- Syntheses gas:H_2 production: Steam reforming, Partial Oxidation	12 hr
3	**Intermediate Petrochemicals:** Methanol, , Acetic acid, Vinyl chloride M, Ethylene Oxide Ethanolamine, , Ethylene glycol , Acrylonitrile, Adipic Acid, Methyl Tetra butyl ether, Ethyl benzene, Styrene, Phenol, Nitrobenzene, Cyclohexane, Benzoic acid, Terephthalic acid.	9 hr
4	**Polymers:** LDPE, HDPE, PP, PVC,PPSynthetic Fibers	3 hr
5	**Petrochemical Complexes :** Ethylene ,Propylene ,Benzen , C4 ,BTX	3 hr

University of Technology
Department of Chemical Engineering

Program	Chemical and Petroleum Refinery Engineering					
Course Code	**CES.R.111**	Credits hr				Units
Course Title	Technical English I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Basic principles in English language (grammars and vocabularies)	**2**	**-**	**-**	**2**	**2**

Course Description

Define a specialknowledge and basic concepts in English language, review of (words, terms and phrases commonly utilized)with practical everyday language that students need, the fundamental principles of grammars used in English language such as question and answer, the negative, the tail questions, the singular and plural, the numbers, nouns, pronouns, the verb (to be, to have, and to do), adjectives, regular and irregular verbs, using so & neither, and adverbs, degrees of comparison, conjunctions and interjections, kinds of letter (S) with general exercises. Also, accurate description of the nature of vocabularies and idioms used by the chemical engineers and that the student needs in his/her academic and/or in his/her professional career by means of applying two reading passages focus mainly on studying the chemical engineer work in the factories as well as equipment, tools and materials used.

Course Text

1- The language of chemical engineering in English, Roy V. Hughson (1979), Regents publishing company, Inc.
2- New headway plus (English Course), Liz & John Soars (2014), Oxford University press.

Other support books :-

1- Life Lines workbook (Pre-intermediate and Intermediate level), Tom Hutchinson (2007), Oxford University press.
2- English in a simplified way, Tahir Al- Bayati (1991), Baghdad.

Course Objectives: at the end of the semester the student should be able to :-

The objective of this course focuses on:

1-in-depth understanding and comprehension of the essential grammars in the English language that usually used in writing and/or speaking with choosing the correct way of speaking and/or listening the vocabulary (phonetics and spelling) by the use of common phrases and words.

2-Also, focus on the use of technical English(reading passages) as a heart of chemical engineer work, such as what chemical engineers do, research and development.

3- The development of the student's ability to apply and arrange knowledge in English language and thus become able to employ them appropriately in his/her daily dealing without the complexity.

4- As well, encourage students to develop their capabilities in the field of English language through participation by the training on the use and improve their language.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Academic Comprehension: (Reading passages related to chemical engineering):** The first reading passage (What chemical engineers do) (Special terms or definitions, vocabulary practice - the word and its meaning, paragraphs - read and explanation, review, and discussion)	8 hr
2	**Academic Comprehension: (Reading passages related to chemical engineering):** The second reading passage (Research and development). (Special terms or definitions, vocabulary practice - the word and its meaning, paragraphs - read and explanation, review, and discussion).	8 hr
3	**English Grammar:** A general introduction to the English language and its importance as a means of communication between different peoples around the world,Review of the words, terms and phrases commonly used,Review of the simple grammars in English language, such as question and answer, the negative, the tail questions, the singular and plural, the numbers, telling the date, and telling the time, Nouns, pronouns, the verb to be, the verb to have, the verb to do, Adjectives and regular and irregular verbs, Reading and writing grammars that include short forms and words with two different meanings, The use of so & neither, and adverbs, Degrees of comparison,Conjunctions and interjections with general exercises, Kinds of letter (S) with general exercises.	14 hr

University of Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R.121**	Credits hr				Units
Course Title	Mathematics I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematic of secondary school	**2**	**-**	**1**	**3**	**2**

Course Description

Introduction to functions, limits, Special functions, Derivatives, Chain rule, and their applications. Introduction to integral calculus, Methods of integration.

Course Text

1- Thomas Calculus, by George B.Thomas,Jr,Elevnth Edition Media Upgrade 2018"

Other support books:-

2- Engineering Mathematics for Semesters I and II, by C.B. Gupta, S.R. Singh, M. Kumar, 2015.
3- Advanced Engineering Mathematics, Fifth Edition, by C.Raywylie,LouisC.Barrett, 1982.
4- Mathematical Methods in chemical Engineering, Second Edition, by V.G.Jenson and G.V. Jeffreys, 1977.

Course Objectives : at the end of the semester the student should be able to :-

1-To develop an understanding with the concepts of calculus and analytic geometry and the applications of these concepts to the solution of engineering problems.
2-Provide practice at developing critical thinking skills, solving open ended problems and to work in teams.
3- Develop a deep understanding of issues related to the basic principles of calculus, and how to solve problems in chemical engineering

Topics Covered (Syllabus)/ Mathematics I

No.	Contents	Duration
1	**Functions** • Absolute value, • Coordinates of the plane, • Slope of lines and angle of inclination, • Functions and graph of the functions, • Domain and range, • Identifying functions, sum, differences, products and quotients, • Composite functions, • Shifting a graph of a function, • Scaling and reflecting a graph of a function,	**9 hr**

2	**Transcendental functions** • Logarithmic and exponential functions, • Trigonometric functions, • Inverse trigonometric functions.	**6 hr**
3	**Derivatives** • Definition, • Chain rule, • Derivative of inverse trigonometric functions, • Derivative of exponential and logarithmic functions, • L, hopitals rule, • Partial derivative, • Function of two or more variables.	**9 hr**
4	**Determinates and Matrices** • Definition, • Determinate evaluation, • Solution of system of linear equation by matrix; (Inverse of matrix, Gauss elimination), • Rank of matrix, • Eigen value and Eigen vectors.	**6 hr**

Universityof Technology
Department of Chemical Engineering

Program	Chemical and Petroleum Refinery Engineering					
Course Code	**CES.R.123**	Credits hr				Units
Course Title	Chemistry					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemistry of Secondary School	**2**	**2**	**0**	**4**	**3**

Course Description

Fundamentals of atoms, molecules , Quantitative analysis , Environmental , Transition Metal Chemistry and Spectroscopic Techniques which are mostly used in all other chemical engineering courses

Course Text

1- Skoog, D.A., West D.M., Holler F.J., and Crouch S.R. “Fundamentals of analytical chemistry”,8ed edition ,brooks/Cole Cengage Learning. 2004

Other support books :-

1- Harrison, R.M,” Understanding Our Environment An Introduction to Environmental Chemistry and Pollution”,3ed edition, The Royal Society of Chemistry 1999

2- Atkins, P., de Paula, J."Physical Chemistry and Collide Science"8ed edition, W. H. Freeman and Company. 2006

3- Huheey, J. E. "Inorganic Chemistry: Principles of Structure and Reactivity", 4ed edition, Prentice Hall. 1997

Course Objectives: at the end of the semester the student should be able to:-

1- Students will learn to use the language of chemistry: symbolic representation, nomenclature, and terminology.
2- Students will learn to think about chemical reactions and chemical and physical properties at the particulate level and will be able to visualize and depict the structure of matter and its reactions at the microscopic (atomic and molecular) level.
3- Students will gain a conceptual understanding of and will be able to perform quantitative problem-solving skills in atomic structure, Stoichiometry, chemical equilibria, and electrochemistry.
4- Students will be able to use their knowledge to analyze and construct solutions by instruments
5- Students will learn to use theories of bonding in coordination compounds

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Atoms and Molecules:** Mechanical picture of atomic structure, Derivation of Schrodinger wave equation, Chemical Bonding- Orbital concepts in bonding, V.B. and M.O. theory, M.O. diagrams, Intermolecular interactions.	3 hr
2	**Quantitative analysis :**	6 hr

	Atomic weight , Molecular formula, Chemical equations, Mole concept, Chemical, equilibrium, equilibrium constants, Preparation and properties, Molarity, Normality, ppm, pH, pOH, Buffers, Solubility Ksp, Gravimetric Analysis, Precipitation reaction, Potentiometric Titration, Complex titration.	
3	**Electrochemistry:** Arrhenius theory of electrolytic dissociation, Transport number, Kohlrausch's law, Solubility product, Redox reaction, Electrochemical and concentration cells	**4 hr**
4	**Photochemistry and Spectroscopic Techniques:** Photoexcitation of organic molecules, Jablonski diagram, Laws of photochemistry and quantum yield, Some examples of photochemical reactions, Chemistry of vision and other applications of photochemistry. General introduction to UV, IR, NMR and Chromatography	**7 hr**
5	**Transition Metal Chemistry:** Structure of coordination compounds corresponding to coordination number up to 6, Types of ligands, Isomerism [geometrical, optical, ionization, linkage and coordination], Theories of bonding in coordination compounds- crystal field theory, Valence bond theory, Chelation	**6 hr**
6	**Environmental :** Introduction, Water, air, soil pollution	**4 hr**

Practical: (Chem. lab.)

No.	Experiment Name
1	**Introduction and chemical safety basic rules**
2	**Equipment and how to use it**
3	**Preparation of standard solution (primary and secondary)**
4	**Direct Titration**
5	**Quantitative determination of a carbonate and hydroxide in mixture**
6	**Back titration**
7	**Titration Curves**
8	**Determination of Chloride Ions in Water**
9	**Standardization of $KMnO_4$ and the determination of ferrous sulfate (Redox reaction)**
10	**Determination of Hardness of Water**
11	**Paper Chromatography**
12	**Qualitative analysis silver group**

Program	Chemical and Petroleum Refinery Engineering					
Course Code	**CES.R.125**	Credits hr				Units
Course Title	Physics					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Physics of secondary school	2	-	1	3	3

Course Description

This course aims to help students acquire the knowledge and understand concepts, fundamental laws, principles, and processes in physics necessary for students who intend to complete their bachelor's degree in the chemical engineering department.

Course Textbooks

1. Shipman, James, Jerry D. Wilson, Charles A. Higgins, and Bo Lou. An introduction to physical science. Cengage Learning, 2013.
2. Principle of Physics, Kinetic Books Company, 2007.

Course Objectives: at the end of the semester, the student should be able to understanding:-

1. Determine the components of linear motion (displacement, velocity, and acceleration).
2. Solve problems involving forces and work.
3. Apply Newton's laws to physical problems.
4. Identify the different types of energy.
5. Solve problems using principles of conservation of energy.
6. Define the principles of momentum and collisions.
7. Use principles of momentum to solve problems.
8. Problems solving ability, e.g., analyzing a situation or data, establishing a relationship between cause and effects.

Topics Covered (Syllabus)/ Physics

No.	Contents	Duration
1	**Motion in One Dimension** • Position • Displacement • Velocity • Acceleration • Derivation: creating new equations • Motion equations for constant acceleration • Free-fall acceleration	2 hr

2	**Properties of matter** • Elasticity • Surface Tension • Viscosity	2 hr
3	**Force and Newton's Laws:** • Force • Newton's first law • Gravitational force: weight • Newton's second law • Newton's third law • Normal force • Tension • Newton's second and third laws • Free body diagram • Static and kinetic friction • Hooke's law and spring force • Air resistance	6 hr
4	**Applications of Newton's Laws** • Presenting and solving on Newton's Laws	2 hr
5	**Work, Energy, and Power:** • Energy • Kinetic energy • Work-kinetic energy theorem • Power • potential energy • Work and gravitational potential energy • Conservation of energy	4 hr
6	**Momentum** • Linear momentum • Conservation of momentum • Collisions	2 hr
7	**Thermodynamics** • Temperature and Heat • Temperature and thermometers • Temperature scales • Temperature scale conversions • Heat • Zeroth law of thermodynamics • Internal energy	4 hr

	• Thermal expansion and its types • Specific capacity • Phase changes • Latent heat • Modes of heat transfer • Global warming and the greenhouse effect	
8	**Modern Physics** • Electron, thermionic, emission, photoelectric emission, • X-ray • The nucleus • Structure of nucleus and atom • Radioactivity • Nuclear energy • Ionizing radiation • Health hazards	**4 hr**
9	**Introduction to IS units and DC circuit:** Material use inelectric component, ohms law, temperature Coefficient, Review of Kirchhoff's Laws, Series and Parallel circuit, Resistance and resistivity	**2 hr**
12	**Chemical Effect of Electricity:** Electrolysis, Electroplating, Electrical Cells	**2 hr**

University of Technology
Department of Chemical Engineering

Program	***Chemical and Petroleum Refinery Engineering***					
Course Code	**CES.R.126**	Credits hr				Units
Course Title	Engineering drawing					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	None	**1**	**2**	**---**	**3**	**2**

Course Description

Introduction inEngineering drawing, engineering drawing applications, engineering process , analysis model to view and study the full and half Sections , conclusion of the third projection ,Draw isometric and Oblique.

Course Text

1. الرسم الهندسي،تاليف (عبد الرسول الخفاف) الطبعة الثانية،1993
2. R.P Hoelscher and C.H Springer "Engineering Drawing and Geometry ".2nd edition

Course Objectives: at the end of the semester the student should be able to :-

1.The students can be use Tools Drawing in draw and analyze geometric shapes
2. Enable students to draw devices, equipment & PFD in chemical engineering.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	Introduction	**3 hr**
2	Planning of Drawing paper	**3 hr**
3	Types of line	**3 hr**
4	Engineering operation	**3 hr**
5	Projection Drawing	**3 hr**
6	First angle projection	**3 hr**
7	Third angle projection	**3 hr**
8	Full section	**3 hr**
9	Half section	**3 hr**
10	The finding of third view	**3 hr**
11	Application Example	**3 hr**
12	Pictorial Drawing (Isometric and Oblique)	**3 hr**
13	Application Example	**3 hr**
14	Dimensions	**3 hr**
15	Examples of chemical engineering drawing and exercises.	**3 hr**

Program	**Chemical and Petroleum Refinery Engineering**					
Course Code	**CES.R.113**	Credits hr				Units
Course Title	**Computer Science**					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	None	**1**	**2**	**---**	**3**	**2**

Course Description

This course provides an overview of The Operating Systems, Types Of Operating Systems, Computer Operating Systems, Smartphone Operating Systems, operating system Windows 7, Windows 7 is a series of personal computer operating systems produced by Microsoft as part of its Windows NT family of operating systems. It is the successor to Windows 8.1, and was released to manufacturing on July 15, 2009, and broadly released for retail sale on July 29, 2010and the program of Microsoft Office 2010, Microsoft Office 2010, Microsoft Excel 2010. we an overview the Visual Basic and includes the operation of Visual Basic and describe the elements of the design environment and user interface design and the difference between the project and the program and introduce students to the philosophy of programming using visual Basic and a programming process events Event-Driven Programming and programming objects Object Oriented Programming and gives the student an introduction to object-oriented programming and introduce students to the fundamental differences between the concept of the programming language BASIC visual and languages BASIC traditional and explain the steps to design and program planning.

Course Text

1- David a. "How computer hardware and software work" 2009.
2- Introduction to windows 7
3- Sabgayyeshi " basic networking tutorial",2011
4- IC3"Key applications using Microsoft office 2010
5- “Visual Basic: Crash Course - The Ultimate Beginner's Course to Learning Visual Basic Programming”, 3rd Edition, A. Tannenbaum, Prentice-Hall, 1996.
6 Bryan Newsome Worx " Beginning Visual Basic " USL Press, | December 2003 | ISBN-10: 1119092116 |
7-. F,Halsall “Course Notes for Learn Visual Basic 6.0”, 4th Edition, Addison-Wesley, 2000.

Course Objectives: at the end of the semester the student should be able to :-

1-	Learn how to turn on the Windows operating system windows
2-	Start Microsoft Office applications and work with the Microsoft Office interface Create documents in Microsoft Word. Create workbooks in Microsoft Excel.
3-	Learn how to deal with the web and how to navigate
4-	Define and modify the properties and methods associated with an object
5-	Load, modify, and save changes made to forms and projects in the Visual Basic environment

6- Define and implement form objects including data arrays, control arrays, text boxes, message boxes, dialog boxes, labels, controls, menus, frames, picture boxes, pull-down menus, and combo boxes

Topics Covered (Syllabus)/ Computer Science

No.	Contents	Duration
1	**Operating System:** Types of operating systems, computer operating systems, smartphone operating systems.	1 hr
2	**Windows 7:** The operating system Windows 7, Computer Fundamentals: (Computer components, types, operations, Computer Fundamentals: (hardware units, software types), numeric systems, **I**ntroduction to Windows, Desktop, Desktop icons, change desktop properties, taskbar and toolbars, start menu basics, context menu, operation in window, control panel features.	1 hr
3	**Microsoft office World 2010:** Introduction to the office system, Microsoft World, Microsoft World, Program Interface and how to write scripts, Microsoft World, Text Processing and typesetting	1 hr
4	**Microsoft Excel 2010:** Program Interface, how statistical tables and graphs work, Microsoft Excel 2010, How to use mathematical and statistical functions	1 hr
5	**Introduction to Visual Basic Programming** Menu bar, Tools bar, Project explorer, Tool box, Properties windows, Form, Code, Controls, Command Buttons, Label, Textbox, Pointers, Picture box, frame, Naming Controls, Properties for controls: Height, Width, Left, Top, Font, Forecolor, Backcolor , Name, Caption, Text, and Visible, Events, Saving Visual Basic Project, Examples, Chemical Engineering Applications.	1 hr
6	**Mathematics** Arithmetic Operations: +, , *, /, \, mod, ^. (Using Simple Example for each Operation), Logical Operations. AND, OR, NOT. And the Truth Table for each Operation, (Using Simple Example for each Operation), Relational Operation: >, <, >=, <=, <>, =, String Concatenation (&), Operation Precedence. For all arithmetic, logical, relational operators, Print statement and Formatting. Illustrate (colon, comma, and semicolon), Examples: Chemical Engineering Applications **Built in Functions:** Built-in math functions, Abs(x), Int(x), Rnd(x), sgn(x), sqr(x), str(x), val(x), round(x,n),CInt(x),Fix(x),String Functions, InputBox, MsgBox, Examples: Chemical Engineering Applications.	1 hr

7	**Selection Structure** Single Selection: If/Then structure, Double Selection: If/Then/Else structure, Nested If/Then/Else structure, Select Case Multiple Selection Structure, Examples: Chemical Engineering Applications.	1 hr
8	**Reputation Structure:** For ... Next Loop, while ... Wend, Do .... While ... Loop, Do ... Loop Until, Exit Do, Exit For Examples: Chemical Engineering Applications.	1 hr
9	**Variables** Data Types: Boolean, Integer, Long, Single, Double, String, Valid Naming of Variables, Initial Value for each Type of the Variables (Initial Value for each Data Type), Size of each Variable Type in Bytes, How to Declare Variables. (Dim statement).	1 hr
10	**Using: Dim variable name As Data type, Using Suffix:** Integer, Long, Single, Double, String, Constant Variable. Examples: Chemical Engineering Applications.	1 hr
11	**Arrays** Introduction: Defining Arrays, Array Declaration Statement, Assigning Values for Arrays (i.e., Filling array's element value either by loop or by direct assignment statement), Re Dim Statement, Using Loops with Arrays. (i.e. writing an application on array using loops), Two Dimensional Arrays, Operations on Arrays,	2 hr
12	Fill Array Elements with Random Numbers using and Function, Sorting, Searching. (i.e., Linear search), Swapping Two Elements. Examples: Chemical Engineering Applications.	1 hr
13	**Graphics in Visual Basic:** Graphics control, Picture box, Image box, Coordinate system, Pixel,	1 hr
14	Graphics methods (Line, Circle, pset) Examples: Chemical Engineering Applications.	1 hr

Practical :(Comp.Sci.Lab)

No.	Contents
1	**Windows 7:** the operating system Windows 7 , Computer Fundamentals: (Computer components, types, operations,Computer Fundamentals: (hardware units, software types), numeric systems. **I**ntroduction to Windows, Desktop, Desktop icons, change desktop properties, taskbar and toolbars, start menu basics, context menu, operation in window, control panel features.
2	Microsoft office, Introduction to the office system, Microsoft World, Program Interface and how to write scripts, Text Processing and typesetting
3	Microsoft Excel 2010, Program Interface, How statistical tables and graphs work
4	Microsoft Excel 2010, How to use mathematical and statistical functions
5	Operating Systems, Types Of Operating Systems
6	Computer Operating Systems, Smartphone Operating Systems
7	**Introduction to Visual Basic Programming:** Menu bar, Tools bar, Project explorer, Tool box, Properties windows, Form, Code, Controls, Command Buttons, Label, Textbox, Pointers, Picture box, frame, Naming Controls, Properties for controls: Height, Width, Left, Top, Font, Forecolor, Backcolor, Name, Caption, Text, and Visible, Events, Saving Visual Basic Project, Examples, Chemical Engineering Applications.
8	**Mathematics** Arithmetic Operations: +, , *, /, \, mod, ^. (Using Simple Example for each Operation), Logical Operations. AND, OR, NOT. And the Truth Table for each Operation, (Using Simple Example for each Operation), Relational Operation: >, <, >=, <=, <>, =, String Concatenation (&), Operation Precedence. For all arithmetic, logical, relational operators, Print statement and Formatting. Illustrate (colon, comma, and semicolon), Examples: Chemical Engineering Applications
9	**Built in Functions:** Built-in math functions, Abs(x), Int(x), Rnd(x), sgn(x), sqr(x), str(x), Val(x), round(x,n),CInt(x),Fix(x),String Functions, InputBox, MsgBox, Examples: Chemical Engineering Applications
10	**Selection Structure:** Single Selection: If/Then structure, Double Selection: If/Then/Else structure, Nested If/Then/Else structure, Select Case Multiple Selection Structure, Examples: Chemical Engineering Applications.
11	For ... Next Loop, while ... Wend, Do.... While ... Loop, Do ... Loop Until, Exit Do, Exit For

	Examples: Chemical Engineering Applications.
12	**Variables** Data Types: Boolean, Integer, Long, Single, Double, String, Valid Naming of Variables, Initial Value for each Type of the Variables (Initial Value for each Data Type), Size of each Variable Type in Bytes, How to Declare Variables. (Dim statement), Using: Dim variable name As Data type, Using Suffix: Integer, Long, Single, Double, String, ConstantVariable. Chemical Engineering Applications.
13	**Arrays:** Introduction: Defining Arrays, Array Declaration Statement, Assigning Values for Arrays (i.e., Filling array's element value either by loop or by direct assignment statement), Re Dim Statement, Using Loops with Arrays. (i.e., writing an application on array using loops), Two Dimensional Arrays, Operations on Arrays, Fill Array Elements with Random Numbers using and Function, Sorting, Searching. (i.e., Linear search), Swapping Two Elements. Examples: Chemical Engineering Applications
14	**Graphics in Visual Basic:** Graphics control, Picture box, Image box, Coordinate system,Pixel,Graphics methods(Line,Circle,pset) Examples: Chemical Engineering Applications.

Universityof Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical and Petroleum Refinery Engineering</td></tr>
<tr><td>Course Code</td><td>CES.R.112</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Technical English II</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Technical English I</td><td>2</td><td>-</td><td>-</td><td>2</td><td>2</td></tr>
</table>

Course Description

Define a specialknowledge and basic concepts in English language, review of phonetics and spellingwith words and sounds that need attention in understanding the meaning and pronunciation, the fundamental principles of grammars utilized in English language such as the use of the prefixes (un, im, in, and dis), the use of since & for, the definite and indefinite articles. As well as simple, continuous and perfect tenses (present, past, and future), the punctuation, active voice and passive voice, direct and indirect speech, finite and non-finite verbs, analyses and kinds of sentences. Also, accurate description of the nature of vocabularies and idioms used by the chemical engineers and that the student needs in his/her academic and/or in his/her professional career by means of applying two reading passages focus mainly on studying the chemical engineer work in the factories as well as equipment, tools and materials used.

Course Text

1- The language of chemical engineering in English, Roy V. Hughson (1979), Regents publishing company, Inc.
2- New headway plus (English Course), Liz & John Soars (2014), Oxford University press.

Other support books :-

1- Life Lines workbook (Pre-intermediate and Intermediate level), Tom Hutchinson (2007), Oxford University press.
2- English in a simplified way, Tahir Al- Bayati (1991), Baghdad.

Course Objectives: at the end of the semester the student should be able to :-

The objective of this course focuses on:

1- Study and conception of the advance grammars in the English language that usually employed in academic writing and also explain the use of grammars correctlyin speaking and/or listening the vocabulary (phonetics and spelling) via increasing the ability to rapid recognize the words that have two different meanings depending on their presence in the context of speech

2- Accurate description of the nature of vocabulary and idioms used by the chemical engineers in dealing with their respective fields in addition to the vocabulary of daily dealing. Also, focus on the use of reading passages such as process design and plant operation, which are related to student competence and his/her profession as an engineer in the chemical companies.

3- Enhancement of student's ability by applying modern information in English language about the characteristics of the chemical engineer job and then try to the simulation that in writing the scientific report, expression, and formulate of simple sentences and complex ones without the difficulty.

4- Finally, promote the qualifications of students in the field of English language by training on the use and the progress of their language in order to allow them to easily use it in his/her future academic study in chemical engineering.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Academic Comprehension: (Reading passages related to chemical engineering):** The third reading passage (*Process design*) (Special terms or definitions, vocabulary practice - the word and its meaning, paragraphs - read and explanation, review, and discussion)	**8 hr**
2	**Academic Comprehension: (Reading passages related to chemical engineering):** The fourth reading passage (*Plant operation*). (Special terms or definitions, vocabulary practice - the word and its meaning, paragraphs - read and explanation, review, and discussion).	**8 hr**
3	**English Grammar:** Phonetics & Spelling (consonant sounds & vowel sounds), Words and sounds that need attention in understanding the meaning and pronunciation, as well as the use of the prefixes (un, im, in, and dis),The use of since & for, as well as the definite and indefinite articles,Punctuation (such as the use of the capital letter, the question mark, and the comma….etc), Simple tenses (present, past, and future), Continuous and perfect tenses (present, past, and future), Active voice and passive voice,Direct and indirect speech, Finite and non-finite verbs, Analyses of sentences, and kinds of sentences (either according to form or to number of statements).	**14 hr**

Program	Chemical and Petroleum Refinery Engineering					
Course Code	**CES.R.122**	Credits hr				Units
Course Title	Mathematics II					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematics I	**2**	**-**	**1**	**3**	**2**

Course Description

Definite integral and applications, Polar coordinates, Vector analysis, Determinant and matrices

Course Text

1- Thomas' Calculus, by George B. Thomas, Jr., Fourteenth Edition, Media Upgrade 2018.

Other support books: -

2- Engineering Mathematics for Semesters I and II, by C.B. Gupta, S.R. Singh, M. Kumar, 2015.

3- Advanced Engineering Mathematics, Fifth Edition, by C.Raywylie,LouisC.Barrett, 1982.

4- Mathematical Methods in chemical Engineering, Second Edition, by V.G.Jenson and G.V. Jeffreys, 1977.

Course Objectives : at the end of the semester the student should be able to :-

1- To understand these concepts of applications and how to evaluate volumes, surface area , and to understand analytic geometry.

2- Provide practice at developing critical thinking skills, solving open ended problems and to work in teams.

3- Develop a deep understanding of issues related to the basic principles of polar coordinates, vector analysis, determinants, and how to solve problems in chemical engineering

Topics Covered (Syllabus)/ Mathematics II

No.	Contents	Duration
1	**Integration** • Indefinite integration, • Integration of inverse trigonometric functions, • Integration methods; (substitution, by part, trigonometric substitution, partial fraction).	**12 hr**

2	**Definite integration and Applications** • Double integrals, • Reverse order of integration, • Length of curves, • Surface area, • Volumes	9 hr
3	**Vector Analysis** • Definitions, • Properties, • Vector in space, • Scalar and cross product of vector, • Product of three vectors.	9 hr

Universityof Technology
Department of Chemical Engineering

Program	***Chemical and Petroleum Refinery Engineering***					
Course Code-	**CES.R.131**	Credits hr				Units
Course title	Chemical Engineering Principles I					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematic I; Chemistry I	3		1	4	3

Course Description

Understanding the basic concepts and expressions in chemical engineering and learning calculations related to chemical reactions, material balance, gases and vapours.

Course Text

- D.M.Himmelblau and J.B.Riggs ,Basic Principles and Calculations in Chemical Engineering ,7th Edition , 2004 .
- R.M.Felder and R.W.Rousseau ,Elementary Principles of Chemical Processes ,3rd Edition ,2005 .

Other support books :-

Skogestad, S. (2008). Chemical and energy process engineering. CRC press.

Course Objectives: at the end of the semester the student should be able to:-

1- Have a deep knowledge, wide scope and improved understanding of the mechanisms in heat balance as well as a better insight into analytical and empirical methods applied in analysis of material balance related problems.

2- Gain knowledge for applying the material (equation) balance in chemical engineering problems.

3- To provide experience for students to solve material balance for different process

Topics Covered (Syllabus)

No.	Contents	Duration
1	**General Knowledge of Chemical Engineering** ➢ Definition of chemical engineering. ➢ Chemical process industries (CPI). ➢ Generalized chemical process. ➢ flow sheet and block diagram of a chemical process ➢ The difference between the chemist and the chemical engineer**.**	**6 hr**

2	**Physical and Chemical Principles** ➢ Units and Dimensions ➢ Operations with Units ➢ Addition, Subtraction, Equality ➢ Multiplication and Division ➢ Conversion of Units and Conversion Factors ➢ Dimensional Consistency (Homogeneity) ➢ Nondimensional Groups:	**12 hr**
3	**Concepts of flow rates, density, specific gravity, temperature and pressure** ➢ Four types of temperature ➢ Temperature Conversion ➢ Heat capacity ➢ Pressure and Its Units ➢ Types of pressures ➢ Measurement of Pressure	**15 hr**
4	**Introduction to Material Balances** ➢ The Concept of a Material Balance ➢ Open and Closed Systems ➢ Steady-State and Unsteady-State Systems ➢ Multiple Component Systems	**12 hr**

University of Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R.124**	Credits hr				Units
Course Title	Chemistry of Petroleum					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemistry I	**2**	**2**	**0**	**4**	**3**

Course Description

An Introduction to Organic Compounds, preparation, reaction including petroleum and heterocyclic compound

Course Text

1- Ghatak,k.l," textbook of organic chemistry and problem analysis",PHL Learning.2014.

Other support books :-

1- Morrison, Thornton R.; Boyd, Neilson, R."Organic Chemistry" 6th edition, J. Chem. Educ. 1992

2- Bruice,P.Y.,J.M "organic chemistry",7th edition ,. Books a la Carte Edition, 2014

Course Objectives: at the end of the semester the student should be able to :-

1- Students will learn the basic concepts of organic chemistry
2- understanding the concepts of organic reactions for analysis of unit processes
3- Students will learn the Petroleum chemistry and refining

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	An Introduction to Organic Compounds: Nomenclature, Physical Properties, and Representation of Structure	**6 hr**
2	Preparation and Reactions : Alkanes, Alkenes, Dienes, Alkynes, aromatic hydrocarbon	**6 hr**
3	Preparation and Reactions : alkanes derivative (RX, ROH, RCOOH, RCOH, RCOR,….etc. Organometalic	**9 hr**
4	Mechanisms of organic reactions: (elimination, substation, addition)	**2 hr**
5	Petroleum : Origin of petroleum, Composition, Refining, Kerosene, Naphtha	**4 hr**
6	Heterocyclic compounds : Isolation and reactions of furan, pyrrole, pyridine Terpenes	**3 hr**

Practical: (Chem. of Petro lab.)

No.	Experiment Name
1	Boiling point determination
2	Melting point determination
3	Simple Distillation
4	Preparation of aspirin
5	Preparation of ester
6	Identification of functional groups-I
7	Identification of functional groups-II
8	Saponification reaction
9	Preparation of phenolphthalein
10	Synthesis of adipic acid
11	Synthesis of furan

University of Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical and Petroleum Refinery Engineering</td></tr>
<tr><td>Course Code</td><td>CES.R.127</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>AutoCAD</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Computer Sience
-Eng. Drawing</td><td>1</td><td>2</td><td>---</td><td>3</td><td>2</td></tr>
</table>

Course Description

introduction , AutoCAD program components and how to use it , knowing AutoCAD commands like point , lines, Rectangle, Polygon, Poly line , Arc with their option to draw 2D engineering drawing, learning Hatching, text, mtext , Dimension creation and editing , Modify command and Layers for 2D engineering drawing.
3D drawing methods: Surfaces, Solids and Composite solid.
Render, background, lights for drawing.

Course Text

1-Terry T. Wohler, applying AutoCAD 2002 fundamentals, Glencoe /McGraw-Hill
2-James A. Leach, AutoCAD 2002 Companion Essentials of AutoCAD plus Solid modeling ,2003 , McGraw-Hill, Boston
3- Terry T. Wohler, applying AutoCAD a step by step approach for AutoCAD release 13, 1996, Glencoe McGraw-Hill
4- James A. Leach, AutoCAD 14 Companion Essentials of AutoCAD plus Solid modeling ,1999,WCB / McGraw-Hill, Boston
Other support books :-
David Byrnes and Mark Middlebrook, AutoCAD® 2007 For Dummies , Wiley Publishing, Inc
5-2001 الرسم بمساعدة الحاسوب أ.م علي حسين علي م. فادي جنان جبرائيل م. وليد يوسف شهاب

Course Objectives : at the end of the semester the student should be able to :-

1- The students can use AutoCAD program and produce 2D and 3D chemical engineering drawings.
2- Enable students to draw designed equipment in AutoCAD program.

Topics Covered (Syllabus)/ Course Title

No.	**Contents**	**Duration**
1	Introduction, Drawing program screen components, Setting drawing limits, Units, Grid and snap, Zoom, Orthogonal, Osnap, UCS. 2D drafting: Cartesian system coordinate, AutoCAD drawing command:	**1 hr**
2	Point, Line: line, multi-line, construction line, drawing line by using: absolute coordinate, polar coordinate, relative coordinate, Example	**1 hr**
3	Continuous line drawing: Rectangle, Polygon, Poly line with their options, Example	**1 hr**
4	Curves drawing: Arc, Circle, point –SP line, Ellipse with their options, **Example.**	**1 hr**

5	Hatching, text command: text, mtext, Example	**1 hr**
6	Dimension creation and editing, Example	**1 hr**
7	Region, block, insert block, Example	**1 hr**
8	Modify command: 1-coy tool: copy, mirror, offset, array. 2- Erase tool: erase, trim, break .3-move tool: move, rotate .4- Change tool: stretch, Lengthen, Extend, Scale, Chamfer, and Fillet .5-Explode, Example	**1 hr**
9	Layers: Create a new layer ,rename layer, active layer, run and extinguishing layers ,Freezing layers, Lock and open layers, the color ,Font type ,Line width, Example	**1 hr**
10	3D drawing methods: Surfaces drawing: box, Wedge, Pyramid, Dome, Sphere, Cone, Torus, Dish, Example	**1 hr**
11	3D drawing methods: Solids: box, Cylinder, Sphere, Cone, Wedge, Torus, Example	**1 hr**
12	Composite solid: Union, Subtraction, Intersection, Example	**1 hr**
13	Examples of chemical engineering drawing and exercises	**1 hr**
14	Examples of chemical engineering drawing and exercises	**1 hr**
15	Examples of chemical engineering drawing and exercises	**1 hr**

Practical: (AutoCAD lab.)

No.	Experiments
1-	**Drawing rectangular using lines in absolute coordinate, polar coordinate, relative coordinate**
2-	**Drawing line, rectangular, polygon**
3-	**Drawing Arc, Circle, point –SP line, Ellipse**
4-	**Drawing of geometry shape and applied Hatching, text command**
5-	**Drawing simple 2D shape and applying Modify commands such as copy, mirror, offset, array , trim, move, rotate , stretch, Lengthen, Extend, Scale, Chamfer, and Fillet**
6-	**Drawing a simple 2D chemical engineering drawing and applied layers.**
7-	**Drawing chemical engineering Applications**
8-	**Drawing chemical engineering Applications**

University of Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R.128**	Credits hr				Units
Course Title	Engineering Mechanics and Strength of Materials					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Physics	**2**	**-**	**1**	**3**	**2**

Course Description

This class focuses on the following topics, including principles of equilibrium of a force system, Moment of a force, Centroid and center of gravity, Analysis of internal force, Strain, Stress-strain diagram, Hook's law, Shearing deformation, Poisson's ratio, Volumetric strain, Thin-walled cylinders, Thermal stress, Shear and bending moment in the beam.

Course Text

1- Engineering Mechanic-Statics and Dynamics volume 1; Higdon, A. and Stiles, W.B., 3ed Edition, Prentice-Hall, India, (1968).
2- Strength of Materials; Singer, F.L. and Pytel, A., 3ed Edition, Harper and Row, London, (1980).
3. Hibbeler, R. C. (2016). Engineering Mechanics: Statics, 14th SI Edition.

Course Objectives: at the end of the semester, the student should be able to:-

1. This class is designed to study the effects of external forces on a group of solid objects.
2. This class is designed to study the resistance of materials and their applications in chemical engineering.

Topics Covered (Syllabus)/ Engineering Mechanics and Strength of Materials

No.	Contents	Duration
1	Equilibrium of rigid bodies	**3 hr**
2	Moment of a Force Moment about a point, Resultant moment of multiple forces, Moment of Couple	**3 hr**
3	Centroid and Center of Gravity	**3 hr**
4	Introduction Force in Rigid Bodies: Definitions of Stress and Strain, Stress-Strain Diagrams	**2 hr**
5	Proportional Limits: Elastic limit, Stiffness elasticity, Plasticity, Hardness and working stress.	**4 hr**
6	Hook's Law	**3 hr**
7	Poisson Ratio, Composite Stresses: Volumetric Stress, Bulk Modulus, Thin-Walled Cylinders	**4 hr**
8	Thermal Stress	**4 hr**
9	Shear and Bending Moments in Beam	**4 hr**

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R.116**	Credits hr				Units
Course Title	Human Rights & Democracy					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	none	**2**	**-**	**-**	**2**	**2**

Course Description

The concept of human rights Characteristics of human rights _ Human rights groups _ The relationship between human rights and other concepts.and
The study of the democracy concept and history and is relationship to religions and relationwith development also the advantages and the disadvantages of democracy

Course Text

1. عبد الكريم خليفة، القانون الدولي لحقوق الإنسان، بدون طبعة)الإسكند رية: دار الجامعة الجديدة، 2013
2. مبادئ و قواعد عامة في حقوق الأنسان , د. صلاح حسن مطرود
3. د. محمد علي الشجيري ، حقوق الأنسان بين الأسلامي و العالمي
4. د. زكريا أبراهيم ، مشكلة الحرية
5. د. ماهر صلاح الجبوري ، حقوق الأنسان و الديمقراطية
6. د.سعدون هليل. الطبقة الوسطى والتحول الديمقراطي.
7. د.جورج طرابيشي. الديمقراطية والحداثة.

Course Objectives : at the end of the semester the student should be able to :-

1-Define the concept of human rights and their characteristics
2-To promote the culture of human rights in society

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	Introduction to Human Rights Human Rights and Secularism	**2 hr**
2	The concept of human rights Positions of the Arab intellectual currents of human rights	**2 hr**
3	Characteristics of human rights The future of human rights	**2 hr**

4	Human Rights and Islam Human Rights Classification	**2 hr**
5	Human Rights in Ancient Civilizations Human rights between universality and privacy	**2 hr**
6	Human rights sources andHuman Rights and Globalization	**2 hr**
7	Universal Declaration of Human Rights Human rights and political parties	**2 hr**
8	Human Rights and the Constitution of the Republic of Iraq 2005	**2 hr**
9	The concept of democracy. Characteristics and Categories forms of democracy	**2 hr**
10	The historical development of democracy Democratic systems of government	**2 hr**
11	Democracy between challenges and external pressures ideological democracy	**2 hr**
12	Democracy between privacy and universality Pros and cons of democracy	**2 hr**
13	Voting in democracies Democracy and the phenomenon of globalization	**2 hr**
14	Political freedom and the state The role of the middle class in democracies	**2 hr**
15	The relationship between the intellectual and the authority Democracy between capitalism and socialism	**2 hr**

University of Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R.221**	Credits hr				Units
Course Title	Mathematics III					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematics I, Mathematics II	**2**	**-**	**1**	**3**	**2**

Course Description

This course describes the evaluation of double, triple integrals, area and volume.Provide knowledge and skills in writing a periodic function in its Fourier series form and on their applications. Develop skills for applying this course in the future on various chemical engineering applications.

Course Text

Text book:

1. Higher Engineering Mathematics by Dr.B.S.Grewal, Khanna Publishers, 40th Edition, 2007.

Reference book:

1. Advanced Engineering Mathematics by Erwin Kreyszig, 8th edition, 2007.

Course Objectives: at the end of the semester the student should be able to:-

1- Able to evaluate double, triple integrals and the area, volume by double & triple integrals respectively.
2- . Understand the concept of Fourier-series representation of periodic functions and their applications.

Topics Covered (Syllabus)/ Mathematics III

No.	Contents	Duration
1	**Multiple Integrals:** Double Integral, Area, Volume, Double Integral in polar coordinates, Triple Integral in rectangular coordinates, physical application of double and triple integration.	**12 hr**
2	**Function and definite Integrals:** The error function, the gamma function, the beta function, factorial function.	**6 hr**
3	**Infinite Sequences and Series:** Sequences, Convergence, Geometric series, nth partial sum, tests of convergence, alternating series, power and Taylor's series.	**6 hr**
4	**Fourier series:** Periodic functions, Fourier series, Even and odd functions, Half range expansion.	**6 hr**

Program	***Chemical and Petroleum Refinery Engineering.***					
Course Code-	**CES.R.231**	Credits hr				Units
Course title	Chemical Engineering Principles II					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemical Engineering Principles I	**2**		**1**	**3**	**2**

Course Description

Understanding the basic concepts and expressions in chemical engineering and learning calculations related to chemical reactions, material balance, gases and vapours.

Course Text

- D.M.Himmelblau and J.B.Riggs ,Basic Principles and Calculations in Chemical Engineering ,7th Edition , 2004 .
- R.M.Felder and R.W.Rousseau ,Elementary Principles of Chemical Processes ,3rd Edition ,2005 .

Other support books :-

Skogestad, S. (2008). Chemical and energy process engineering. CRC press.

Course Objectives: at the end of the semester the student should be able to:-

1- Have a deep knowledge, wide scope and improved understanding of the mechanisms in heat balance as well as a better insight into analytical and empirical methods applied in analysis of material balance related problems.
2- Gain knowledge for applying the material (equation) balance in chemical engineering problems.
3- To provide experience for students to solve material balance for different process

Topics Covered (Syllabus)

No.	Contents	Duration
1	**Systematic steps of solving material balance problems:** ➢ Material balances without chemical reactions. ➢ Material balances with chemical reactions. ➢ Species Material Balances	**4 hr**

	➢ Processes Involving a Single Reaction ➢ Processes Involving Multiple Reactions ➢ Element Material Balances ➢ Material balances on combustion processes	
2	**Material Balances for Processes Involving Chemical Reaction** ➢ Species Material Balances ➢ Processes Involving a Single Reaction ➢ Processes Involving Multiple Reactions ➢ Element Material Balances	**10 hr**
3	**Material Balance Problems Involving Multiple Units, Material balances involving recycle, bypass and purge streams:** ➢ Process flow sheet ➢ Recycle without Chemical Reaction ➢ Recycle with Chemical Reaction ➢ Bypass and Purge	**8 hr**
4	**Gases and Vapors** ➢ Ideal gas law. ➢ Ideal gas mixtures. ➢ Real gas relationships.	**4 hr**
5	**Introduction to Energy Balance**	**4 hr**

Universityof Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R.233**	Credits hr				Units
Course Title	Fluid Flow I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematic I & II, Chemical Engineering Principles I	**2**	**2**	**1**	**5**	**3**

Course Description

Define and show the student what about related with fluids statics and dynamics, its types, and flow patterns. Introduction to Fluid Flow. Course material includes an introduction to the concepts and applications of fluid flow and dimensional analysis and static fluid, analysis of engineering applications of incompressible Newtonian and fluid Non-Newtonian fluid flow pipe systems, Pumps and pumping of liquid.

Course Text

4. Coulson, J.M and Richardson J.F. "Chemical Engineering, volume 1", Fifth edition 2002, Elsevier Science, Linacre House, Jordan Hill, Oxford
5. Coulson, J.M and Richardson J.F. "Chemical Engineering, volume 2", Fifth edition 2002, Elsevier Science, Linacre House, Jordan Hill, Oxford
6. F.A. Holland and R. Bragg "Fluid Flow for Chemical Engineers", 2nd Ed. (1995) Elsevier Ltd.

Other support books :-

7. DARBY. R., M. Dekker "Chemical Engineering Fluid Mechanics", 2nd Ed. (2001)
8. James O. Wilkes "Fluid Mechanics for Chemical Engineers", Prentice Hall PTR, New Jersey, USA, 1999.
9. De Nevers, N. "Fluid Mechanics for Chemical Engineers", (1991) McGraw-Hill, Singapore.

10. Streeter and Wylie "Fluid Mechanics", McGraw-Hill, (1981).

Course Objectives: at the end of the semester the student should be able to :-

1. Recognize the incompressible fluid flow, single- and two-phase flow, fluid statics and dynamics, Newtonian and non-Newtonian fluids and essential basic hydrodynamics.
2. Define the problems in fluid dynamics in various engineering applications. Distinguish the energy variation and its applications spatially the frictional energy losses calculations and the required energy for fluid pumping.
3. Define the necessary fluid parameters of full scale projects by performing simple model experiments and share ideas and work in a team in an efficient and effective manner under controlled supervision or independently.

Topics Covered (Syllabus) Fluid Flow I

No.	Contents	Time
1	Introduction Definition of a fluid, and fluid mechanics. Physical properties of fluids: Density, specific gravity, viscosity, kinematic viscosity, surface tension and capillarity, bulk modulus of elasticity, Pressure & Shear stress, Newton's law of viscosity, Types of Fluids, Newtonian, non-Newtonian fluids ideal and real fluids	3 hr
2	Dimensional Analysis Fundamental dimensions, dimensional homogeneity, dimensionless numbers. Methods of dimensional analysis, 1- Rayleigh's method (power series) 2- Buckingham's Π- method / Theorem.	3 hr
3	Fluid Statics Basic concept of fluid statics, Pressure terminology, pressure (head) of liquid. Measurement of pressure: (Piezometer, Manometers, types of Manometers, Mechanical Gauges).	3 hr
4	Fluid Dynamics Fluid kinematics: Types of fluid flow (steady and unsteady flows, uniform and non-uniform flows, one, two, and three dimensional flows, Rotational and irrotational flows, laminar and turbulent, compressible and incompressible flows, Boundary layer, Continuity equation. General energy equation. Bernoulli's equation, equation of motion, derivation of Euler's equation of motion, modified Bernoulli's equation.	6 hr
5	Newtonian's Fluid (Incompressible flow in Pipes and Channels) Reynolds experiment, Pressure drop (head losses) in pipes (Skin friction), Velocity distribution, Hagen-Poiseuille's equation and Darcy equation. Pressure drop (head losses) in fittings, valves and any obstruction, (Form friction). Hydraulic diameter for flow in non-circular pipes, Boundary layer, Unsteady state examples, Two-phase (gas-liquid) flow definitions.	6 hr
6	Non-Newtonian Fluids in Pipes Definition, types of fluid depended on time, calculation of friction and pressure drop for general time independent in laminar and turbulent flow, Velocity profile of power law fluid flow.	3 hr
7	Pumping of Liquids Total and pump heads, Cavitation & NPSH, Horse Power and, Pumping Efficiencies, Pump Characteristics curves, Pump specific speed Types of the pumps, Pumps selection Priming the pump. Centrifugal pump relations, homologous centrifugal pump, centrifugal pumps in series and in parallel	6 hr
Total hours		**30**

Practical: (Fluid Flow lab.)

No.	Experiment Name.
1	Calibration Of Bourdon Tube Pressure Gauge
2	Impact Of Jet
3	Reynolds Experiment
4	Energy Losses In Pipes
5	Friction Losses In Piping Systems
6	Centrifugal Pump Characteristics
7	Gear Pump
8	Non-Newtonion Fluids

University of Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering.*					
Course Code	**CES.R.235**	Credits hr				Units
Course Title	Physical Chemistry I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Chemical Engineering Principles I -Chemistry -Chemistry Petroleum Engineering	**2**	**2**	**-**	**4**	**3**

Course Description

Physical Chemistry Is the application of the methods of physical to chemical problems. It includes the qualitative and quantitative study. Both experimental and theoretical of the general principles determining the behavior of matter.

Course Text

1. J. Laidler, Physical Chemistry and Collide Science, Bosten; Houghton M, ffl.n company, 1999.
2. G. Mortimer, Physical Chemistry and Collide Science, San Francisco; Altarcourt science and technology company, 2000.

Course Objectives : at the end of the semester the student should be able to :-

1- Be able to solve problems involving ideal mixture and dilute solutions.
2- Understand the principles govering phase diagrams and be able to interpret phase diagrams for various kinds of systems.
3- Be able to solve problems involving surface tension.
4- . Be able to solve several simple rate laws and to solve a variety of problems related to these solutions.
5- Be able to apply experimental techniques to the determination of rate law and rate constant.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Chemical Kinetics:** Rate of consumption and formation, rate of reaction, empirical rate Equation, order of reaction (zero, 1st , 2nd , 3ed) , reactions having no order, rate constants and rate coefficients, enzyme reactions kinetics , analysis of kinetic results.	**10 hr**
2	**Surface chemistry:** Adsorption, adsorption isotherms, surface tension and capillary rise, solid- liquid interfaces, colloidal systems, electrical properties of colloidal systems, gels, emulsions.	**10 hr**
3	**PhaApplications of the equations of ideal gases:** The PVT behaviour of pure substances, the ideal gas, the constant volume process, the constant pressure process, the adiabatic process, the polytropic process.	**10 hr**

Practical: (phy.Chem. lab.)

No.	Experiment Name.
1	Hydrolysis of Hydrogen Peroxide at the Presence of Catalyst
2	Saponification of Ethyl Acetate
3	Surface Chemistry Adsorption by Solid from Solution
4	Determination of the Surface Tension for Liquids
5	Viscosity
6	Three component system

<table>
<tr><td>Program</td><td colspan="6">Chemical and Petroleum Refinery Engineering</td></tr>
<tr><td>Course Code</td><td>CES.R.223</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Computer Programming I</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Basic Principles of Chemical engineering I.
-Mathematics I& II.</td><td>1</td><td>2</td><td>1</td><td>4</td><td>2</td></tr>
</table>

Course Description

To introduce chemical engineering students to modern calculating tool used in the practice of engineering by being able to construct plots, fit data, and use built-in functions in MATLAB.

Course Text

1- RudraPratap: Getting started with MATLAB 7, Oxford Press (Indian edition),2006.

2- Desmond J. Higham and Nicolas J. Higham: Matlab Guide, SIAM, 2000.

Other support books :-

1- Duane Hanselman and Bruce Littlefield: Mastering Matlab-6: A Comprehensive Tutorial and Reference, Prentice Hall, 2001.

2- Schilling R. J., Harries S.L., Applied Numerical Methods for Engineers using MATLAB & C, Thomson Books, 2002.

Course Objectives: at the end of the semester the student should be able to :-

1- Develop the confidence necessary to successfully solve Mathematical problems with a computer.

2- Formulate and write structured code in MATLAB.

3- Understand the foundation behind the basic numerical methods for Matrix manipulations.

Universityof Technology
Department of Chemical Engineering

Topics Covered (Syllabus) /CourseTitle

No.	Contents	Duration
1	**Starting With Matlab:** MATLAB windows , Menus and the toolbar, Working in the commandwindow , Arithmetic operations with scalars , Display formats , Elementary mathbuilt-infunctions, Use fulcomm and sformanaging variables, Script Files and the Editor Debugger,Matlab Help System	2 hr
2	**ALGEBRA:** Symbolic objects, and symbolic expressions, Changing the form of an existing symbolic expression, Solvinga lgebraic equations, Differentiation, Integration, Solving an ordinary differential equation.	2 hr
3	**Vector:** Only one row and a column vector has only one column. Entering Vectors and Matrices,ColumnVectors,Transposing,Vectors Addition and subtraction,Vectorsmultiplication,element-wise operation,The Colon Operator,The Colon Operator,Other Operations on Vectors (length, size, find, sum, max, min, mean, sort, all, abs)	2 hr
4	**Interpolation :** One-Dimensional Interpolation (interp1), Two-Dimensional Interpolation (interp2)	1 hr
5	**Polynomials in Matlab :** Roots, Poly Val, Polyfit	2 hr
6	**Matrices:** Entering matrices, Transpose, Matrix operations Addition and subtraction, Matrix multiplication, Matrix division, Element-wise operation, The Colon Operator, Referencing elements, Matrix Inverse, Predefined Matrix, Other Operations on Matrix	2 hr
7	**Matrix Algebra:** Introduction, Solving Linear Equations Using Matrix Algebra.	2 hr
8	**Condition:** If Statement, Loop(For loop, While Loop), Break statement	2 hr

Practical: (Comp. Prog lab.)

No.	Experiment Name
1	Starting With Matlab
2	Algebra
3	Vector
4	Interpolation
5	Polynomials in Matlab
6	Matrices
7	Matrix Algebra
8	Condition

Universityof Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R.225**	Credits hr				Units
Course Title	Material Eng. I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Eng. Mechanics &Strength of material -Chemistry	**2**	**-**	**1**	**3**	**2**

Course Description

Introduction to classification of materials and the atomic structure of it, Study the mechanical, thermal and electrical properties of materials and Crystal structure and imperfection in solid materials.

Course Text

1-Donaled R. Askeland, The science and engineering of materials, international student edition, 2006 .
2-William D. Callister, Jr. , Materials science and engineering, Fifth edition, 2000.
3-Lawrence H. Vanvlack , Elements of materials science and engineering, Fifth edition, 1987.

Course Objectives : at the end of the semester the student should be able to :-

1. Describe and solve problems on atomic arrangement and geometry of imperfections.
2. Describe and solve problems on mechanical, thermal and electrical properties of materials.

Topics Covered (Syllabus)/ Material Eng. (I)

No.	Contents	Duration
1	**Classification of Materials:** Classification of materials, classification of materials based on structure, advanced materials	4 hr
2	**Mechanical Properties of Materials:** Stress-strain behavior, ductility, brittleness, toughness, modulus of resilience, poison̓s ratio, hardness, effect of temperature.	6 hr
3	**Atomic structure:** The structure of atom, atomic bonding, bonding energy and inter-atomic spacing	6 hr
4	**Atomic order in solids :** **Types of atomic or ionic arrangements, crystal structure, lattice, unit cells, metallic crystal** **structure, crystal systems, crystal direction and crystal planes , diffraction techniques for crystal structure analysis**	8 hr
5	**Thermal and electrical properties of materials:** **Heat capacity, thermal expansion, thermal conductivity, thermal stresses, Glass transition temperature, Creep resistance, electrical conductivity, electron mobility, electrical resistivity of metals**	6 hr

Program	Chemical and Petroleum Refinery Engineering					
CourseCode	**CES.R.237**	Creditshr				Units
CourseTitle	Fuels Technology					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemistryof Petroleum	**2**	**2**	**0**	**4**	**3**

CourseDescription

The objective of this course to underst and the types and properties of fuel (solid, liquid and gas), and the properties of crude oil, the physical and chemical properties of fuel and the five or six basic products of crude oil, the purification and the distillation of crude oil to obtain different products and explain in details all the properties of the products

CourseText

1. Speight, J.G, Hand book of petroleum product analysis,JohnWilley&Sons,2002.
2. SpeightJ.G.andOzum, B; Petroleum Refinery processes, MacelDekker, NewYork, 2002.
3. SpeightJ.G. The chemistry and Technology of petroleum, 3rd Edition.MarcelDekker,NewYork1999.
4. Petroleum Fuels Manufacturing handbook; Surinder Parkash, McGraw-Hillcompanies, 2010.
5. Fundamentals of Petroleum and Petrochemical Engineering, Uttam Ray Chaudhuri, Taylor & Francis Group, 2011

Topics Covered (Syllabus)/Fuel Technology

No	Duration	Contents
1	**Introduction to Fuel Technology:** Types of fuel and its importance	2 hr
2	**Solid Fuel:** Coal classification, composition and basis Coal preparation and washing	2 hr
3	**Different types of coal combustion techniques** Combustion of coal and coke making Coal liquefaction	4 hr
4	**Liquid Fuel:** Theories of petroleum formation, Classification as a Hydrocarbon Resource, Production of Petroleum, Composition of Crude Oils	2 hr
5	**Evaluation of crude** - Crude oil assays - **Properties of crude oil and petroleum products**: -Types of Gasoline & it's Important Properties and tests such as ASTM Distillation, RVP, Octane Number, Oxidation Stability, Sulphur Content etc, - Various Types of Naphtha and their Important Properties & Applications. Important Tests & Properties of Kerosene such as Flash& Fire Point, Smoke Point , Aniline Point etc., - Types of Diesel & its Important Properties & Tests such as Pour Point, Diesel Index, Cetane Number etc. - Lubricating oil, Production and properties, test methods Heavy Fractions like Lube Oil, Bitumen, Asphalt etc. & their Important.	12 hr
6	**Gas Fuel:** History of Gaseous Fuel Producing of Gas Natural Gas, composition, classification, sweeting	4 hr
7	**LPG:** Properties of LPG, composition, production, Test methods,	4 hr

Practical: (Fuels Tech lab.)

No.	ExperimentName.
1	**AST Mdistillation exp.**
2	**Density and specificgravity exp**
3	**Viscosity&viscosity index exp.**
4	**Salt contentincrude oil**
5	**Gum and gum stability**
6	**Flash&fire point**
7	**Ashcontent for petroleum products**
8	**ConradSon Carbonresidue of petroleum**

University of Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R.222**	Credits hr				Units
Course Title	Mathematics IV					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematics I, II, III	**2**	**-**	**1**	**3**	**2**

Course Description

This course describe the providing of knowledge on solving ordinary differential equations and applications of first order ordinary differential equations and chemical engineering applications of the theory portion covered will be emphasized.

Course Text

Text book:

1. Higher Engineering Mathematics by Dr.B.S.Grewal, Khanna Publishers, 40^{th} Edition, 2007.

Reference book:

1. Advanced Engineering Mathematics by Erwin Kreyszig, 8^{th} edition, 2007.

Course Objectives: at the end of the semester the student should be able to:-

1- Understand methods of solving First order and Higher order ordinary differential equations along with some physical applications.

2- Demonstrate the relevance of the mathematical methods learnt to chemical engineering.

Topics Covered (Syllabus)/ Mathematics IV

No	Contents	Duration
1	**Ordinary Differential Equations:** • Introduction, • **First Order Ordinary Differential Equations:** • Variable Separable Equation • Homogenous Equation • Exact Equation • Linear Equation • Bernoulli, s Equation. • **Second Order Ordinary Differential Equations:** • Non-Linear Differential Equations • Equations with Dependent Variable Missing • Equations with Independent Variable Missing • Homogenous Equation • Linear Differential Equations • Equations with Constant Coefficient • Equations with Coefficients as a Function of the Independent Variable • **Higher Order Ordinary Differential Equations.** • Simultaneous Differential Equations. • Series Solution of Differential Equations.	**10 hr**

2	**Application of Ordinary Differential Equations:** Representation problems of 1st and 2nd ordinary differential equations (linear and nonlinear, homogeneous …etc.).	**5 hr**
3	**Solution by Series:** • Infinite series by Taylor theorem, • Method of Frobenius (Case I, II, IIIa, and IIIb), • Bessels's and Modified Bessel's Equation, • Properties of Bessel Functions, • Applications in chemical engineering, • Tubular Gas Preheater, • Reaction in axisymmetric Spherical and Cylindrical pellets.	**15 hr**

University of Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical and Petroleum Refinery Engineering.</td></tr>
<tr><td>Course Code-</td><td>CES.R.232</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course title</td><td>Chemical Engineering Principles III</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Chemical Engineering Principles I, Chemical Engineering Principles II</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td></tr>
</table>

Course Description

Understanding the basic concepts and expressions in chemical engineering and learning calculations related to chemical reactions, energy balance,

Course Text

- D.M.Himmelblau and J.B.Riggs ,Basic Principles and Calculations in Chemical Engineering ,7th Edition , 2004 .
- R.M.Felder and R.W.Rousseau ,Elementary Principles of Chemical Processes ,3rd Edition ,2005 .

Other support books :-

Skogestad, S. (2008). Chemical and energy process engineering. CRC press.

Course Objectives: at the end of the semester the student should be able to:-

1- Have a deep knowledge, wide scope and improved understanding of the mechanisms in heat balance as well as a better insight into analytical and empirical methods applied in analysis of energy balance related problems.
2- Gain knowledge for applying the energy (equation) balance in chemical engineering problems.
3- To provide experience for students to solve energy balance for different process

Topics Covered (Syllabus)

No.	Contents	Duration
1	**Introduction, Basic concept and definitions** ➢ First law of thermodynamics ➢ Temperature integral heat capacity (mean heat capacity) ➢ - Latent heat temperature dependence	**2 hr**
2	**General Energy Balance Without Chemical Reaction** ➢ Energy Balance on Closed System ➢ -Energy Balance on open System ➢ -Heat Capacity ➢ -Sensible & latent heat principles	**8 hr**
3	**Calculation of Enthalpy Change** ➢ Enthalpy Change Without Change in Phase ➢ Enthalpy Change Including Phase Transition	**8 hr**
4	**General Energy Balance With Chemical Reaction** ➢ Standard Heat of Formation ➢ Standard Heat of consumption ➢ Standard Heat of Reaction ➢ Heat of reaction temperature dependence ➢ Heat effects of industrial reactions	**12 hr**

<table>
<tr><td>Program</td><td colspan="6">Chemical and Petroleum Refinery Engineering.</td></tr>
<tr><td>Course Code</td><td>CES.R.234</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Fluid Flow II</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Fluid Flow I,
-Chemical Engineering Principles II,
-Physical Chemistry I & II</td><td>2</td><td>2</td><td>1</td><td>5</td><td>3</td></tr>
</table>

Course Description

Define and show the student what about related with fluid flow measurements types and principles. Course material includes an introduction to the concepts and applications of compressible fluid flow and compressors, analysis of engineering applications of liquid mixing with their power consumption. Fluid flow though packed bed fluidization and transportation of particles.

Course Text

11. Coulson, J.M and Richardson J.F. "Chemical Engineering, volume 1", Fifth edition 2002, Elsevier Science, Linacre House, Jordan Hill, Oxford
12. Coulson, J.M and Richardson J.F. "Chemical Engineering, volume 2", Fifth edition 2002, Elsevier Science, Linacre House, Jordan Hill, Oxford
13. F.A. Holland and R. Bragg "Fluid Flow for Chemical Engineers", 2nd Ed. (1995) Elsevier Ltd.

Other support books :-

4. DARBY. R., M. Dekker "Chemical Engineering Fluid Mechanics", 2ndEd. (2001)
5. James O. Wilkes "Fluid Mechanics for Chemical Engineers", Prentice Hall PTR, New Jersey, USA, 1999.
6. De Nevers, N. "Fluid Mechanics for Chemical Engineers", (1991) McGraw-Hill, Singapore.

Course Objectives : at the end of the semester the student should be able to :-

1. Recognize the compressible fluid flow, pumping tools of the compressible fluid flow, fluid flow measurements, liquid mixing and its power consumptions, flow through packed columns, fluidization and particles transportation.
2. Define the problems in fluid dynamics in various engineering applications. Distinguish the energy variation and its applications spatially the frictional energy losses calculations and the required energy for fluid pumping.
3. Define the necessary fluid parameters of full scale projects by performing simple model experiments and share ideas and work in a team in an efficient and effective manner under controlled supervision or independently.

Topics Covered (Syllabus)/ Fluid Flow II

No.	Contents	Duration
1	Flow Measurement Flow in closed channels: Pitot tubes, Orifice meter, Venturi meter, Nozzle meter, Rotameters, special flow measurements Hot wire and other types of flow meters, Flow in open channels and weirs: Rectangular, Triangular and Trapezoidal notches with unsteady state applications;	**6 hr**
2	Flow of Compressible Fluid General energy equation, Sonic velocity and Mach No., Isothermal, and Adiabatic flow of an ideal gas in pipes, maximum fluid velocity. Compressible fluid flow through converging-diverging nozzle. Types of gas pumping equipment, Compressors & gas compression cycle (ideal and real, single and multistage) with total work done.	**8 hr**
3	Liquid Mixing Stirring and mixing types, Stirred vessels (power consumption, power curves, scaled-up), Equation of motion for rotational flow (vortex).	**6 hr**
4	Motion of Particles in a Fluid Drag force on a particle, terminal falling velocities of fine and coarse particles	**4 hr**
5	Flow of Fluid through Granular Bed and Packed Columns Pressure drop in granular beds (fixed packed columns): Packings types and specification, Pressure drop relations (Darcy, Kozeny and Kozeny - Carmen equations)	**4 hr**
6	Fluidization and Particles transportation Minimum fluidization velocity, Pressure, Pressure drop, Ergun equation, bed expansion and transport of particles.	**2 hr**
Total hours		**30**

Practical: (Fluid Flow lab.)

No.	Experiment Name
1	Bernoulli's Theorem Demonstration
2	Discharge Through An Orifice
3	Flow Through Venturi Meter
4	Open Channel Flow Over Weir
5	Flow Of Compressible Fluid
6	Forced Vortex
7	Fluidization

University of Technology
Department of Chemical Engineering

Program	***Chemical and Petroleum Refinery Engineering.***					
Course Code	**CES.R.236**	Credits hr				Units
Course Title	Physical Chemistry II					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Physical Chemistry I	**2**	**-**	**-**	**2**	**2**

Course Description

In this semester deals with the various transformations that can be brought about an ideal gases have played a very important part in the development of thermodynamics. It is include properties of solutions of electrolytes and with processes that occur at electrodes. It concerned with galvanic cells, in which a chemical reaction produce an electric potential difference between two electrodes.

Course Text

1. J. Laidler, Physical Chemistry and Collide Science, Bosten; Houghton M, ffl.n company, 1999.
2. G. Mortimer, Physical Chemistry and Collide Science , San Francisco; Altarcourt science and technology company, 2000.

Course Objectives: at the end of the semester the student should be able to :-

1- . Be able to solve problems related to the macroscopic equilibrium properties of gases and liquid.
2- Understand how the thermodynamics of non simple system is applied to electrochemical cells.
3- . Be able to calculate cell voltages for standard conditions and other conditions using standard reduction potentials and the nerst equation.
4- . Be able to solve problems relating equilibrium constants and Gibbs energy changes to electrochemically measured quantities.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Phase Equilibria:** Equilibrium between phases, one component systems, binary systems involving vapor, liquid vapor equilibria of two component system, liquid vapor equilibrium in system not obeying Raoults law, temperature composition diagram (boiling point curves), distillation, azeotropes, solubility of gases in liquids.	**10 hr**
2	**Solutions of electrolytes :** Electrical units, Faradays laws of electrolysis, molar conductivity, weak electrolytes, strong electrolytes, activity and ionic strength, determination of activity coefficient from solubility, the Debye-Hackle theory, acid- base catalysis and their dissociation constant.	**10 hr**

3	**Electrochemical cells:** Electromotive force (EMF) of a cell, measurements of EMF- the potentiometer, the polarity of electrodes, the cell reactions and reversible cells, free energy and reversible cells, typical of half-cell's classification EMF, standard electrode potentials, standard free energy and energy of aqueous ions, calculation of EMF of cell, oxidation reduction reactions, concentrations cells, electrolysis.	10 hr

University of Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical and Petroleum Refinery Engineering</td></tr>
<tr><td>Course Code</td><td>CES.R.224</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Computer Programming II</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Basic Principles of chemical engineering I.
-Mathematics I.
-Computer Programming I</td><td>1</td><td>2</td><td>1</td><td>4</td><td>2</td></tr>
</table>

Course Description

To introduce chemical engineering students to modern calculating tool used in the practice of engineering by demonstrating an ability to create small structured programs in a MATLAB programming environment and understanding how user written functions interact with numerical methodsroutines.

Course Text

1- Rudra Pratap: Getting started with MATLAB 7, Oxford Press (Indian edition),2006.
2- Desmond J. Higham and Nicolas J. Higham: Matlab Guide, SIAM, 2000.

Other support books :-

1- Duane Hanselman and Bruce Littlefield: Mastering Matlab-6: A Comprehensive Tutorial and Reference, Prentice Hall, 2001.
2- Schilling R. J., Harries S.L., Applied Numerical Methods for Engineers using MATLAB & C, Thomson Books, 2002.

Course Objectives: at the end of the semester the student should be able to:-

1- Solve sets of linear and nonlinear equations using numerical methods as well as in-built MATLAB functions.
2- Apply numerical methods and MATLAB functions to differentiate and integrate a function or a set of discrete points.
3- Apply explicit and implicit numerical methods and MATLAB functions to integrate single and multiple sets of initial value problems

Topics Covered (Syllabus)

No.	Contents	Duration
1	**Two-dimensional plot:** The plot command ,Using the plot Command ,Line styles, Markers, and Colors ,Adding Grids, Labels, Text, or a Legend ,Customizing Axes ,Plotting multiple graphs in the same plot ,Multiple figure windows (subplot command) ,Plots with special graphics ,The fplot , ezplot command ,area, bar,barh, stairs ,semilogx,semilogy,log log, errorbar,stem, plotyy ,Histograms ,Polar ,Pie,erf.	2 hr
2	**Three dimensional plot :** plot3 ,Meshgrid ,mesh ,surf ,ezmesh ,ezplot3 ,ezsurf ,cylinder ,sphere	1 hr
3	**Functions :** Functions types: local function, Nested function, Anonymous function, function Handle ,Creating and calling a local function file ,Structure of a local function file ,Local and global variables in local function ,Saving a local function file ,Examples of simple local function (user-defined functions) ,Comparison between script files and function files ,Add local functions ,Sub-local functions ,Nested functions ,Anonymous Functions ,Multiple Anonymous Functions ,Anonymous Functions with No Inputs ,Anonymous Functions with Multiple Inputs or Outputs ,Function Handle ,What Is a Function Handle? ,Creating Function Handles ,Create handles to anonymous functions ,Saving and Loading Function	4 hr
4	**Introduction to Numerical analysis:** Numerical solution of of Differential Equations ,Ordinary Differential Equation ,Euler's Method	2 hr
5	**Differential Equations:** Numerical solution of multi simultaneous differential equations,Runge-KuttaMethod,Integration two or more coupled first-order ODE's,MATLAB Built-In Routines for solving ODES	2 hr
6	**Partial differential equations:** Numerical solution of partial differential equations,Higher order ode's,Non-Linear Equation Solving MATLABs built-in function: (fsolve).	2 hr
7	**Numerical Analysis applications in Chemical Engineering:** Solving chemical engineering problems	2 hr

Practical: (Comp. Prog lab.)

No.	Experiment Name
1	Two-dimensional plots
2	Three dimensional plots
3	Functions
4	Introduction to Numerical analysis
5	Differential Equations
6	Partial differential equations:
7	Numerical Analysis applications in Chemical Engineering

University of Technology
Department of Chemical Engineering

Program	Chemical and Petroleum Refinery Engineering					
Course Code	**CES.R.226**	Credits hr				Units
Course Title	Material Eng. II					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Material Eng. I	**2**	**2**	**1**	**5**	**3**

Course Description

Imperfection in solid. diffusion and atomic movement in solid. Solid solution and phase diagram for different alloys. Ceramic materials and composite materials.

Course Text

1-Donaled R. Askeland, The science and engineering of materials, international student edition, 2006 .
2-William D. Callister, Jr. , Materials science and engineering, Fifth edition, 2000.
3-Lawrence H. Vanvlack , Elements of materials science and engineering, Fifth edition, 1987.

Course Objectives : at the end of the semester the student should be able to :-

1- Describe the geometry of imperfections
2- Calculate the extent of diffusion- driving composition changes based upon composition, time and temperature.
3- Predict the equilibrium microstructure of a material given the binary phase diagram, thermal history of the materials.
4- Describe the types and properties of ceramic and composite materials.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Imperfections in solids** Point defects, line defects, interfacial imperfections, Macroscopic defects	**6 hr**
2	**Atomic and ion movements in materials** Stability of atoms and ions, mechanisms for diffusion, rate of diffusion (Fick's first law), factors affecting diffusion, non-steady state diffusion (Fick's second law) .	**6 hr**
3	**Solid solutions and phase diagrams.** Basic concepts, solubility and solid solution, phase and phase diagram, unary phase diagram, binary Iso-morphous system, binary eutectic system.	**6 hr**
4	**The Iron-Carbon system** The Iron-Iron carbide phase diagram, development of microstructures in Iron-carbon alloys	**6 hr**
5	**Ceramic materials** Crystal structure, mechanical properties of ceramic, classification of ceramic materials on the basis of its application.	**2 hr**
6	**Composites** Material combination, Reinforced composites, structural composites.	**4 hr**

Practical: (Material Eng. lab.)

No.	Experiment Name
1	*Tension test*
2	*Hardness Testing*
3	*Bending Test*
4	*Creep Test*
5	*Abrasion Test*
6	*Impact Test*
7	*Moisture Measurement in Engineering Materials*
8	*Determination of Linear Thermal Expansion for a Solid*
9	*Microstructure Examination of pb-Sn alloys using the metallurgical microscope*

University of Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R.227**	Credits hr				Units
Course Title	Statistics					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Mathematics I, -Mathematics II	**2**	**0**	**1**	**3**	**2**

Course Description

The subject is to be given in one semester its consists of organization of data & summarized in a frequency distribution table which is graphically represented, and determination of dispersion & center measurement, study of continuous & discrete probability distribution, curve fitting and least square method & the study of chi square distribution. Use of statistical methods in relation to applications of environmental engineering sciences, analysis of industrial problems and oil pollution

Course Text

1. Statistics, Murray R. Spiegel, 7 Ed. 2009
2. Statistical methods for technologists, C.G. Paradise.2005
3. Statistical Methods in Analytical Chemistry, Peter C. Meier and Richard E. Zund, 2 Ed, A Wily-Intercedence Publication,2000

Course Objectives: at the end of the semester the student should be able to: -

We are teaching students how to use statistical methods.
Application of statistical methods in description and analysis of data.
Use statistics to solve different problems and Comprehension measurement instruments' fundamental principles.

Topics Covered (Syllabus)/ statistics

No.	Contents	Duration
1	Introduction, statistics population, descriptive and inductive statistics. Tutorial	**2 hr**
2	Frequency distribution table, types of frequency.Tutorial of frequency distribution table. Tutorial	**2 hr**
3	Graphical representation of frequency distribution table. Tutorial	**2 hr**
4	Measures of Location, Mode, Median, Arithmetic Mean, and Other Mean Measures.	**2 hr**
5	Measures of Dispersion Mean Absolute Deviation, Standard Deviation, Variation, Coefficient of Variation, Properties of Z, Tutorial.	**2 hr**
6	Probability distribution, Discrete Prob. Distribution, continuous & discrete probability dist., normal dist., table of the area under normal dist., Tutorial	**2 hr**
7	Tutorial and the binomial distribution, Approximation of binomial dist., normal & Poisson dist., Tutorial.	**2 hr**

8	The chi-square test, confidence intervals, Test of independence	**2 hr**
9	degree of a significant test، Test of hypothesis، Chi-square test for goodness of fit, Tutorial	**2 hr**
10	Curve fitting, least squares method, variance, and correlation coefficient.	**2 hr**
11	Tutorial of the least square methods.	**2 hr**
12	Multiple and partial correlations.	**2 hr**
13	normal equations for the least square regression, Tutorial.	**2 hr**
14	Coefficient of correlation. Tutorial in partial correlation.	**2 hr**
15	Tutorial	**2 hr**

University of Technology
Department of Chemical Engineering

Program	***Chemical and Petroleum Refinery Engineering***					
Course Code	**CES.R.331**	Credits hr				Units
Course Title	Thermodynamics I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Engineering Principle II,Physical -Chemistry and ,Fluid Flow	**2**	**0**	**1**	**3**	**2**

Course Description

The course of chemical engineering thermodynamics I comprises the study of volumetric properties of pure fluids; Entropy and second law analysis of engineering systems; Thermodynamic properties of fluids; Applications of thermodynamics to flow processes.

Course Text

1- J. M. Smith,H.C.Van Ness, Introduction to chemical engineering thermodynamics, 6th edition (International Edition), Mc-Graw Hall, 2008.

Other support books :-

2- K.V.Narayanan, Atext book of chemical engineering thermodynamics, prentice Hall of India, New Delhi, 2011.

3- B.G.Kyle, Chemical and process thermodynamics ,(3rd Edition), prentice Hall Inc.New Jersey, 1984.

4- J. Rayner, Basic engineering thermodynamics inSI units, printed in great Britain,1971.

Course Objectives : at the end of the semester the student should be able to :-

1. To familiarize the students with basic concepts of the first and second laws of thermodynamics and their applications in engineering problems.
2. Develop a practical ability to solveChemical Engineering Principle II problems, minimum work.
3. Students will demonstrate basic understanding of basics and definitions of thermodynamics and properties of pure substances.
4. Describe the reversible and irreversible processes (macroscopic description of an ideal and real process).

Topics Covered (Syllabus)/ Course Title

No.	Content	Duration
1	**Introduction** Basic definitions, work, energy, heat, types of systems, extensive and intensive properties, thermodynamic processes, zero law of thermodynamics, 1st law of thermodynamic, energy balance for open and close system	**2 hr**
2	**Volumetric properties of pure fluids** Review on virile equation of state, cubic equation of state, generalized correlations for gases and for liquids.	**6 hr**
3	**The 2nd law of thermodynamics** Review on the 2nd law and Carnot heat engine, entropy balance for open system, calculation of ideal work, lost work.	**6 hr**
4	**Heat capacity** Heat effect, heat capacity calculations, sensible heat, latent heat, standard heat of reaction, heat effect of industrial reactions.	**4 hr**
5	**Thermodynamic properties of fluids** Review on the property relations (ΔH, ΔS, ΔUandΔG residual properties, two phase systems, thermodynamic diagrams and tables, generalized property correlations for gases.	**6 hr**
6	**Applications of thermodynamics to flow processes** Duct flow of compressible fluids, pipe flow, nozzles, throttling process, turbines, compression processes compressors, ejectors	**6 hr**

University of Technology
Department of Chemical Engineering

Program	***Chemical and Petroleum Refinery Engineering***					
Course Code	**CES.R.321**	Credits hr				Units
Course Title	Numerical Analysis					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Computer Programming I , II	**2**	**2**	**1**	**5**	**3**

Course Description

This course introduces students to: Error analysis; Finding roots of a non-linear function; Approximation and interpolation; Numerical integration and differentiation; direct and indirect solution of systems of linear equations; Solution of systems of nonlinear equation; solving ordinary differential equations and partial differential equations. All examples within the course concerning with principles of chemical engineering.

Course Text

1. "Numerical Methods for Engineers", Steven C. Chapra, Raymond P. Canale, McGraw Hill, 6th edition, 2010.
2. "Numerical Methods for Engineers and Scientists", Joe Hoffman, McGraw-Hill Book Company,1993.
3. "Applied Numerical Analysis", Gerald,C.F. and Wheatley, P.O., 6th Edition, Pearson Education, 2006.
4. "Numerical Methods for Chemical Engineers with MATLAB Applications", AlkisConstantinides, NavidMostoufi, Prentice Hall, 1999.

Course Objectives: at the end of the semester the student should be able to:-

To solve chemical engineering problems with numerical analysis techniques.

Topics Covered (Syllabus)/ Numerical Analysis

No.	Contents	Duration
1	**Introduction to Numerical Analysis:** • Numerical Solution, type of errors; relative error, absolute error, percentage error, truncation error, round off error. Floating point.	**2 hr**
2	**Interpolation and Polynomials Approximation:** • Lagrangian Polynomials (Linear, Quadratic, and General Form). • Newton's Divided differences (Linear, Quadratic, and General Form). • Cubic spline interpolating polynomials.	**3 hr**
3	**Curve Fitting** • Linear regression, Polynomial Models, Nonlinear Data.	**2 hr**

4	**Root Finding:** Roots of polynomials, Bisection method, Secant method, Newton-Raphson method.	3 hr
5	**Numerical Differentiation and Numerical Integration:** Forward, backward and central difference approximation. Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rules. Double integrals using trapezoidal and Simpson's rules.	6 hr
6	**Solving System of Equations:** Solution of linear system of equations by direct methods (Gaussian elimination and Gauss-Jordon). Solution of linear system of equations by Iterative methods (Jacobi and Gauss-Seidel). Solution of non-linear system of equations by Newton-raphson.	4 hr
7	**Solution of ordinary Differential Equations:** Initial value problems. Solution of first-order ordinary differential equations using Taylor', Eular, Runge-Kutta and Predictor-corrector methods. Solution of simultaneous ordinary differential equations.	4 hr
8	**Solution of Partial Differential Equations:** Types of Partial Differential Equations: Elliptic (Poisson) equation, Parabolic (heat) equation, Hyperbolic (wave) equation. Finite difference solution of Partial Differential Equations. Numerical solution of partial differential equations using explicit, implicit and Crank-Nicolson methods elliptic (Laplace) equation.	6 hr

Topics Covered (Syllabus)/ Numerical Analysis Laboratory Guide

No.	Contents
1	Review of properties of Matlab programming language.
2	Bisection method and Secant method.
3	Newton-raphson method.
4	Lagrange interpolation.
5	Newton’s forward and backward difference formulas.
6	Trapezoidal rule.
7	Simpson’s 1/3 and 3/8 rules.
8	Solution of linear system of equations by direct methods (Gaussian elimination and Gauss-Jordon).
9	Solution of linear system of equations by Iterative methods (Gauss-Seidel and Jacobi).
10	Solution of differential equation using Euler’s method.
11	Solution of differential equation using Runge-Kutta method.
12	Solution of partial differential equations using explicit and implicit methods.
13	Solution of partial differential equations using Crank-Nicolson method.
14	Solution of steady state diffusion through catalyst
15	Solution of un-steady state diffusion through catalyst

University of Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R.333**	Credits hr				Units
Course Title	Mass Transfer					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Chemical engineering -principles II &III, -fluid flow I & II	**2**	**2**	**1**	**5**	**3**

Course Description

This course covers diffusion and mass transfer in binary& multi-components, molecular diffusion in fluids, convective mass transfer, mass transfer coefficients, mass transfer correlations, interphase mass transfer, mass transfer theories.

Course Text

1- Coulson, J. M & Richardson J. F. (2006). "Chemical engineering, Volume 1", 3rd Edition, Robert Maxwell. M. C.

2- Dutta Binary K. (2007), "Principles of Mass Transfer & Separation Process", Bvt. Ltd. Prentice Hall, ISPN 8-1203-2990-2.

Other support books:-

1- Treybal Robert E. (1975), "Mass transfer Operation" 2ed Edition, Mc-Graw-Hill Book.
2- McCabe, W., Smith, J., Harriott, P. (2004), "Unit Operations of Chemical Engineering", Mc-Graw-H Co., 7th Edition, ISBN0072848235.

Course Objectives: at the end of the semester the student should be able to:-

1- Understand the basics of diffusion as applicable to mass transfer phenomena.

2- Estimate Molar fluxes in convective and inter phase mass transfer.

3- Explain the concept of diffusion theories.

4- Applying the convective mass transfer correlations to calculate mass transfer rates in many units operation.

Topics Covered (Syllabus)/ Mass transfer

No.	Contents	Duration
1	**Introduction:** Fundamentals of mass transfer processes, concentrations, velocities, mass & molar fluxes.	2 hr
2	**Diffusion in binary gaseous:** Fick's first law of diffusion. Diffusion in gas mixtures, Equimolecular diffusion, diffusion in stationary layer. Correlations to calculate diffusivity, correcting diffusivity	6 hr
3	**Diffusion in multi component mixtures:** Multi-component gas phase systems, effective diffusivity. Maxwell's law of diffusion	4 hr
4	**Diffusion in liquids.**	2 hr
5	**Diffusion in solids.**	2 hr
6	**Diffusion theories**: Diffusion across phase boundary, Film theory, two film theory, Mass transfer coefficients (individual & overall) in laminar and turbulent flow.	4 hr
7	**Diffusion resistances:** Calculating the resistance to mass transfer in both phases. Calculating intermediate concentrations.	4 hr
8	**Unsteady state mass transfer:** Introduction to unsteady state mass transfer, mass transfer accompanied by a chemical reaction.	6 hr

Practical: (Mass Transfer lab.)

No.	Experiment Name
1	**Liquid-Liquid diffusion**
2	**Absorption**
3	**Batch Distillation Column**
4	**Fluid Mechanics of Packed Bed**
5	**Sieve Analysis**
6	**Gas Solid Fluidization**

Program	***Chemical and Petroleum Refinery Engineering***					
Course Code	**CES.R.335**	Credits hr				Units
Course Title	Chemical Reaction Kinetics					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Physical Chemistry II	**2**	**-**	**1**	**3**	**2**

Course Description

Theory,Kinetic parameters and rate law, multiple reactions, yield and selectivity, stoichiometric considerationsand collection and analysis of rate data

Course Text

1-Octave Levenspiel (1999), CHEMICAL REACTOR ENGINEERING, 3rd edition, John Wiley & Sons Inc., USA ISBN: 9780471254249.

2-J.M. Smith (1987), CHEMICAL ENGINEERING KINETICS, 3rd edition, McGraw-Hill International Editions, Singapore. ISBN: 9780070587106

Other support books :-

1- Ronald W. Missen; Charles A. Mims; Bradley A. Saville (1999), INTRODUCTION TO CHEMICAL REACTION ENGINEERING AND KINETICS,1st edition, John Wiley & Sons Inc.,USA

Course Objectives : at the end of the semester the student should be able to :-

This course aims to establish fundamental knowledge for the students in chemical reaction kinetics. At the end of this course, students should be able to:

(i) Interpret and analyseschemical reaction kinetics data.
(ii) Apply reaction kinetics principles in chemical reaction.
(iii) Identify and formulate problems in chemical reaction kinetics and find appropriate solutions**.**

Topics Covered (Syllabus)/ Chemical Reaction Kinetics

No.	Contents	Duration
1	**Introduction to reactor design:** Interpretation of rate data, scale-up, and design Classification of reactors.	**2 hr**
2	**Kinetic parameters and rate law:** Definition in terms of reacting compounds and reaction extent; irreversible and reversible reactions, homogeneous catalyticreactions, conversion, yield. Rate laws, stoichiometry, reaction order and elementary reactions. Reaction rate constants, Arrhenius equation andvan,t Hoff equation and Heat of reaction. Temperature and pressure effects on reaction rates.	**8 hr**

3	**Reactors design and Stoichiometry:** Mole Balances. Batch Reactor Design Equations. Design of Continuous Stirred-Tank Reactor. Design of Plug Flow Reactor. Stoichiometry in batch systems. Stoichiometry in flow systems. Reversible Reactions and EquilibriumConversion.	**10 hr**
4	**Multiple reactions, yield and selectivity:** Types of multiple reactions. Definitions of yield and selectivity. Analysis of parallel, series, consecutive reactions. Effect of pressure and temperature on multiple reactions. The Denbigh reaction and its special cases.	**10 hr**

Universityof Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical and Petroleum Refinery Engineering</td></tr>
<tr><td>Course Code</td><td>CES.R.337</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Heat transfer I</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Fluid Flow II&Math III& IV</td><td>2</td><td>0</td><td>1</td><td>3</td><td>2</td></tr>
</table>

Course Description

The course will introduce the fundamental concepts of various modes of heat transfer. Additionally, it will elaborate these concepts with theories and applications to solve practically relevant chemical engineering problems. Moreover, this course will help students formulate the models necessary to study, analyze and design heat transfer systems by applying these principles. Furthermore, this course will focus on developing problem-solving skills, which are essential to good heat transfer engineering practice in real-world applications.

Course Text

4- - Holman, J.P. (2009) Heat Transfer. 10th Edition, McGraw-Hill, New York.
   Other support books: -
5- Harker, J. H., J. R. Backhurst, and J. F. Richardson. Chemical Engineering Volume 1. Vol. 1. Elsevier, 2013
6- Incropera, Frank P., David P. DeWitt, Theodore L. Bergman, and Adrienne S. Lavine. Fundamentals of heat and mass transfer. Vol. 6. New York: Wiley, 1996.

Course Objectives: at the end of the semester the student should be able to:-

1. Understand the fundamental laws of heat transfer.
2. Account for the consequence of heat transfer in thermal analyses of engineering systems.
3. Analyze problems involving steady-state heat conduction in simple geometries.
4. Develop solutions for transient heat conduction in simple geometries.
5. Understand the fundamentals of the convective heat transfer process.
6. Evaluate heat transfer coefficients for forced convection over exterior surfaces.
7. Evaluate heat transfer coefficients for forced convection inside tubes and ducts.
8. Contribute to the ability of the student to identify, formulate, and solve engineering problems.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction** • Cover syllabus and introduction to class • Temperature scales • Conduction Heat Transfer • Thermal Conductivity • Convection Heat Transfer • Radiation Heat Transfer	**4 hr**

2	**Steady State Heat Conduction in One Dimension:** • The Plane Wall • Heat conduction through a composite wall • Radial Systems • The Overall Heat-Transfer Coefficient • Critical Thickness of Insulation • Heat-Source Systems • Cylinder with Heat Sources • Conduction-Convection Systems • Extended surfaces (Fins)	10 hr
3	**Unsteady-State Conduction** • Introduction • Lumped-Heat-Capacity System	4 hr
4	**Principles of Convection:** • Viscous Flow • Inviscid Flow • Laminar Boundary Layer on a Flat Plate • Energy Equation of the Boundary Layer • The Thermal Boundary Layer • Calculation of the heat transfer coefficient for flow over a flat plate • The Relation Between Fluid Friction and Heat Transfer	8 hr
5	**Empirical and Practical Relations for Forced-Convection Heat Transfer** • Introduction • Empirical Relations for Pipe and Tube Flow • Flow Across Tube Banks	4 hr

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R.339**	Credits hr				Units
Course Title	Combustion					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Chemical Engineering Principle III -Chemical Engineering Principle II	**2**	**-**	**-**	**2**	**2**

Course Description

Scope and History of Combustion, Combustion of Gaseous and Vaporized Fuels. Gas –fired furnace combustion and flames, Combustion of Liquid Fuels and Oil –Fired Furnaces Combustion , Direct –Injection Engine Combustion , Combustion of Solid Fuels

Course Text

1-Gary L.borman,Combustion(Engineering),1998 by Mc Grawhill
2-Stephen R.turns,(An introduction to Combustion), 2000 by Mc Grawhill.
3-F .ElMahallawy and S.ElD in Habik ,"(Fundamentals and Technology of Combustion)",2002 by Elsevier

Course Objectives: at the end of the semester the student should be able to :-

1- Study the nature of combustion ,scope of internal combustion engine
2- Types of flame ,study the effect of temp and pressure
3- study the types of solid fuels and the drying of solid fuels
4- Study the types of furnaces and furnaces efficiency

Topics Covered (syllabus) / Course Title

No	Contents	Duration
1	**Scope and History of Combustion:** The nature of combustion, Historical perspective of fuels, Historical perspective of combustion technology (lighting /steam boilers/ internal –combustion engines/compression ignition engines/gas turbines/rocket engines).	**2 hr**
2	**Combustion of Gaseous and VapourizedFuels :** **1-Gas –fired furnace combustion** Furnaces and tubular furnace,Chemical Engineering Principle II and furnace efficiency (Furnace efficiency and heat loss calculations), burners types, radiation and convection rooms in furnace, furnace wall layers and refractories ,chimney height calculation, tube layers in furnaces.	**16 hr**

	2-Flames: First law combustion calculations (adiabatic flame temperature), Laminar premixed flames: (effect of stoichiometry on laminar burning velocity /effect of reactant pressure and temperature on laminar burning velocity/stabilization of a premixed flame), laminar flame theory(laminar burning velocity theory /simplified laminar flame model), diffusion flames, combustion zones and temperature profiles, flammability limits, flame stability, flame and combustion speed.	
3	**Combustion of Liquid Fuels:** **1- Spray Formation And Droplet Behavior** Spray formation, size distributions, fuel injectors, spray dynamics (diesel spray dynamics, single –droplet dynamics), vaporization of single droplets. **2-Oil –Fired Furnaces Combustion** Gas turbine sprays combustion, Gas turbine operating parameters, combustor design, combustion rate, Liner heat transfer. **3-Direct –Injection Engine Combustion** introduction to diesel engine combustion, fuel injection, combustion rates	**10 hr**
4	**Combustion of Solid Fuels:** **Solid Fuel Combustion Mechanisms** Solid fuel, drying of solid fuels, devolatilization of solid fuels.	**2 hr**

University of Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical and Petroleum Refinery Engineering</td></tr>
<tr><td>Course Code</td><td>CES.R.3310</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Chemicals from Petroleum</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Chemistry
-Chemistry of Petroleum Engineering</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td></tr>
</table>

Course Description

Primary and secondary raw materials ,Ethylene ,Butylenes ,Higher olewfins and Syn gases Derivative Of Ethylene, Propylene, Syn gas, End products –Polymers PCS and complexes.

Course Text

1. Sami Matar, Lewis F. Hatch, Chemistry of Petrochemical Process, 2nd edition.
2. William D. Callister, David G. Rethwisc, Materials Science and Engineering.

Course Objectives: at the end of the semester the student should be able to :-

1- To know sources of feed stock. These sources are petroleum fractions and natural gases.

2- To introduce petrochemicals generations: first (basic petrochemicals), 2nd derivatives, 3rd and product.

3- Ability to select of appropriate equipment for the separation of materials in process plant.

4- Provide practice at developing critical thinking skills, solving open ended problems and to work in teams

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction :** Raw material, characterization	**3 hr**
2	**Primary Petrochemicals:** Olefins, Diolefins, Higher Olefins, LAB, Aromatics, separation Aromatics, Syn gas, H_2 production, steam reforming ,PO	**12 hr**
3	**Derivatives Syn gas derivatives**: Methanol, Acetic acid **Ethylene derivatives :** Vinyl chloride M, Ethylene Oxide. Ethylene glycol, MEA, DEA&TEA **Propylene derivatives :** Acrylonitrile, **Derivatives of C_4 hydrocarbon** : MTBE, Adipic acid.	**9 hr**

	Benzene derivatives Ethyl benzene, styrene, nitrobenzene, aniline, cyclohexane, cumene, Phenol, acetone. **Toluene derivatives :** Benzoic acid **Xylene derivatives :** Terephthalic acid .	
4	**Products:** polymers: LDPE, HDPE, PVC, PP.	3 hr
5	**Petrochemical complexes:** Ethylene,Propylene,Benzen, C4, BTX	3 hr

Universityof Technology
Department of Chemical Engineering

Program	Chemical and Petroleum Refinery Engineering					
Course Code	**CES.R.3311**	Credits hr				Units
Course Title	Equipment Design					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Fluid Flow I & II, -Principles of Chemical Eng. I, II, III.	**2**	**---**	**1**	**3**	**2**

Course Description

The course content process planning, piping and pumps network , gas-gad separation ,solid handling, hear and mass transfer equipments

Course Text

-Sinnott R. and Towler C; 2013 " chemical Engineering Design" 5th edition Butterworth-Heinemann
-Coke,A.K ;2007"Ludwig s Applied Process Design of Chemical and petrochemical Plant" vol. 1 4th edition Gulf professional Publisher

Course Objectives: at the end of the semester the student should be able to :-

The ability to apply the design equation and equipments specifications as practical
To prepare students to be able to read and understand chemical engineering plants drawing

Topics Covered (Syllabus)/ Equipment Design

No.	Contents	Duration
1	**Process planning:** Introduction, Nature of design, the organization of a chemical engineering projects Scheduling .Standards and codes. Flow sheet design, flow sheet types and designation .Block diagram .Process flow sheet .Piping and instrumentation diagram .Utilities, Computer aided drafting ,process simulation programs .Layout and plot plan .Project evaluation and cost estimation	**10 hr**
2	**Piping network, Pumps and compressors** Valves selection. Piping design standards and codes. Pipe size selection .Mechanical design of piping system. Pump type, pump specifications, and pump data sheet	**6 hr**
3	**Vessels and tanks** Types of vessels. Criteria in vessel design, stress considerations. Materials of construction commonly used in vessels tanks. Design of tall vertical vessels. Pressure vessels Design. Vessels supports and foundations	**10 hr**
4	**Solid Handling** Screening Classification with Streams of Air or Water Air Classifiers. Size Reduction. Equipment for Size Reduction Particle Size Enlargement Extrusion Processes	**4 hr**

<table>
<tr><td>Program</td><td colspan="6">Chemical and Petroleum Refinery Engineering</td></tr>
<tr><td>Course Code</td><td>CES.R.332</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Thermodynamics II</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Mass Transfer,
-Thermodynamics I</td><td>2</td><td>2</td><td>1</td><td>5</td><td>3</td></tr>
</table>

Course Description

The course discuss the study of Power cycles; Refrigeration and liquefaction process; Theory and application of solution thermodynamics ;Vapor/liquid equilibrium in both: binary and multi-components; Ideal and non-ideal solutions are discussed using Raoult's and modified Raoult's law; Fugacity and fugacity coefficient definitions; Chemical reaction equilibriumandThermodynamic analysis of processes.

Course Text

1- J. M.Smith,H.C.Van Ness, Introduction to chemical engineering thermodynamics, 6th edition (International Edition), Mc-Graw Hall, 2008.

Other support books :-

1-K.V.Narayanan, Atext book of chemical engineering thermodynamics, prentice Hall of India, New Delhi, 2011.

2- B.G.Kyle, Chemical and process thermodynamics ,(3rd Edition), prentice Hall Inc.New Jersey, 1984.

3-J. Rayner, Basic engineering thermodynamicsinSIunits, printed in great Britain,1971.

Course Objectives : at the end of the semester the student should be able to :-

1-Apply the laws of thermodynamics to power, refrigeration and liquefaction cycle.

2-Establish thermodynamic constraint that apply to VLE, and explain qualitatively the VLE diagram.

3. Apply thermodynamics to VLE of pure components and solutions in terms of fugacity and fugacity coefficients.

4. Apply equilibrium criteria to chemical reactions and evaluate the effect of temperature.

5. Revision for thermodynamic analysis of processes.

Topics Covered (Syllabus)/ Course Title

No.	Content	Duration
1	**Solution thermodynamics: theory** Fundamental property relations, the chemical potential and phase equilibrium, ideal gas mixtures, fugacity and fugacity coefficient, the fundamental residual property relations, the ideal solutions.	**4 hr**
2	**Vapor\liquid equilibrium; introduction :** The nature of equilibrium, the phase rule, Duhem,s theorem, diagrams for vapor liquid equilibrium, simple models for VL equilibrium: Rault,s law, dew point and bubble point calculations, Henrys law, VLE by modified Raults law, VLE from K value correlations, flash calculations.	**8 hr**

3	**Chemical Reaction equilibrium:** The reaction coordinate, standard Gibbs energy change and equilibrium constant, effect of temperature on equilibrium constant, evaluation of equilibrium constant, liquid phase reactions, equilibrium conversion for single reactions.	8 hr
4	**Production of power from heat**: The steam power plant, Rankin cycle, the regenerative cycle, internal combustion engines Otto engine, diesel engine, gas turbine engine.	4 hr
5	**Refrigeration and liquefaction:** The Carnot refrigerator, the vapor compression cycle, the choice of refrigerant, absorption refrigeration, the heat pump, liquefaction processes	4 hr
6	**Thermodynamic analysis of processes:** Second law relation for steady state flow processes, calculation of ideal work, thermodynamic analysis of steady state flow processes.	2 hr

Practical: (Thermo. lab.)

No	Name of Experiment
1	**Pressure and Temperature relationship for steam**
2	**Liquid -vapor equilibrium Isotropic Mixtures**
3	**Boyles' law**
4	**Refrigeration**
5	**Hydrolysis of methyl acetate**
6	**Regulating and charging battery**
7	**Measurement of the solar irradiation**
8	**Alternating current solar installation**

Universityof Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical and Petroleum Refinery Engineering</td></tr>
<tr><td>Course Code</td><td>CES.R.322</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Applied Mathematics in Chemical Engineering</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Mathematics III and IV
-Numerical Analysis</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td></tr>
</table>

Course Description

This course introduces students to: Solve ordinary differential equations: apply Laplace transform to solve various systems of ordinary differential equations: Solve different types of partial differential equations. At the end of the course students should be able to apply these methods to tackle all kinds of problems that appear in chemical engineering.

Course Text

1- "Mathematical Methods in Chemical Engineering", Jenson. V.J. and Jeffereys, G.V, 2nd Edition, Academic Press New York, 1977.
2- "Applied Mathematics and Modeling for Chemical Engineers",Rice R G. and. Do, D. D., John Wiley and Sons, New York, 1995.
3- "Applied Mathematical Methods for Chemical Engineers",Loney, Norman W., 2nd edition, CRC Press – Taylor & Francis Group, Boca Raton, 2007.

Course Objectives: at the end of the semester the student should be able to:-

Apply different analytical methods to solve chemical engineering problems.

Topics Covered (Syllabus)/Applied Mathematics in chemical Engineering

No.	Contents	Duration
1	**Review: (Ordinary Differential Equations):** First Order Ordinary Differential Equations. Second Order Ordinary Differential Equations. Higher Order Ordinary Differential Equations.	**6 hr**
2	**Partial Differential Equations:** Method of Direct Integration. Separation of Variables (Forier Transforms). Combination of Variables (Variation of Parameters). Laplace Transforms.	**8 hr**

3	**Laplace Transforms** Definitions (Laplace Transforms of Some Elementary Functions, Rules of Laplace Transforms). The First Shifting Theorem, Multiplicity by X or X^n. The Inverse of Laplace Transforms (Completing the Square in the Denominator, By Partial Fractions, By Convolution Integral, By Conversion Integral) Laplace Transform of Derivatives Solution of Ordinary Differential Equations (Ordinary Differential Equations with Constant Coefficient, Ordinary Differential Equations with Variable Coefficient). Partial Differential Equations. The Unit Step Function, The Unit Impulse Function. The Second Shifting Theorem	**8 hr**
4	**Formulation of Chemical Engineering Problems (Modeling):**: Storage Tanks. Mixing Tanks. Chemical Reaction Vessels. Heat Transfer Problems. Mass Transfer Problems. Momentum Transfer Problems. Process Control System. Another Problems.	**8 hr**

University of Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R.334**	Credits hr				Units
Course Title	Unit Operations I					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemical Engineering Principles I, II&Mass transfer	**3**	**0**	**1**	**4**	**3**

Course Description

This course covers three main operations, gas absorption, stripping, distillation for binary and multi component mixtures and boundary layer. Concepts to design mass transfer equipment.The course aims to provide deeper knowledge, a wide scope and improved understanding of the mechanisms in mass transfer as well as a better insight into analytical and empirical methods applied in analysis and synthesis of mass transfer related problems.

Course Text

1- Coulson, J. M & Richardson J. F. (2006). "Chemical engineering", Volume 2, 3rd Edition, Robert Maxwell. M. C.

2- Dutta Binary K. (2007), "Principles of Mass Transfer & Separation Process", Bvt. Ltd. Prentice Hall, ISPN 8-1203-2990-2.

Other support books:-

1- Treybal Robert E. (1975), "Mass transfer Operation" 2nd Edition, Mc-Graw-Hill Book.

2-McCabe, W., Smith, J., Harriott, P. (2004), "Unit Operations of Chemical Engineering",Mc-Graw-Hill Co., 7th Edition, ISBN0072848235.

Course Objectives: at the end of the semester the student should be able to:-

1- Understand the basics of gas absorption, stripping and distillation.

2- Design absorbers, strippers and distillation columns.

3- Find Operating lines, feed line and No. of trays or amounts of packing required.

4- Calculate columns efficiency.

5- Derive basic momentum equation models from first principles for the boundary layer.

Topics Covered (Syllabus)/ Unit Operation I

No.	Contents	Duration
1	**Introduction to separation processes:** General separation techniques. The mechanism of absorption and stripping processes. Flow regimes.	3 hr
2	**Absorption in packed bed columns**: Constructions, mass transfer coefficients & specific area, capacity, height of columns based on gas film, liquid film, and based on overall conditions, operating line, the transfer units, the importance of gas and liquid flow rates.	6 hr
3	**Absorption in Tray towers :** Types of trays, number of trays analytically and graphically. How to calculate the tray and column efficiency.	6 hr
4	**Introduction to distillation process:** Partial pressure, Dalton's, Raoult's& Henry's laws. Relative volatility, non ideal systems. Method of diffusion, binary mixtures, batch distillation, flash distillation, steam distillation. Fractionating column.	6 hr
5	**Fractionating process**: Number of plates required importance of reflux ratio, location of feed point, multiple feeds and side streams.	3 hr
6	**Multi-component Distillation :** Key components. Components distributions, equilibrium data, feed & product compositions, minimum reflux ratio, calculation number of trays required, relation between reflux ratio & number of plates.	9 hr
7	**Plate & packed distillation columns:** General designed methods, column efficiency	3 hr
8	**Reynolds Analogy**: Mass transfer with bulk flow, flow over a plane surface, flow in a pipe.	9 hr

University of Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical and Petroleum Refinery Engineering,</td></tr>
<tr><td>Course Code</td><td>CES.R.336</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Reactor Design</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Chemical Reaction Kinetics</td><td>2</td><td>-</td><td>1</td><td>2</td><td>2</td></tr>
</table>

Course Description

Theory,design fundamentals and mass conservation equations for ideal reactors, isothermal reactors for homogeneous reactions, non-isothermal reactors, multiple reactor System.

Course Text

1-Octave Levenspiel (1999),CHEMICAL REACTOR ENGINEERING, 3rd edition, John Wiley & Sons Inc., USA ISBN: 9780471254249.

2-J.M. Smith (1987), CHEMICAL ENGINEERING KINETICS, 3rd edition, McGraw-Hill International Editions, Singapore. ISBN: 9780070587106

Other support books :-

1- Ronald W. Missen; Charles A. Mims; Bradley A. Saville (1999), INTRODUCTION TO CHEMICAL REACTION ENGINEERING AND KINETICS, 1stedition, John Wiley & Sons Inc.,USA.

2- . H. S. Fogler, Elements of Chemical Reaction Engineering, 4th Ed (2006),

a. Prentice Hall,NewYorK.

Course Objectives : at the end of the semester the student should be able to :-

This course aims to establish fundamental knowledge for the students in chemical reactor engineering.

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

(i) apply reaction kinetics principles in chemical reactor engineering.

(ii) identify and formulate problems in chemical reactor engineering and find appropriate solutions.

(iii) specify and size the most common industrial chemical reactors to achieve production goals for processes involving homogeneous reaction systems.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction to reactor design:** Interpretation of rate data, scale-up, and design Classification of reactors.	2 hr

2	**Design fundamentals and mass conservation equations for ideal reactors:** Conservation of mass in reactors. The ideal stirred-tank reactor (Batch and steady-state flow) The ideal tubular flow reactor (PFR) Space time and space velocity	4 hr
3	**Isothermal reactors for homogeneous reactions:** Design procedure: Batch reactor (constant volume and constant pressure) Design procedure: Continuous stirred-tank reactors (Single and multiple reactions) Design procedure: Tubular-flow reactors Comparison of stirred-tank and tubular-flow reactors. Flow recycle reactors Non-steady flow (semi-batch) reactors	8 hr
4	**Non-isothermal reactors:** Energy conservation equations Batch stirred-tank reactors Continuous stirred-tank reactors	8 hr
5	**Multiple reactor System:** Plug flow reactors in series and/or parallel Equal- size mixed flow reactors in series (first order and second order reactions) Mixed Flow Reactors of different sizes in series. Best arrangement of a set of ideal reactors	8 hr

Universityof Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical and Petroleum Refinery Engineering</td></tr>
<tr><td>Course Code</td><td>CES.R.338</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Heat transfer II</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Heat transfer I</td><td>2</td><td>2</td><td>1</td><td>5</td><td>3</td></tr>
</table>

Course Description

This course will focus on the following topics:

- Learning about the heat exchanger and its types.
- Presenting the methods of predicting heat-exchanger performance.
- Discussing the methods that may be used to estimate the heat exchanger size and type necessary to accomplish a particular task.
- Understanding the phenomena of boiling and condensation process.
- Estimating the heat transfer for pool boiling and condensation process.
- Introducing the industrial furnaces and their types, and what are the design considerations.
- Learn about the different types of renewable energies.

Course Text

1-Holman, J.P. (2009) Heat Transfer. 10th Edition, McGraw-Hill, New York.

Other support books: -

2-Harker, J. H., J. R. Backhurst, and J. F. Richardson. Chemical Engineering Volume 1. Vol. 1. Elsevier, 2013.

3-Incropera, Frank P., David P. DeWitt, Theodore L. Bergman, and Adrienne S. Lavine. Fundamentals of heat and mass transfer. Vol. 6. New York: Wiley, 1996.

Course Objectives: at the end of the semester the student should be able to:-

1- Process principles of heat transfer in chemical process industry.

2- Practical heat exchanger design.

3- The students must understand the processes involved in boiling and condensation to design the appropriate heat-transfer equipment.

4- Define and solve problems in boiling and condensation heat transfer.

Topics Covered (Syllabus)/ Heat Transfer II

No.	Contents	Duration
1	**Heat Exchangers:** • Introduction • Types of Heat Exchangers • The Overall Heat-Transfer Coefficient • Fouling Factors • The Log Mean Temperature Difference • Design of heat exchanger by the conventional and Effectiveness-NTU methods • Heat-Exchanger Design Considerations	10 hr
2	**Shell and Tube Exchanger:** • Presenting a complete design of shell and tube heat exchanger. • Types and various specifications, design calculations by conventional and by effectiveness (NTU) methods and optimum design calculation.	6 hr
3	**Condensation and Boiling Heat Transfer:** • Introduction • Condensation Heat-Transfer Phenomena • The Condensation Number • Film Condensation Inside Horizontal Tubes • Boiling Heat Transfer • Simplified Relations for Boiling Heat Transfer with Water.	6 hr
4	**Radiation and Furnace design:** • Radiation properties, shape factor, heat exchange for nonblack bodies, parallel planes, shields, gas tradition. • Introduction about the types of furnaces	4 hr
5	**Renewable Energy:** • Solar radiation • Solar water heater • Solar air heaters • Heat exchangers for ocean thermal energy • Heat storage and transmits.	4 hr

Practical: (heat transfer lab.)

No.	Experiment Name
1	Conductive Heat Transfer in Steady State.
2	Coil Heat Exchanger.
3	Determination of overall Heat Transfer Coefficient under different Air Velocity conditions
4	Heat transfer in fluidized bed reactor
5	Graphite Heat Exchanger
6	Extended Surface Heat Transfer
7	Film and dropwise condensation experiment

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R.3312**	Credits hr				Units
Course Title	Equipment Design Using CAD					
Term	2 nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Thermodynamics, -Heat and Mass Transfer	**2**	**2**	**1**	**5**	**3**

Course Description

The aim of the subject is to engaged students with chemical plants by explain the main items of plants design by computer software, and also supervise students design of heat exchangers and gas-liquids column by traditional design procedures

Course Text

1- Sinnott R. and Towler C; 2013 " chemical Engineering Design" 5th edition Butterworth-Heinemann

2- Coke,A.K ;2007"Ludwig s Applied Process Design of Chemical and petrochemical Plant" vol. 1 4th edition Gulf professional Publisher

Course Objectives : at the end of the semester the student should be able to :-

1-Provide practice at developing critical thinking skills, solving open ended problems and to work in teams.

2- The student be able to use computer software packages to perform design activity beside the conventional methods

3- The student should have the necessary skills to design equipments

Topics Covered (Syllabus)/ Equipment Design Using CAD

No.	Contents	Duration
1	Applied Design for Pressure vessels ,pumps and compressors flash drum, gas-liquid separator, liquid-liquid separator, gas movers and compressors with computer aided	6 hr
2	Applied Design for heat equipments (shell And tube heat exchanger, plate heat exchanger , coil type exchanger, condenser, vaporizer, air cooler …….etc) manually and with computer aided	12 hr
3	Applied Design for mass transfer equipments (distillation column, absorber column, leaching equipment, scrubber………….etc) manually and with computer aided	12 hr

Practical: (Equipment design lab.)

No.	Contents
1	Introduction
2	Equation of state & stream
3	Rotating Equipment (3.1 Compressor, 3.2 Expander, 3.3 pump)
4	Separation Operations (Separator , 3-Phases Separator , 4.3 Tank)
5	Heat Transfer Equipment (Heater & Cooler, Heat Exchanger, LNG,Air Cooler)
6	Column distillation (Column Installation, Column Property View, Column-Specific Operations and Running the Column)
7	Reactors (CSTR, General Reactor, Gibbs, Equilibrium, conversion)
8	Logical Operations (Adjust, Balance, Recycle, Set)
9	process plant involving reaction and separation
10	Examination lab

University of Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R.3313**	Credits hr				Units
Course Title	Petroleum and Gas Field Processing					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemistry of Petroleum	**2**	**0**	**0**	**2**	**2**

Course Description

"**Petroleum and Gas Field Processing**" course deals on the various surface unit operations commonly used in production facilities.

Course Text

1-H. K. Abdel- Aal, Mohamed eggour, M. M Fahim "Petroleum and Gas Field Processing, (2003).
2-Francis S. Manning-Oilfield Processing of Petroleum, Vol. 1_ Natural Gas, (1991).
3- Francis S. Manning, Richard E. Thompson-Oilfield Processing, Vol. 2_ Crude Oil, (1995).

Course Objectives: at the end of the semester the student should be able to :-

1. To provide an understanding of the general principles and importance of Petroleum and Gas Field Processing in the petroleum industry,
2. A comprehensive understanding the fundamentals of the Petroleum and Gas Field Processing mechanisms at the basis of the processes.
3. Provide criteria affect the processing options and the processing equipment required in a Petroleum and Gas Field Processing at developing critical thinking skills, solving open ended problems and to work in teams.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Oil and Gas, From Formation to Production:** Formation and Accumulation of Oil and Gas Types of Petroleum Reservoir	**3 hr**
2	**Two-Phase Gas-Oil Separation :** Introduction, The Separation Problem, Theory of Gas-Oil Separation, Methods of Separation, Gas-Oil Separation Equipments	**6 hr**
3	**Three-Phase Oil-Water-Gas:** Introduction, Separation Theory, Separator Types, Separator Sizing Equation and Rules.	**3 hr**
4	**Treatment of Crude Oil :** Emulsion Treatment and Dehydration of Crude Oil, Desalting of Crude Oil, Crude Oil Stabilization and Sweetening	**6 hr**
5	**Field Processing and Treatment of Natural Gas :** Overview of Gas FieldProcessing, Sour Gas Treating, Gas Dehydration, Recovery, Separation,and Fractionation ofNatural Gas Liquids	**12 hr**

University of Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R.421**	Credits hr				Units
Course Title	Project I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Basic Principles of chemical engineering I -Basic Principles of chemical engineering II -Material &Chemical Engineering Principle II. -Thermodynamics I & II	**1**	**2**	**---**	**3**	**2**

Course Description

The course includes the design aspects and design considerations for plant of chemical industry.

Course Text

Sinnott R.K. "Chemical Engineering Design", Coulson and Richardson's. Chemical Engineering, Volume 6, Fourth edition, (2005).

Other support books :-

1- Peters M. S., Timmerhaus K.D. and West R.E. Plant Design and Economics for Chemical Engineering, Fifth edition, (2003).

Course Objectives: at the end of the semester the student should be able to:-

To learn the students the basic information's of designing the chemical plants and the economic and engineering aspects

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction to Design:** The anatomy of chemical manufacturing process, general overall design considerations, development of design data base, process creation, types of process design.	**5 hr**
2	**Design Information and Data:** Source of information of physical properties , predication of physical properties (density, viscosity, thermal conductivity , etc)	**5 hr**
3	**Material andChemical Engineering Principle II**: Review of material andChemical Engineering Principle II, flow sheet symbols, PFD information in flow diagram	**5 hr**

Project Requirements

No.	Contents	Duration
1	**Chapter One** Introduction, Historical Profile, Physical and Chemical Properties, Applications for chemical material production.	4 hr
2	**Chapter Two** Production Methods, Comparison between Processes, Selected the optimum Process, Physical properties of raw materials and by products, Production Capacity.	4 hr
3	**Chapter Three** Material balance for the plant process.	10 hr
4	**Chapter Four** Chemical Engineering Principle II for the plant process, Process flow diagram (PFD).	10 hr
5	**Poster and Oral Presentation**	2 hr

University of Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code-	**CES.R. 431**	Credits hr				Units
Course title	Unit Operation II					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Chemical Engg -Principle II&III, -Fluid Flow I & II -Thermodynamics I,&II, -Unit operation I, -Heat Treansfear I &II,	**2**	**2**	**1**	**5**	**3**

Course Description

Theory, applications and design of unit operations which are mostly employed in the chemical industry, drying of solid, humidification, dehumidification and cooling tower and liquid evaporation and crystallization.

Course Text

1- Coulson, J.M and Richardson J.F. "Chemical Engineering , Volume 1, 3rd edition ,Robert Maxwell.M.C.

2- Coulson J.M, and Richardson J.F. "Chemical Engineering, Volume 2, 3rd edition, Robert Maxwell.M.C.

Other support books :-

1- Perry,J.H, "Chemical engineering handbook ",Mc-Graw –Hill Bookcom.1975.

2- Binay.K.Dutta "Mass transfer and separation process" 2007.

3- Trebal Robert E., "Mass transfer operation"2nd edition, Mc-Graw –Hill Book com.1975.

Course Objectives: at the end of the semester the student should be able to:-

1- To provide an understanding of the general principles of separation processes to allow students to make sensible options given a separation task (Humidification, Dehumidification and Cooling tower, Evaporation, crystallization, and Wet Solid Drying).

2- A comprehensive understanding of the transport processes related to chemical engineering operations, with focus on both theory and applications.

3- Ability to select of appropriate equipment for the separation of materials in process plant.

4- Provide practice at developing critical thinking skills, solving open ended problems and to work in teams.

Topics Covered (Syllabus)/Course Title

No.	Contents	Duration
1	**Drying of Solids:** Introduction Drying of Solids....General Principles. Wet Solid Group.Terminology and Definitions. Humidity Measurement. Humidity Data for Air – Water system. Temperature –Humidity Chart (Psychometric Chart). Uses of Humidity Chart. Rate of Drying. Calculation method of Drying Rate and Time. Drying Rate. Drying Time. Mechanism of Moisture Movement in Wet Solid. Material and Heat Balance for Continuous Dryers. Rate of Drying for continuous Direct Heat Driers. Drying at High Temperature. Drying at Low Temperature. Drying Equipment.	6 hr
2	**Humidification, dehumidification and Cooling towers:** Introduction. Humidification Operations. Adiabatic Operations. Non-Adiabatic Operations. Mixing of Humid Streams. Mixing of Two Stream of Humid Gas. Addition of Liquid or Vapor to a Gas. Humidification Processes Theory. Cooling Tower Principles and Operations. Cooling Tower Classification. Design Cooling Tower. Adiabatic Humidification — Cooling. Dehumidification Tower	9 hr
3	**Evaporation:** Introduction, Types of Evaporations, Evaporation Equipment, Heat transfer in Evaporation Process, single, double and Multi effect Evaporators, Design of evaporators, Comparison of Forward, backward and Parallel effect evaporators, boiling Point rise.	9 hr
4	**Crystallization:** Crystallization fundamentals, cooling crystallizer, Evaporating crystallizer, Batch and continuous crystallization Crystallizer selection.	6 hr

Practical: (unit operation lab.)

No.	Experiment Name
1	**Tray Dryer**
2	**Plate and Frame Filtration**
3	**Rotary Drum Filtration**
4	**Design of Cooling Tower**
5	**Sedimentation**
6	**Liquid - Liquid Extraction**

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R. 433**	Credits hr				Units
Course Title	Process Dynamics					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Chemical Engineering -Principles II & III -Applied Mathmatics in Chem. Eng	**2**	**-**	**1**	**3**	**2**

Course Description

Study of dynamics characteristics of open-loop Chemical and Petroleum Refinery Engineering processes to formulate transfer function and analysis response of the system to design and select closed-loop controlscheme.

Course Text

1. D.R. Coughanowr and S. LeBlanc, Process Systems Analysis and Control, McGraw-Hill, 3rd edition, 2008.

2. Stephanopoulos G., “Chemical Process Control-An Introduction to Theory and Practice, ”Prentice -Hall, New Jersey, 1984.

Other support books :-

1. Luyben W. L., “Process Modeling, Simulation and Control for Chemical Engineers,” McGraw-Hill, New York, 2nd Ed., 1990 .

2. *Process Dynamics: Modeling, Analysis and Simulation, by Wayne Bequette.*

Course Objectives: at the end of the semester the student should be able to :-

1. Study of dynamic analysis of chemical processes to allow students to identify the system under different operating conditions.
2. Understanding of formulate transfer function of the system.
3. Testing and selecting of critical process variables.
4. Developing of skills, solving open ended problems and to work in teams.

Topics Covered (Syllabus)/ Process Dynamic

No.	Contents	Duration
1	**Linear Open-Loop Systems** Transfer function**,** Transient Response,ForcingFunctions:Step Response **,**Impulse Response Ramp Response Sinusoidal Response.	10 hr
2	**Applications of First Order Systems** Liquid –level system, heating system, Mass transfer system, Reactors, absorber, pressure vessel, Linearization.	8 hr
3	**Response of First-Order Systems in Series** Non-interacting System, Interacting System.	4 hr
4	**Higher-Order Systems** Second-Order: Under-damped, Critical and over-damped, Transportation Lag	8 hr

University of Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R.435**	Credits hr				Units
Course Title	Petroleum Refinery Engineering I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Chemistry of petroleum. -Fuel Tech.	**2**	**2**	**1**	**5**	**3**

Course Description

An introduction to petroleum feedstocks, refining processes, and how refined products are made. Heating of crude oil, Design of atmospheric and vacuum columns for petroleum fractionation will be explained. This course contains Solvent extraction processes for lube oil base stocks

Course Text

1. W.L..Nelson "Petroleum Refining Engineering" 4th Edition. McGraw Hill, New York, 1985
2. M.A. Fahim, T.A. Al-Sahhaf, and A.S. Elkilani," Fundamentals of Petroleum Refining", Elsevier, 2010.
3. J.H. Gary and G. E. Handwerk and M.J. Kaiser, "Petroleum Refining Technology and Economics", 5th Ed. CRC Press, 2007.

Course Objectives: at the end of the semester the student should be able to :-

1- Become knowledgeable in composition, properties and classification of crude oil or Petroleum.
2- Become familiar with the overall refinery processes including physical separation operations.
3- Be able to learn basic calculations and methods used to design and run some petroleum refining facilities.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction to petroleum refinery:** World petroleum resources, petroleum industries in IRAQ.	2 hr
2	**General review of refining processes of crude oil. Refinery configurations**	2 hr
3	**Composition and classification of crude, methods of evaluation :** ASTM, TBP and EFV distillation. Classification: Compound type, Correlation index, density, carbon distribution.	4 hr

4	**Properties and specifications of petroleum products :** Such as FG, Gasoline, naphtha, kerosene, diesel oils, lubricating oils, waxes and the like. Composition: Chemical composition, hydrocarbon components. viz. paraffinic, naphthanic, aromatic olefinic.	4 hr
5	**Separation processes:** introduction	2 hr
6	**Heating of crude oil :** Types of pipe still heaters, calculations of radiant absorption rates, Wilson lobo Hotel equations, lobo Evans method pipe still design. Heat exchanger in refinery design and operational problems fluid mechanics and refinery applications use of combustion Charts.	4 hr
7	**Distillation of crude oil** 1) Atmospheric distillation tower, types of refluxes. Energy balance in a topping tower and calculations involve estimation of top, side, bottom draw tray temperatures. Calculation of side steam strippers 2)Vacuum distillation tower, type of operations, economic consideration, flash zone & tower base calculations, flash zone pressure, steam requirements, heat & material balance calculation.	8 hr
8	**Solvent extraction processes for lube oil base stocks and wax processing :** solvent de-waxing,deasphalting, clay contacting, principles operating parameters, feed and product equalities and yields.	4 hr

Practical: (petroleum refinery Eng. lab.)

No.	Experiment Name
1	**Atmospheric Distillation**
2	**Characteristics of Airplane Turbine Fuel**
3	**Combustion Behavior of Gaseous Fuel**
4	**Asphalt Content**
5	**Characteristics of Diesel fuel**
6	**Blending Properties**
7	**Properties of Petroleum Products at low Temperature**
8	**Total Acidity**
9	**Lubricating oil by Gasoline Dilution**
10	**Water content in crude oil**
11	**Sediments content in crude oil**
12	**Sulfur content in crude oil**
13	**Smoke Point**

University of Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R. 423**	Credits hr.				Units
Course Title	Refinery Management & Ethics					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)		**2**		**1**	**3**	**2**

Course Description

Theory and applications, of Industrial Engineering Management which are mostly employed in The chemical industry Industrial Engineering Management; ,Industrial organization, Maintenance Work Measurement Techniques, Engineering Ethics, Quality Control, ISO and Safety Requirements.

Course Text

T.R. Banga and S.C. Sharma "Industrial Engineering Management" including Production Management, Eleventh Edition:2008.
M.S. Peters, K.D. Timmerhaus and R.E. West "Plant Design and Economics for Chemical Engineers" Fifth Edition: 2003.

Course Objectives: at the end of the semester the student should be able to:-

To helps and learn in the optimum use of plant, equipment, efforts towards productivity improvement, establishing the most efficient and effective utilization of human effort and synchronizing various resources like men, machine and material as well as Engineering Ethics.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Management** Principle of management, types and classifications, management responsibility, organization responsibility.	**2 hr**
2	**Industrial organization** Site, Feasibility study, Development of efficient work method (plant layout, flow of material, material handling), Workstations, Inputs and Outputs, Production planning (types of Productions).	**2 hr**
3	**Maintenance** Classification, Cost, Machine replacements, Case studies and examples.	**2 hr**
4	**Network Analysis** Principles and applications, Critical path method (CMP), Gant Chart, Pert techniques (examples and case studies).	**2 hr**
5	**Work Measurement Techniques** Time and Motion study.	**2 hr**

6	**Engineering Ethics:** Engineering has a direct and vital impact on the quality of life for all people. Engineering is an important and learned job. Engineers are expected to exhibit the highest standards of honesty and integrity. Accordingly, the services provided by engineers require honesty, impartiality, fairness, and equity, and must be dedicated to the protection of the public health, safety, and welfare. Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct.	**10 hr**
7	**Quality Control:** Standardization, Specification, Sampling techniques, Inspection- analysis of results. Quality costs (preventive cost, appraisal cost and failure cost). Application of quality control chart-examples, Reliability.	**4 hr**
8	**ISO:** Requirements, applications, ISO series, Quality management system (QMS), Total Quality management (TQM), Requirements and applications.	**3 hr**
9	**7-Safety Requirements:** Hazards (type's e.g. industrial hazards, pollution (air pollution, water pollution, industrial pollution). Industrial by products and industrial waste, Safety requirements of industrial sites, Requirements of suitable work environment (examples with particular emphasis in chemical industry).	**3 hr**

<table>
<tr><td>Program</td><td colspan="6">Chemical and Petroleum Refinery Engineering</td></tr>
<tr><td>Course Code</td><td>CES.R. 437</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Heterogeneous Reactor & Catalyst</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Mass- and Heat- Transfer,
-Fluid Flow I and
Thermodynamics II</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td></tr>
</table>

Course Description

This course includes definition of catalysis and catalyst, classification of catalysis processes with examples, mechanisms of catalysis, studying properties of porous catalysts, kinetics of heterogeneous catalytic reactions, studying the types of catalysts, preparation of supported catalysts and catalyst deactivation, characterization techniques of catalysts and studying applications of catalysts in catalytic processes.

Practical Unit Operation II Course Text

1. H. Scott Fogler, Elements of Chemical Reaction Engineering, 5th edition, 2016.
2. Chorkendorff, J. W. Niemantsverdriet, Concepts of Modern Catalysis and Kinetics, 2003.
3. Jens Hagen, Industrial Catalysis, 2006
4. Calvin H. Bartholomew, Robert J. Farrauto, Fundamentals of Industrial Catalytic Process, 2nd edition, 2006.
5. Julian Ross, Heterogenous Catalysis, 2012.
6. Robert L. Augustine, Heterogenous Catalysis for the Synthetic Chemist, 1996.
7. Yoshio Ono, Hideshi Hattori, Solid Base Catalysis, 2011.

Course Objectives: at the end of the semester the student should be able to :-

1. Understand the catalysis processes and acknowledge the different types.
2. Know the types of catalysts, properties of catalysts, how to make a catalyst and how catalysts lose their activities (studying the types of catalyst deactivation).
3. Suggest mechanisms and determine which step of heterogenous reaction is limiting and find the rate law in addition to understand how to analyze the heterogeneous data and design the heterogenous reactor.
4. Prepare the catalysts and improve the catalysts by reducing the deactivation of catalysts.
5. Test the catalysts using different characterization techniques to study the structural and functional properties of catalysts.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction:** Definition, classification of catalysts, mechanisms of catalysis, properties of porous catalysts (i.e. mechanical strength, stability, activity, and selectivity), morphology, pore size, solid density and porosity calculations, pore volume distribution, developing the support, promoters and inhibitors, coke formation on the catalyst surface, catalyst deactivation and reactivation.	6 hr
2	**Applications of catalysts in catalytic processes:** History of the catalysts in catalytic processes, such as direct oxidation of materials, hydrogenation in a packed bed reactor.	4 hr
3	**Surface area and kinetic parameters determinations:** Determination the surface area of catalyst, calculations of pressure drop and void fraction in a solid catalyst within a packed bed, calculations both the reaction rate and the activation energy over a solid catalyst, operating condition (i.e. temperature, pressure, residence time; *W/F*) and catalyst performance	4 hr
4	**Diffusion of bulk fluid over a solid catalyst within a packed bed:** Fixed-bed reactors: mass and heat-transfer coefficients (fluid-particle), fluidized-bed reactors: particle-fluid mass and heat transfer, slurry-bed reactors: mass-transfer coefficients: gas bubble to liquid (k_L), and liquid to catalyst particle (k_c), trickle-bed reactors: mass-transfer coefficients: gas to liquid (k_La_g), and liquid to particle (kcac) with calculation of global rate.	8 hr
5	**Intra-particle and diffusivities estimation** inside porous catalysts: Diffusion coefficient of Knudsen and Bulk diffusion, Gaseous diffusion in the micro- and macro- cylindrical pores, Diffusion in liquids, Diffusion within porous catalysts (effective diffusivity), pore models (parallel-pore model and random-pore model), surface diffusion, effectiveness factors.	6 hr
6	**Characterisation techniques** of **industrial catalysts:** Developing of catalysts and catalytic cost, characterisation of catalyst framework structure.	2 hr

Program	***Chemical and Petroleum Refinery Engineering***					
Course Code	**CES.R. 438**	Credits hr				Units
Course Title	Environmental Pollution. & Safety in Petroleum Refineries					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Petroleum & Gas Field Processing	**2**	**0**	**1**	**3**	**2**

Course Description

Definitions of pollutants emission from petroleum refinery. Classification of air pollutants, Sources and type of air pollution, Particulate and air born particulate. Air pollution control equipment: types of equipment, Design of settling chamber and cyclones.

Source of water, Utilization, and classification. Type of water pollutants and its effect, Wastewater treatment. Oxygen demanding wastewater: Dissolved Oxygen DO, BOD, Oxygen sage curve and the related equations. Classification of solid waste, the methods of disposal of the solid waste.

Safety in petroleum refinery

Course Text

1- C.S.Rao, “Environmental Pollution Control Engineering”, 2nd Edition, New Age International (P) Limited, Published, 2006, Reprint 2007.
2- R. K. Sinnott, Chemical Engineering Design, Vol. 6. 4th edition, Chemical Engineering Design, 2005, pp. 450-457.
3- Noel de Never, “Air Pollution Control Engineering”, McGrow-Hill, Inc 1987.

Course Objectives: at the end of the semester the student should be able to :-

1- Understand the concept of the environment and environmental pollution and global problems resulting from environmental pollution.
2- Provide solutions to environmental problems.
3- Concerned with local and worldwide environmental issues.
4- Design devices that are used in the control of air pollution.
5- Environmental engineers conduct hazardous-waste management studies in which they evaluate the significance of the hazard, offer analysis on treatment and containment.

Topics Covered **(Syllabus)/ Course Title**

No.	Contents	Duration
1	**Introduction:** Definition: Environment, Environmental Eng., Environmental Pollution and Pollutant. Causes effect and control measures of different types of petroleum pollutants of; Air, Water, Soil, Marine, Noise pollution and Nuclear Hazards. Petroleum pollution allowable limits in the environment.	2 hr
2	**The Impact of Production Operations:** Measuring Toxicity, Hydrocarbons, Salt, Heavy metals, Production chemicals, Produced water, Air pollution.	2 hr
3	**Treatment of Wastewater from Petroleum Industry:** Removal of suspended Hydrocarbons, Removal of Dissolved Hydrocarbons, Removal suspended solids and Removal of Dissolved Solids processes.	10 hr
4	**Treatment of Air Emissions:** Air pollutants (Hydrocarbons, Particulates, Gases), Characterization, Meteorological factor influencing, Characteristics of Stack Plume. Control of Particulates. Control of Gases (CO, SO_X, NO_X). Chimney Design.	8 hr
5	**Treatment of Solids:** Removal water, Removal Hydrocarbons, Solidification	2 hr
6	**Safety in Petroleum Refinery:** Fire Prevention and Control. Materials handling and storage, Noise Hazardous, Radiation Hazardous, Common Hazardous Materials in Refinery	6 hr

Universityof Technology
Department of Chemical Engineering

Program	*Chemical and Petroleum Refinery Engineering*					
Course Code	**CES.R. 422**	Credits hr				Units
Course Title	Project II					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Mass Transfer -Unit OperationI & II -Heat Transfer I & II -Equipment Design -Catalysis Eng. & Reactor Design	**1**	**2**	**---**	**3**	**2**

Course Description

The course includes the design aspects and design considerations for plant of chemical industry.

Course Text

Sinnott R.K. "Chemical Engineering Design", Coulson and Richardson's. Chemical Engineering, Volume 6, Fourth edition, (2005).

Other support books :-

1- Peters M. S., Timmerhaus K.D. and West R.E. Plant Design and Economics for Chemical Engineering, Fifth edition, (2003).

Course Objectives: at the end of the semester the student should be able to:-

To learn the students the basic information's of designing the chemical plants and the economic and engineering aspects

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	Choice of Plant Location and Layout Standard	**3 hr**
2	Piping and Instrumentation Pipes, valves, Pumps, Mechanical design and control	**4 hr**
3	Cost and Project Evaluation	**3 hr**
4	Safety and Loss Prevention	**2 hr**
5	Design with Computer Aided	**3 hr**

Project Requirements

No.	Contents	Duration
1	**Chapter Five** Design main equipment by design equation with mechanical design, cost evaluation, control andcomputer aided using Hysys software	**14 hr**
2	Design supported equipment with mechanical design, cost evaluation and control.	**6 hr**
3	**Chapter Six** Environmental effect for raw materials, products and by products	**6 hr**
4	**Poster and Oral Presentation**	**4 hr**

Program	***Chemical and Petroleum Refinery Engineering***					
Course Code-	**CES.R. 432**	Credits hr				Units
Course title	Unit Operation III					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Engineering Principle II&III, -Fluid Flow I, II, -Thermodynamics I, II, Mass Transfer, unit operation I II, Heat treansfearI, II,	**3**	**0**	**1**	**4**	**3**

Course Description

A comprehensive understanding of the transport processes related to chemical engineering operations with focus on theory, design and applications ofSolid–liquid filtration, Sedimentation, liquid - liquid extraction, Leaching and Washing.

Course Text

- Coulson ,J.M and Richardson J.F. “Chemical Engineering” , Volume 1, 3rd edition, Robert Maxwell.M.C.
- Coulson,J.M and Richardson J.F. “Chemical Engineering” , Volume 2, 3rd edition , Robert Maxwell.M.C.

Other support books :-

- De Sinha and Parameswar De “Mass Transfer: Principles and Operations”, ParameswarDe , New Delhi, 2012
- Binay.K.Dutta “Mass transfer and separation process” 2007.
- Trebal Robert E., “Mass transfer operation”2nd edition, Mc-Graw –Hill Book com.1975.

Course Objectives: at the end of the semester the student should be able to :-

1- Basic information, concepts and terminology of the general principles of separation processes of Solid –liquid filtration, Sedimentation, liquid - liquid extraction, Leaching and Washing.

2- Demonstrating a broad and integrated knowledge and a deep understanding of issues related to separation processes in a chemical process and important role it plays in the success of the process both economically and environmentally.

3- Ability to select of appropriate equipment for the separation of materials in process plant.

4- An ability to apply effective, creative and innovative solutions, both independently and cooperatively, to current and future problems in separation processes and transport phenomena.

Topics Covered (Syllabus)

No.	Contents	Duration
1	**Filtration:** Type of Filters, Filtration theory, Plate and frame filter press, leaf filter, filtration at Constant ΔP, Filtration at Constant rate, washing Time.	12 hr
2	**Sedimentation:** Introduction, Settling and Sedimentation in particle fluid separation, Sedimentation and thickening design, equipment for settling and Sedimentation.	9 hr
3	**Liquid - Liquid Extraction and Leaching:** Definition, Extraction process, Equilateral Triangular coordinates (Ternary Diagram), system of three liquid _ one pair partially soluble, choice of solvent, Equipment in extraction cross _ current extraction, multi stage Cross Current extracting cross current for insoluble Liquid , Continuous Counter current extraction , Continuous Counter Current in Soluble , Liquid , Minimum Solvent . General principles, Equipment for leaching	18 hr
4	**Membrane** Introduction , classification of membrane processes , general membrane equation , liquid permeation membrane processes , gas permeation membrane processes reverse osmosis , reverse osmosis with water treatment plant , ultra filtration membrane processes , micro filtration membrane processes	6 hr

Universityof Technology
Department of Chemical Engineering

Program	**Chemical and Petroleum Refinery Engineering**					
Course Code	**CES.R. 434**	Credits hr				Units
Course Title	Process Control					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Process Dynamic	**2**	**2**	**1**	**5**	**3**

Course Description

Analysis ofclosed-loop Petroleum Refinery Engineering processes system to design and select closed-loop controlscheme that will operate the plant with stable conditions.

Course Text

1. D.R. Coughanowr and S. LeBlanc, Process Systems Analysis and Control, McGraw-Hill, 3rd edition, 2008.

2. Stephanopoulos G., “Chemical Process Control-An Introduction to Theory and Practice, ”Prentice -Hall, New Jersey, 1984.

Other support books :-

1. Luyben W. L., “Process Modeling, Simulation and Control for Chemical Engineers,” McGraw-Hill, New York, 2nd Ed., 1990.

2. *Process Dynamics: Modeling, Analysis and Simulation*, *by Wayne Bequette.*

Course Objectives : at the end of the semester the student should be able to :-

1- To enhancement the ability of students for the analysis of closed-loop system and response of controlled system under different operating conditions.

2- Construction of transfer functions of the closed system for different schemes.

3- Provide practice of tuning of controller parameters and limiting of stable operating conditions.

4- Motivation and encourage the students for solving open ended problems.

Topics Covered (Syllabus)/ Process Control for Petroleum Refinery

No.	Contents	Duration
1	**Instrumentation:** Sensors: pressure, temperature, level, flow and concentration. Control valve. Dynamics characteristics of Instruments.	**6 hr**

2	**Linear Closed-Loop Systems:** The Control System, Controllers and Final Control Elements, Block Diagram of Controlled System, Overall Closed-Loop Transfer Functions.	**4 hr**
3	**Characteristics of the Closed Loop System** Transient Response of Simple Control Systems, Stability	**7 hr**
4	**Frequency Response Methods:** Introduction to Frequency Response Bode Diagrams, Control System Design by Frequency Response, Ziegler-Nichols Controller Settings.	**7 hr**
5	**Computer Control of Chemical process:** Analog Computer, Digital Computer, Computer Control Loops.	**3 hr**
6	**Control of Complex Processes:** Distillation Column, Heat Exchanger, Catalytic Reactor.	**3 hr**

Practical: (process control lab.)

No.	Experiment Name
1	**Feedback Control**
2	**Dynamic Behavior of Second order under Damped System (Orifice)**
3	**Flow rate Control**
4	**Level Control in the Tank**
5	**Pressure Control**
6	**Dynamic Behavior of Second order over Damped System (Stirred Tanks)**
7	**Dynamic Behavior of Second order over Damped System (Stirred Tanks Heater)**
8	**Temperature Control**
9	**PH Control**
10	**Control of Water Treatment Unit**

University of Technology
Department of Chemical Engineering

Program	***Chemical and Petroleum Refinery Engineering***					
Course Code	**CES.R. 436**	Credits hr				Units
Course Title	Petroleum Refinery Eng II					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Chemistry of Petroleum -Petroleum Ref. Eng I.	**2**	**-**	**1**	**3**	**2**

Course Description

"**Petroleum Refinery Eng II**" course deals with conversion processes for petroleum fractions as produced by the separation operations that are covered in the **Petroleum Refinery Eng I course**.

Course Text

1. W.L..Nelson "Petroleum Refining Engineering" 4th Edition. McGraw Hill, New
2. York, 1985Mohamed A. Fahim, Taher A. Al-Sahhaf, Amal Elkilani-Fundamentals of Petroleum Refining-Elsevier Science (2009)
3. Pierre Leprince-PETROLEUM REFINING V.3_ Conversion Processes (Publication IFP)-Editions Technip (2000)

Other support books: -

1. James H. Gary, Glenn E. Handwerk, Mark J. Kaiser, PETROLEUM REFINING Technology and, Fifth Edition, CRC Press © 2007 by Taylor & Francis Group, LLC

Course Objectives: at the end of the semester the student should be able to:-

1- To provide an understanding of the general principles and importance of conversion processes in the refining industry,

2- A comprehensive understanding the fundamentals of the chemical mechanisms at the basis of the processes. These disciplines are thermodynamics, chemical kinetics, reactor calculation and industrial catalysts.

3- Provide criteria affect the processing options and the processing equipment required in a modern refinery

Topics Covered (Syllabus)/ Petroleum Refinery Eng II

No.	Contents	Duration
1	**Thermal Cracking: introduction, Coking**: Delayed Coking, Feed Types, Background, Typical Product Yields and Characteristics, Description of the Delayed Information, Typical Yields, Process Description, Uses for Low Btu Gas, Use of Purge Coke.	**4 hr**
2	**Visbreaking of Residues:** Background Information, Feed Composition, Cracking Reactions, Reaction Kinetics and Mechanism, Process Data, Operating Variables, Product Properties and Yields, Process Flow Schemes, Specific Equipment, Environment.	**2 hr**
3	**Catalytic Cracking:** Overview, The FCC Process, Introduction, Feeds and Products, Description, Thermal Balance, Fluidization and Pressure Balance, Operating Variables, Conversion, and Cracking Severity, Changing Technology, Residue Cracking, Reactions, Reactivity, and Mechanisms, Reactions, Modern FCC Catalyst.	**4 hr**

4	**Hydrocracking:** Importance, Background, Typical Feeds, Reaction Thermodynamics, Kinetic, Catalysts, Effects of Feed Impurities and Components, Typical Flow Schemes, Operating Conditions, Product Yields and Quality, Hydrogen Consumption.	**2 hr**
5	**Catalytic Reforming:** Importance, Process Background, Reactions, Catalysts, Operating Variables, Influence of Feeds, Technology, Fixed Bed, Moving Bed, Industrial Performance, Operating Conditions, Typical Yields, Reformate Characteristics.	**6 hr**
6	**Isomerization of C5-C6 Paraffins:** Aim, Thermodynamics, The Catalyst, Reaction Mechanism, Kinetics, The Isomerization Process, Isomerization of n-Butane, Aim, Thermodynamics, Catalysts, Reaction Mechanism, Kinetics.	**2 hr**
7	**Aliphatic Alkylation:** Importance, Reaction Thermodynamics, Alkylate Compositions, Catalysts, Production Mechanisms, Red Oil Production Mechanisms, Structure and Function of Red Oils, Process Data, Feed Composition, Feed Pretreatment, Operating Conditions, Sulfuric Acid Alkylation Processes, HF Alkylation.	**2 hr**
8	**Hydrotreating:** Objectives, Impurities and their Origins, Heteroatoms and Metals, Unsaturated Products, Hydrotreating Processes, Background Information, Hydrotreating Reactions, Catalysts, Process Flow Schemes, Hydrotreating Kerosene and Gas Oil, Hydrotreating Vacuum Distillates.	**4 hr**
9	**Hydrogen Production:** Hydrogen in the Refinery, Requirements, Sources, Hydrogen Balance, Hydrogen Production by Steam Reforming, Production of Synthesis Gas, Carbon Monoxide to Hydrogen Conversion, Carbon Dioxide Removal, Methanation of Residual CO and CO2, Purification by Adsorption, Comparison of Conventional Methanation and Adsorption (PSA) Methods,	**2 hr**
10	**White Products Refining by Sweetening:** Mercaptan Distribution in Petroleum Cuts, Background Data, Recapitulation of Process History, Current Technologies, Industrial Processes.	**2 hr**

University of Technology
Department of Chemical Engineering

Program	***Chemical and Petroleum Refinery Engineering***					
Course Code	**CES.R. 424**	Credits hr				Units
Course Title	Optimization					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Numerical Analysis -Mathematics III, IV -Unit Operation.	**2**	**-**	**1**	**3**	**2**

Course Description

The subject is to be given in one semester. studying the formulation of objective the theory of optimization of single variable using analytical and numerical methods. Determination in the solution of multi variables problems .studying and solving the linear programming problems(LP).

Course Text

1) Optimization, Greirg D.M. Longmangroup limited London.
2) Optimization, converse A.O ,Holt, Reinhart, and Winston.

Other support books :-

1) Numerical methods for unconstrained optimization, Murrayw. Academic press.
2) Constrained optimization by direct search Swann, W.H. Gill and Murray.

Course Objectives : at the end of the semester the student should be able to :-

1- To formulate many problems arising in widely different situations.
2- Ability for finding optimum. Minimum, or maximum in unconstrained or constrained single or multi variables functions..
3- Deals with the special case of linear programing (functions and constraints are linear).
4- Provide practice to deal with industrial optimization problems.

Topics Covered (Syllabus)/ Optimization

No.	Contents	Duration
1	**Introduction to optimization.**	**2 hr**
2	**Recognizing an optimization problem and their solution.** - Formulation of optimization problems. - Unconstrained and constrained problems.	**4 hr**
3	**Optimization methods for single variable problems.** - Analytical methods; constrained and unconstrained. - Graphical method. - Numerical methods. Unconstrained functions; fixed step method, DSC method, Newton method. Constrained functions; sequential search, Dichotomous search; Fibonacci search, Golden ratio search.	**6 hr**

4	**Determining the solution to multivariable optimization problems.** Unconstrained minimization and maximization strategy. - Solving linear and non-linear equations using matrices. - Optimality conditions for unconstrained problems. - Lagrangian criteria. - Simplex method direction step length calculation. Solution of constrained multivariable problems. - Analytical solution. - Lagrangian duality. - Linearization of nonlinear optimization problems. - Simplex method. - Pivot table formulation. Linear programming (LP) formulation. - Solving linear system. - Basic solution of an (LP) problems. - Graphical interpretation.	6 hr
5	**Applications of Optimization**: - Heat Transfer and Energy Conservation. - Separation Processes. - Fluid Flow Systems. - Chemical Reactor Design and Operation. - Optimization in Large-Scale Plant. Design and Operations. - Integrated Planning. Scheduling. And Control in The Process Industries.	8 hr
6	**Introduction to:** - Machine learning. - Deep learning - Neural network. - Artificial Intelligence.	4 hr

University of Technology
Department of Chemical Engineering

Program	***Chemical and Petroleum Refinery Engineering***					
Course Code	**CES.R. 439**	Credits hr				Units
Course Title	Corrosion Eng. In Petroleum Refinery					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Material Engineering I & II	**2**	**-**	**-**	**2**	**2**

Course Description

Introduction, Classification of Corrosion, Kinetics of aqueous corrosion, Thermodynamics, Determining, Passivity, Reference Electrode, Corrosion prevention, Corrosion in refining industries.

Course Text

1- Zaki Ahmed, "Principle of Corrosion Engineering and Corrosion Control",1ST Edition, ,IChemE,ELSEVIER, 2006.
2- Denny A. Jones, "Principle and Prevention of Corrosion", 2nd Edition, Prentice Hall, 1996.
3- Herbert H. UHLIG, " Corrosion and Corrosion Control" John WILEY, 2008.
4- Fontana, M.G and Greene, N.D, "Corrosion Engineering", 3rd Edition, McGraw-HILL, 1986.
5- SankaraPapavinasam, "Corrosion Control in the Oil and Gas Industry", Elsevier, 2014.

Course Objectives : at the end of the semester the student should be able to :-

1- Understanding the concept of corrosion. The form of corrosion, How the material destroyed by corrosion.
2- Determine the corrosion rates and electrochemical behavior of the metals and the thermodynamics of corrosion reactions.
3- Applying the corrosion prevention technology.
4- Selection of materials involved in applying the corrosion prevention technology in petroleum refineries.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction:** Definitions, Corrosive environment, Consequences of corrosion, Cost of corrosion, Why metals corrode, Basic concepts on corrosion, Anodic and Cathodic reactions, Types of cells.	**2 hr**
2	**Classification of corrosion:** Wet corrosion, Dry corrosion, Sweet Corrosion, Sour Corrosion , Forms of corrosion	**4 hr**
3	**Kinetics of aqueous corrosion:** Faraday's laws of electrolysis and its application in determining the corrosion rate, reversibility and exchange current density, polarization, Activation polarization, Concentration polarization, Combined polarization.	**4 hr**

4	**Thermodynamics and its application on corrosion:** Free energy, Cell potential, Reversible electrode potential, Nernst equation	**4 hr**
5	**Determining the corrosion rate:** Corrosion rate measurement units, methods determining corrosion rate: 1- Immersion test 2- Electrochemical technique a-Tafel extrapolation b-Linear polarization	**4 hr**
6	**Passivity:** Active passive metal and conditions for passivity, Kinetics of passivity table passivity, Unstable Passivity	**2 hr**
7	**Reference electrodes:** Hydrogen electrode, Ag/AgCl electrode, $Zn/ZnCl_2$ electrode, $Pb/PbCl_2$ electrode	**2 hr**
8	**Corrosion prevention in Oil Industry:** Materials selection, Alteration of Environment, Design, Coating, Anodic protection, Inhibitors	**2 hr**
9	**Pourbaix diagram:** Equilibrium Diagram, Advantage and Disadvantage of Pourbaix Diagram	**2hr**
10	**Cathodic Protection:** Sacrificial anode corrosion protection, Impressed current anode corrosion protection, Major impressed current anodes, Galvanic systems anode, Design parameters in cathodic protection, Stray current corrosion	**4 hr**

Program	***Chemical and Petroleum Refinery Engineering***					
Course Code	**CES.R. 4310**	Credits hr				Units
Course Title	Petroleum Refinery Economics					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Pet. Ref. eng. 1	**2**	**0**	**0**	**2**	**2**

Course Description

This course presents an overview of refinery economic terminology, including fundamentals and methodology used to assess profitability of ongoing operations, planned.

This course contains Refining Capacity, Refining Costs Estimation: including capital and operating costs, calculation of crack spreads and refining margins, issues influencing feed and product pricing, refinery complexity, Refinery Economic Evaluation,

Process models and linear program applications as operating and optimization tools, feed and process unit economic drivers.

Course Text

1. R.E. Maples, "Petroleum Refinery Process Economics" ,Pennwell Books, 2nd edition., 2000.
2. James H. Gary, Glenn E. Handwerk "Petroleum Refining, Technology & Economics", 5th ed., & Mark J. Kaiser
3. M.A. Fahim, T.A. Al-Sahhaf, and A.S. Elkilani," Fundamentals of Petroleum Refining", Elsevier, 2010.

Course Objectives: at the end of the semester the student should be able to :-

1- Become familiar with refinery margins and economics

2- Ability to maximize refinery margins by optimizing a number of variables including: the type of crude feedstocks and products etc.

3- Ability to use appropriate analytical tools for planning strategy, improving operations, and assessing investment opportunities.

Topics Covered (Syllabus)/ Petroleum Refinery Economics

No.	Contents	Duration
1	**Introduction**	**2 hr**
2	**Refining Capacity**	**2 hr**
3	**Refining Costs Estimation**: Capital Costs, Operating Costs (Variable Cost, Fixed Cost), Factors Affecting Refinery Costs.	**6 hr**
4	**Refining Margins**	**2 hr**
5	**Refinery types and complexity**	**2 hr**

6	**Refinery Economic Evaluation**: Cash Flow Diagram, Time Value of Money, Inflation, Taxation and After-tax Cash Flow, Profitability and Project Evaluation.	6 hr
7	**Refinery Value Drivers:** Cost of Inputs vs. Price of Outputs**,** “Crack” Spreads	2 hr
8	**Global Trends**	2 hr
9	**Refinery Planning:** Linear Programming Overview, Refinery Linear Programming Models, Economics and Planning of Refining processes and process economics: Crude oil evaluation, Production planning, Product blending, Shutdown planning , Configuration studies,Technology evaluation	6 hr

University of Technology
Department of Chemical Engineering

Program	***Chemical Engineering and Oil Pollution***					
Course Code	**CES.E.111**	Credits hr				Units
Course Title	Technical English I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Basic principles in English language (grammars and vocabularies)	**2**	**-**	**-**	**2**	**2**

Course Description

Define a special knowledge and basic concepts in English language, review of (words, terms and phrases commonly utilized) with practical everyday language that students need, the fundamental principles of grammars used in English language such as question and answer, the negative, the tail questions, the singular and plural, the numbers, nouns, pronouns, the verb (to be, to have, and to do), adjectives, regular and irregular verbs, using so & neither, and adverbs, degrees of comparison, conjunctions and interjections, kinds of letter (S) with general exercises. Also, accurate description of the nature of vocabularies and idioms used by the chemical engineers and that the student needs in his/her academic and/or in his/her professional career by means of applying two reading passages focus mainly on studying the chemical engineer work in the factories as well as equipment, tools and materials used.

Course Text

3- The language of chemical engineering in English, Roy V. Hughson (1979), Regents publishing company, Inc.
4- New headway plus (English Course), Liz & John Soars (2014), Oxford University press.

Other support books :-

3- Life Lines workbook (Pre-intermediate and Intermediate level), Tom Hutchinson (2007), Oxford University press.
4- English in a simplified way, Tahir Al- Bayati (1991), Baghdad.

Course Objectives: at the end of the semester the student should be able to :-

The objective of this course focuses on:

1-In-depth understanding and comprehension of the essential grammars in the English language that usually used in writing and/or speaking with choosing the correct way of speaking and/or listening the vocabulary (phonetics and spelling) by the use of common phrases and words.

2-Also, focus on the use of technical English (reading passages) as a heart of chemical engineer work, such as what chemical engineers do, research and development.

3- The development of the student's ability to apply and arrange knowledge in English language and thus become able to employ them appropriately in his/her daily dealing without the complexity.

4- As well, encourage students to develop their capabilities in the field of English language through participation by the training on the use and improve their language.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Academic Comprehension: (Reading passages related to chemical engineering)** The first reading passage (What chemical engineers do) (Special terms or definitions, vocabulary practice - the word and its meaning, paragraphs - read and explanation, review, and discussion)	8 hr
2	**Academic Comprehension: (Reading passages related to chemical engineering)** The second reading passage (Research and development). (Special terms or definitions, vocabulary practice - the word and its meaning, paragraphs - read and explanation, review, and discussion).	8 hr
3	**English Grammar:** A general introduction to the English language and its importance as a means of communication between different peoples around the world, Review of the words, terms and phrases commonly used, Review of the simple grammars in English language, such as question and answer, the negative, The tail questions, the singular and plural, the numbers, telling the date, and telling the time, Nouns, pronouns, the verb to be, the verb to have, the verb to do, Adjectives and regular and irregular verbs, Reading and writing grammars that include short forms and words with two different meanings, the use of so & neither, and adverbs, Degrees of comparison,Conjunctions and interjections with general exercises, Kinds of letter (S) with general exercises.	14 hr

University of Technology
Department of Chemical Engineering

Program	***Chemical Engineering and Oil Pollution***					
Course Code	**CES.E.121**	Credits hr				Units
Course Title	Mathematics I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematic of secondary school	**2**	**-**	**1**	**3**	**2**

Course Description

Introduction to functions, limits, Special functions, Derivatives, Chain rule, and their applications. Introduction to integral calculus, Methods of integration.

Course Text

1- Thomas Calculus, by George B.Thomas, Jr, Elevnth Edition Media Upgrade 2018"

Other support books:-

2- Engineering Mathematics for Semesters I and II, by C.B. Gupta, S.R. Singh, M. Kumar, 2015.
3- Advanced Engineering Mathematics, Fifth Edition, by C.Raywylie, Louis C. Barrett, 1982.
4- Mathematical Methods in chemical Engineering, Second Edition, by V.G. Jenson and G.V. Jeffreys, 1977.

Course Objectives : at the end of the semester the student should be able to :-

1- To develop an understanding with the concepts of calculus and analytic geometry and the applications of these concepts to the solution of engineering problems.
2- Provide practice at developing critical thinking skills, solving open ended problems and to work in teams.
3- Develop a deep understanding of issues related to the basic principles of calculus, and how to solve problems in chemical engineering

Topics Covered (Syllabus)/ Mathematics I

No.	Contents	Duration
1	**Functions** • Absolute value, • Coordinates of the plane, • Slope of lines and angle of inclination, • Functions and graph of the functions, • Domain and range, • Identifying functions, sum, differences, products and quotients, • Composite functions, • Shifting a graph of a function, • Scaling and reflecting a graph of a function,	**9 hr**

2	**Transcendental functions** • Logarithmic and exponential functions, • Trigonometric functions, • Inverse trigonometric functions.	**6 hr**
3	**Derivatives** • Definition, • Chain rule, • Derivative of inverse trigonometric functions, • Derivative of exponential and logarithmic functions, • L, hopitals rule, • Partial derivative, • Function of two or more variables.	**9 hr**
4	**Determinates and Matrices** • Definition, • Determinate evaluation, • Solution of system of linear equation by matrix; (Inverse of matrix, Gauss elimination), • Rank of matrix, • Eigen value and Eigen vectors.	**6 hr**

Universityof Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical Engineering and Oil Pollution</td></tr>
<tr><td>Course Code</td><td>CES.E.123</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Chemistry</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Chemistry of Secondary School</td><td>2</td><td>2</td><td>0</td><td>4</td><td>3</td></tr>
</table>

Course Description

Fundamentals of atoms, molecules, Quantitative analysis, Environmental, Transition Metal Chemistry and Spectroscopic Techniques which are mostly used in all other chemical engineering courses

Course Text

1- Skoog, D.A., West D.M., Holler F.J., and Crouch S.R. "Fundamentals of analytical chemistry",8th edition, brooks/Cole Cengage Learning. 2004

Other support books:-

2- Harrison, R.M," Understanding An Introduction to Environmental Chemistry and Pollution",3rd edition, The Royal Society of Chemistry 1999
3- Atkins, P., de Paula, J."Physical Chemistry"8th edition, W. H. Freeman and Company.2006
4- Huheey, J. E. "Inorganic Chemistry: Principles of Structure and Reactivity", 4th edition, Prentice Hall. 1997

Course Objectives: at the end of the semester the student should be able to :-

1-Students will learn to use the language of chemistry: symbolic representation, nomenclature, and terminology.
2-Students will learn to think about chemical reactions and chemical and physicalproperties at the particulate level and will be able to visualize and depict thestructure of matter and its reactions at the microscopic (atomic and molecular) level.
3- Students will gain a conceptual understanding of and will be able to perform quantitative problem-solving skills in atomic structure, Stoichiometry, chemical equilibria, and electrochemistry.
4-Students will be able to use their knowledge to analyze and construct solutions by instruments

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Safety dealing with chemicals** Personal practice in lab material safety Data sheet chemicals product label GHS labeling	**4 hr**
2	**Quantitative analysis:** Atomic weight, Molecular formula, Chemical equations, Mole concept،Chemical, equilibrium, equilibrium constants, Preparation and properties،Molarity, Normality, ppm, pH, POH, Buffers, Solubility Ksp, Gravimetric Analysis, Precipitation reaction, Potentiometric Titration, Complex Titration.	**16 hr**

3	**Photochemistry and Spectroscopic Techniques:** Photo-excitation of organic molecules, Jablonski diagram, Laws ofphotochemistry and quantum yield, Some examples of photochemicalreactions, Chemistry of vision and other applications of photochemistry.	**2 hr**
4	**Environmental:** Introduction,Water, air, soil pollution	**8 hr**

Practical: (Chem. lab.)

No.	Experiment Name
1.	**Introduction and chemical safety basic rules**
2.	**Equipment and how to use it**
3.	**Preparation of standard solution (primary and secondary)**
4.	**Direct Titration**
5.	**Quantitative determination of a carbonate and hydroxide in mixture**
6.	**Back titration**
7.	**Titration Curves**
8.	**Determination of Chloride Ions in Water**
9.	**Standardization of $KMnO_4$ and the determination of ferrous sulfate (Redox reaction)**
10.	**Determination of Hardness of Water**
11.	**Paper Chromatography**
12.	**Qualitative analysis silver group**

<table>
<tr><td>Program</td><td colspan="6">Chemical Engineering and Oil Pollution</td></tr>
<tr><td>Course Code</td><td>CES.E.125</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Physics of Environmental Engineering</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Physics of secondary school</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td></tr>
</table>

Course Description

This course aims to help students acquire the knowledge and understand concepts, fundamental laws, principles, and processes in physics necessary for students who intend to complete their bachelor's degree in the chemical engineering department.

Course Textbooks

3. Shipman, James, Jerry D. Wilson, Charles A. Higgins, and Bo Lou. An introduction to physical science. Cengage Learning, 2013.
4. Principle of Physics, Kinetic Books Company, 2007.

Course Objectives: at the end of the semester, the student should be able to understanding:-

9. Determine the components of linear motion (displacement, velocity, and acceleration).
10. Solve problems involving forces and work.
11. Apply Newton's laws to physical problems.
12. Identify the different types of energy.
13. Solve problems using principles of conservation of energy.
14. Define the principles of momentum and collisions.
15. Use principles of momentum to solve problems.
16. Problems solving ability, e.g., analyzing a situation or data, establishing a relationship between cause and effects.

Topics Covered (Syllabus)/ Physics

No.	Contents	Duration
1	**Motion in One Dimension** • Position • Displacement • Velocity • Acceleration • Derivation: creating new equations • Motion equations for constant acceleration • Free-fall acceleration	2 hr

2	**Properties of matter** • Elasticity • Surface Tension • Viscosity	**2 hr**
3	**Force and Newton's Laws:** • Force • Newton's first law • Gravitational force: weight • Newton's second law • Newton's third law • Normal force • Tension • Newton's second and third laws • Free body diagram • Static and kinetic friction • Hooke's law and spring force • Air resistance	**6 hr**
4	**Applications of Newton's Laws** • Presenting and solving on Newton's Laws	**2 hr**
5	**Work, Energy, and Power:** • Energy • Kinetic energy • Work-kinetic energy theorem • Power • potential energy • Work and gravitational potential energy • Conservation of energy	**4 hr**
6	**Momentum** • Linear momentum • Conservation of momentum • Collisions	**2 hr**
7	**Thermodynamics** • Temperature and Heat • Temperature and thermometers • Temperature scales • Temperature scale conversions • Heat • Zeroth law of thermodynamics • Internal energy • Thermal expansion and its types	**4 hr**

	• Specific capacity • Phase changes • Latent heat • Modes of heat transfer • Global warming and the greenhouse effect	
8	**Modern Physics** • Electron, thermionic, emission, photoelectric emission, • X-ray • The nucleus • Structure of nucleus and atom • Radioactivity • Nuclear energy • Ionizing radiation • Health hazards	4 hr
9	**Environmental Physics** • Energy and environment • pollution	4 hr

University of Technology
Department of Chemical Engineering

Program	***Chemical Engineering and Oil Pollution***					
Course Code	**CES.E.126**	Credits hr				Units
Course Title	Engineering Drawing					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	None	**1**	**2**	**---**	**3**	**2**

Course Description

Introduction in Engineering drawing, engineering drawing applications, engineering process , analysis model to view and study the full and half sections, conclusion of the third projection, draw isometric and oblique.

Course Text

1- الرسم الهندسي تأليف (عبد الرسول الخفاف) الطبعة الثانية 1993

2- R.P Hoelscher and C.H Springer "Engineering Drawing and Geometry ".2nd edition

Course Objectives: at the end of the semester the student should be able to :-

1- The students can be use Tools Drawing in draw and analyze geometric shapes
2- Enable students to draw devices, equipment & PFD in chemical engineering.

Topics Covered (Syllabus)/ Course Title

No.	**Contents**	**Duration**
1	Introduction	**3 hr**
2	Planning of Drawing paper	**3 hr**
3	Types of line	**3 hr**
4	Engineering operation	**3 hr**
5	Projection Drawing	**3 hr**
6	First angle projection	**3 hr**
7	Third angle projection	**3 hr**
8	Full section	**3 hr**
9	Half section	**3 hr**
10	The finding of third view	**3 hr**
11	Application Example	**3 hr**
12	Pictorial Drawing (Isometric and Oblique)	**3 hr**
13	Application Example	**3 hr**
14	Dimensions	**3 hr**
15	Examples of chemical engineering drawing and exercises.	**3 hr**

Universityof Technology
Department of Chemical Engineering

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.113**	Credits hr				Units
Course Title	**Computer Science**					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	None	**1**	**2**	**---**	**3**	**2**

Course Description

This course provides an overview of the Operating Systems, Types Of Operating Systems, Computer Operating Systems, Smartphone Operating Systems, operating system Windows 7, Windows 7 is a series of personal computer operating systems produced by Microsoft as part of its Windows NT family of operating systems. It is the successor to Windows 8.1, and was released to manufacturing on July 15, 2009, and broadly released for retail sale on July 29, 2010and the program of Microsoft Office 2010, Microsoft Office 2010, Microsoft Excel 2010. we an overview the Visual Basic and includes the operation of Visual Basic and describe the elements of the design environment and user interface design and the difference between the project and the program and introduce students to the philosophy of programming using visual Basic and a programming process events Event-Driven Programming and programming objects Object Oriented Programming and gives the student an introduction to object-oriented programming and introduce students to the fundamental differences between the concept of the programming language BASIC visual and languages BASIC traditional and explain the steps to design and program planning.

Course Text

1- David a. "How computer hardware and software work" 2009.
2- Introduction to windows 7
3- Sabgayyeshi " basic networking tutorial",2011
4- IC3"Key applications using Microsoft office 2010
5- “Visual Basic: Crash Course - The Ultimate Beginner's Course to Learning Visual Basic Programming”, 3rd Edition, A. Tannenbaum, Prentice-Hall, 1996
6- Bryan Newsome Worx "Beginning Visual Basic" USL Press, | December 2003 | ISBN-10: 1119092116 |
7- “Course Notes for Learn Visual Basic 6.0”, 4th Edition, F. Halsall, Addison-Wesley, 2000.

Course Objectives: at the end of the semester the student should be able to :-

1- Learn how to turn on the Windows operating system windows
2- Start Microsoft Office applications and work with the Microsoft Office interface Create documents in Microsoft Word. Create workbooks in Microsoft Excel.
3- Learn how to deal with the web and how to navigate
4- Define and modify the properties and methods associated with an object

5-	Load, modify, and save changes made to forms and projects in the Visual Basic environment
6-	Define and implement form objects including data arrays, control arrays, text boxes, message boxes, dialog boxes, labels, controls, menus, frames, picture boxes, pull-down menus, and combo boxes

Topics Covered (Syllabus)/ Computer Programming (I)

No.	Contents	Duration
1	**Operating Systems:** Types Of Operating Systems, Computer Operating Systems, Smartphone Operating Systems	1 hr
2	**Windows 7:** the operating system Windows 7, Computer Fundamentals: (Computer components, types, operations, Computer Fundamentals: (hardware units, software types), numeric systems, **I**ntroduction to Windows, Desktop, Desktop icons, change desktop properties, taskbar and toolbars, start menu basics, context menu, operation in window, control panel features.	1 hr
3	**Microsoft office World 2010:**Introduction to the office system, Microsoft World, Microsoft World, Program Interface and how to write scripts, Microsoft World, Text Processing and typesetting	1 hr
4	**Microsoft Excel 2010:** Program Interface, how statistical tables and graphs work, Microsoft Excel 2010, How to use mathematical and statistical functions	1 hr
5	**Introduction to Visual Basic Programming** Menu bar, Tools bar, Project explorer, Tool box, Properties windows, Form, Code, Controls, Command Buttons, Label, Textbox, Pointers, Picture box, frame, Naming Controls, Properties for controls: Height, Width, Left, Top, Font, Forecolor, Backcolor , Name, Caption, Text, and Visible, Events, Saving Visual Basic Project, Examples, Chemical Engineering Applications.	1 hr
6	**Mathematics** Arithmetic Operations: +, , *, /, \, mod, ^. (Using Simple Example for each Operation), Logical Operations. AND, OR, NOT. And the Truth Table for each Operation, (Using Simple Example for each Operation), Relational Operation: >, <, >=, <=, <>, =, String Concatenation (&), Operation Precedence. For all arithmetic, logical, relational operators, Print statement and Formatting. Illustrate (colon, comma, and semicolon), Examples: Chemical Engineering Applications **Built in Functions:** Built-in math functions, Abs(x), Int(x), Rnd(x), sgn(x), sqr(x), str(x), val(x), round (x,n), CInt (x), Fix (x), String Functions, Input Box, Msg Box, Examples: Chemical Engineering Applications.	1 hr

7	**Selection Structure** Single Selection: If/Then structure, Double Selection: If/Then/Else structure, Nested If/Then/Else structure, Select Case Multiple Selection Structure, Examples: Chemical Engineering Applications.	1 hr
8	**Reputation Structure:** For ... Next Loop, while ... Wend, Do.... While ... Loop, Do ... Loop Until, Exit Do, Exit For Examples: Chemical Engineering Applications.	1 hr
9	**Variables** Data Types: Boolean, Integer, Long, Single, Double, String, Valid Naming of Variables, Initial Value for each Type of the Variables (Initial Value for each Data Type), Size of each Variable Type in Bytes, How to Declare Variables. (Dim statement).	1 hr
10	Using: Dim variable name As Data type, Using Suffix: Integer, Long, Single, Double, String, Constant Variable. Examples: Chemical Engineering Applications.	1 hr
11	**Arrays** Introduction: Defining Arrays, Array Declaration Statement, Assigning Values for Arrays (i.e., Filling array's element value either by loop or by direct assignment statement), Re Dim Statement, Using Loops with Arrays. (i.e. writing an application on array using loops), Two Dimensional Arrays, Operations on Arrays,	2 hr
12	Fill Array Elements with Random Numbers usingand Function, Sorting, Searching. (i.e., Linear search), Swapping Two Elements. Examples: Chemical Engineering Applications.	1 hr
13	**Graphics in Visual Basic:** Graphics control, Picture box, Image box, Coordinate system, Pixel,	1 hr
14	Graphics methods (Line, Circle, pset) Examples: Chemical Engineering Applications.	1 hr

Laboratories: (comp. sci.)

No.	Contents
1	**Windows 7:** the operating system Windows 7, Computer Fundamentals: (Computer components, types, operations, Computer Fundamentals: (hardware units, software types), numeric systems. **I**ntroduction to Windows, Desktop, Desktop icons, change desktop properties, taskbar and toolbars, start menu basics, context menu, operation in window, control panel features.
2	Microsoft office, Introduction to the office system, Microsoft World, Program Interface and how to write scripts, Text Processing and typesetting
3	Microsoft Excel 2010, Program Interface, How statistical tables and graphs work
4	Microsoft Excel 2010, How to use mathematical and statistical functions
5	Operating Systems, Types Of Operating Systems
6	Computer Operating Systems, Smartphoneoperating Systems
7	**Introduction to Visual Basic Programming:** Menu bar, Tools bar, Project explorer, Tool box, Properties windows, Form, Code, Controls, Command Buttons, Label, Textbox, Pointers, Picture box, frame, Naming Controls, Properties for controls: Height, Width, Left, Top, Font, Forecolor, Backcolor, Name, Caption, Text, and Visible, Events, Saving Visual Basic Project, Examples, Chemical Engineering Applications.
8	**Mathematics** Arithmetic Operations: +, , *, /, \, mod, ^. (Using Simple Example for each Operation), Logical Operations. AND, OR, NOT. And the Truth Table for each Operation, (Using Simple Example for each Operation), Relational Operation: >, <, >=, <=, <>, =, String Concatenation (&), Operation Precedence. For all arithmetic, logical, relational operators, Print statement and Formatting. Illustrate (colon, comma, and semicolon), Examples: Chemical Engineering Applications
9	**Built in Functions:** Built-in math functions, Abs(x), Int(x), Rnd(x), sgn(x), sqr(x), str(x), Val(x), round(x,n),CInt(x),Fix(x),String Functions, InputBox, MsgBox, Examples: Chemical Engineering Applications.
10	**Selection Structure:** Single Selection: If/Then structure, Double Selection: If/Then/Else structure, Nested If/Then/Else structure, Select Case Multiple Selection Structure, Examples: Chemical Engineering Applications.
11	For... Next Loop, while ... Wend, Do.... While ... Loop, Do ... Loop Until, Exit Do, Exit For Examples: Chemical Engineering Applications.

12	**Variables** Data Types: Boolean, Integer, Long, Single, Double, String, Valid Naming of Variables, Initial Value for each Type of the Variables (Initial Value for each Data Type), Size of each Variable Type in Bytes, How to Declare Variables. (Dim statement), Using: Dim variable name As Data type, Using Suffix: Integer, Long, Single, Double, String, Constant Variable. Examples: Chemical Engineering Applications.
13	**Arrays:** Introduction: Defining Arrays, Array Declaration Statement, Assigning Values for Arrays (i.e., Filling array's element value either by loop or by direct assignment statement), Re Dim Statement, Using Loops with Arrays. (i.e., writing an application on array using loops), Two Dimensional Arrays, Operations on Arrays, Fill Array Elements with Random Numbers using and Function, Sorting, Searching. (i.e., Linear search), Swapping Two Elements. Examples: Chemical Engineering Applications
14	**Graphics in Visual Basic:** Graphics control, Picture box, Image box, Coordinate system, Pixel, Graphics methods (Line, Circle, pset) Examples: Chemical Engineering Applications.

Universityof Technology
Department of Chemical Engineering

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.112**	Credits hr				Units
Course Title	Technical English II					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Technical English I	**2**	**-**	**-**	**2**	**2**

Course Description

Define a special knowledge and basic concepts in English language, review of phonetics and spellingwith words and sounds that need attention in understanding the meaning and pronunciation, the fundamental principles of grammars utilized in English language such as the use of the prefixes (un, im, in, and dis), the use of since & for, the definite and indefinite articles. As well as simple, continuous and perfect tenses (present, past, and future), the punctuation, active voice and passive voice, direct and indirect speech, finite and non-finite verbs, analyses and kinds of sentences. Also, accurate description of the nature of vocabularies and idioms used by the chemical engineers and that the student needs in his/her academic and/or in his/her professional career by means of applying two reading passages focus mainly on studying the chemical engineer work in the factories as well as equipment, tools and materials used.

Course Text

1- The language of chemical engineering in English, Roy V. Hughson (1979), Regents publishing company, Inc.
2- New headway plus (English Course), Liz & John Soars (2014), Oxford University press.

Other support books :-

1- Life Lines workbook (Pre-intermediate and Intermediate level), Tom Hutchinson (2007), Oxford University press.
2- English in a simplified way, Tahir Al- Bayati (1991), Baghdad.

Course Objectives: at the end of the semester the student should be able to :-

The objective of this course focuses on:

1- Study and conception of the advance grammars in the English language that usually employed in academic writing and also explain the use of grammars correctlyin speaking and/or listening the vocabulary (phonetics and spelling) via increasing the ability to rapid recognize the words that have two different meanings depending on their presence in the context of speech

2- Accurate description of the nature of vocabulary and idioms used by the chemical engineers in dealing with their respective fields in addition to the vocabulary of daily dealing. Also, focus on the use of reading passages such as process design and plant operation, which are related to student competence and his/her profession as an engineer in the chemical companies.

3- Enhancement of student's ability by applying modern information in English language about the characteristics of the chemical engineer job and then try to the simulation that in writing the scientific report, expression, and formulate of simple sentences and complex ones without the difficulty.

4- Finally, promote the qualifications of students in the field of English language by training on the use and the progress of their language in order to allow them to easily use it in his/her future academic study in chemical engineering.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Academic Comprehension: (Reading passages related to chemical engineering):** The third reading passage (Process design) (Special terms or definitions, vocabulary practice - the word and its meaning, paragraphs - read and explanation, review, and discussion)	8 hr
2	**Academic Comprehension: (Reading passages related to chemical engineering):** The fourth reading passage (Plant operation). (Special terms or definitions, vocabulary practice - the word and its meaning, paragraphs - read and explanation, review, and discussion).	8 hr
3	**English Grammar:** Phonetics & Spelling (consonant sounds & vowel sounds), Words and sounds that need attention in understanding the meaning and pronunciation, as well as the use of the prefixes (un, im, in, and dis), the use of since & for, as well as the definite and indefinite articles,Punctuation (such as the use of the capital letter, the question mark, and the comma….etc), Simple tenses (present, past, and future), Continuous and perfect tenses (present, past, and future), Active voice and passive voice, direct and indirect speech, Finite and non-finite verbs, Analyses of sentences, and kinds of sentences (either according to form or to number of statements).	14 hr

University of Technology
Department of Chemical Engineering

Program	**Chemical Engineering and Oil Pollution**					
Course Code	**CES.E.122**	Credits hr				Units
Course Title	Mathematics II					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematics I	**2**	**-**	**1**	**3**	**2**

Course Description

Definite integral and applications, Polar coordinates, Vector analysis, Determinant and matrices

Course Text

5- Thomas' Calculus, by George B. Thomas, Jr., Fourteenth Edition, Media Upgrade 2018.
Other support books: -
6- Engineering Mathematics for Semesters I and II, by C.B. Gupta, S.R. Singh, M. Kumar, 2015.
7- Advanced Engineering Mathematics, Fifth Edition, by C.Raywylie, Louis C. Barrett, 1982. Mathematical Methods in chemical Engineering, Second Edition, by V.G.Jenson and G.V. Jeffreys, 1977.

Course Objectives : at the end of the semester the student should be able to :-

1- To understand these concepts of applications and how to evaluate volumes, surface area , and to understand analytic geometry.
2- Provide practice at developing critical thinking skills, solving open ended problems and to work in teams.
3- Develop a deep understanding of issues related to the basic principles of polar coordinates, vector analysis, determinants, and how to solve problems in chemical engineering

Topics Covered (Syllabus)/ Mathematics II

No.	Contents	Duration
1	**Integration** • Indefinite integration, • Integration of inverse trigonometric functions, • Integration methods; (substitution, by part, trigonometric substitution, partial fraction).	12 hr
2	**Definite integration and Applications** • Double integrals, • Reverse order of integration, • Length of curves, • Surface area, • Volumes	9 hr

3	**Vector Analysis** • Definitions, • Properties, • Vector in space, • Scalar and cross product of vector, • Product of three vectors.	**9 hr**

<table>
<tr><td>Program</td><td colspan="6">Chemical Engineering and Oil Pollution</td></tr>
<tr><td>Course Code-</td><td>CES.E.131</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course title</td><td>Chemical Engineering Principles I</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Mathematic I
Chemistry I</td><td>3</td><td>-</td><td>1</td><td>4</td><td>3</td></tr>
</table>

Course Description

Understanding the basic concepts and expressions in chemical engineering and learning calculations related to chemical reactions, material balance, gases and vapours.

Course Text

- D.M.Himmelblau and J.B.Riggs, Basic Principles and Calculations in Chemical Engineering, 7th Edition, 2004.
- R.M. Felder and R.W.Rousseau, Elementary Principles of Chemical Processes, 3rd Edition, 2005.

Other support books :-

Skogestad, S. (2008). Chemical and energy process engineering. CRC press.

Course Objectives: at the end of the semester the student should be able to:-

4- Have a deep knowledge, wide scope and improved understanding of the mechanisms in heat balance as well as a better insight into analytical and empirical methods applied in analysis of material balance related problems.

5- Gain knowledge for applying the material (equation) balance in chemical engineering problems.

6- To provide experience for students to solve material balance for different process

Topics Covered (Syllabus)

No.	Contents	Duration
1	**General Knowledge of Chemical Engineering** ➢ Definition of chemical engineering. ➢ Chemical process industries (CPI). ➢ Generalized chemical process. ➢ flow sheet and block diagram of a chemical process ➢ The difference between the chemist and the chemical engineer.	**6 hr**

2	**Physical and Chemical Principles** ➢ Units and Dimensions ➢ Operations with Units ➢ Addition, Subtraction, Equality ➢ Multiplication and Division ➢ Conversion of Units and Conversion Factors ➢ Dimensional Consistency (Homogeneity) ➢ Nondimensional Groups:	**12 hr**
3	**Concepts of flow rates, density, specific gravity, temperature and pressure** ➢ Four types of temperature ➢ Temperature Conversion ➢ Heat capacity ➢ Pressure and Its Units ➢ Types of pressures ➢ Measurement of Pressure	**15 hr**
4	**Introduction to Material Balances** ➢ The Concept of a Material Balance ➢ Open and Closed Systems ➢ Steady-State and Unsteady-State Systems ➢ Multiple Component Systems	**12 hr**

University of Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical Engineering and Oil Pollution</td></tr>
<tr><td>Course Code</td><td>CES.E.124</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Bio-Chemistry</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Chemistry</td><td>2</td><td>2</td><td>0</td><td>4</td><td>3</td></tr>
</table>

Course Description

Fundamentals of biochemistry-chemical basis of life and in environmental

Course Text

1- Lehninger A.L., Nelson D.L., Cox, M.M. "Principles of Biochemistry, Worth Publishers ,2004

Other support books :-

1-S.C. Bhatia Environmental pollution and control in chemical process industries, KHANNA publishers 2011

2- Weiner, R. F. “environmental engineering" 4th edition Elsevier Science 2003.

Course Objectives: at the end of the semester the student should be able to:-

After this course students should be able to understand basic chemical processes in the cell as well as their environmental effects

Topics Covered (Syllabus)

No.	Contents	Duration
1	**Definition of biochemistry-chemical** basis of life, polymeric biomolecules and their monomeric building blocks1	**2 hr**
2	**Carbohydrates:** Classification, Monosaccharide, disaccharide, Oligosaccharides, Polysaccharides	**4 hr**
3	**Lipids:** fatty acid, waxes, phospholipids, prostaglandins, triacylglycerols, steroids, lipophilic Vitamins	**4 hr**
4	**amino acids**: Amino Acid Polymers, proteins, Derivatives, Peptide Bonds	**4 hr**
5	**nucleic acids:** Types, Nucleosides, Nucleotides, Deoxyribonucleic Acid, Ribonucleic Acid	**4 hr**
6	**introduction to enzymology:** classes of enzymes, enzyme specificity and mechanisms of action as well as the regulation of their activity; flow of genetic information - replication،transcription, translation and regulation of gene expression; bioenergetics and basic cellular metabolic processes	**4 hr**

7	**Environmental Implications of Food** Fats, oils, Carbohydrates, proteins, vitamins, fertilizers.	4 hr
8	**Global problems:** Fossil Fuel energy and global warming, Greenhouse Effect	4 hr

Practical: (Bio. Chem. lab.)

No.	Experiment Name
1	**Introduction to Techniques Experiment 1A Use of Pipetmen**
2	**Specific identification of sugars - I**
3	**Specific identification of sugars –II**
4	**Specific identification of lipids- I**
5	**Specific identification of lipids**
6	**Specific identification of amino acid**
7	**Specific identification of protein**
8	**Protein Purification (chromatography)**

<table>
<tr><td>Program</td><td colspan="6">Chemical Engineering and Oil Pollution</td></tr>
<tr><td>Course Code</td><td>CES.E.127</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>AutoCAD</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Computer Programming
-Eng. Drawing</td><td>1</td><td>2</td><td>---</td><td>3</td><td>2</td></tr>
</table>

Course Description

introduction , AutoCAD program components and how to use it , knowing AutoCAD commands like point , lines, Rectangle, Polygon, Poly line , Arc with their option to draw 2D engineering drawing, learning Hatching, text, mtext , Dimension creation and editing , Modify command and Layers for 2D engineering drawing.
3D drawing methods: Surfaces, Solids and Composite solid.
Render, background, lights for drawing.

Course Text

1-Terry T. Wohler, applying AutoCAD 2002 fundamentals, Glencoe /McGraw-Hill
2-James A. Leach, AutoCAD 2002 Companion Essentials of AutoCAD plus Solid modeling ,2003 , McGraw-Hill, Boston
3- Terry T. Wohler, applying AutoCAD a step by step approach for AutoCAD release 13, 1996, Glencoe McGraw-Hill
4- James A. Leach, AutoCAD 14 Companion Essentials of AutoCAD plus Solid modeling ,1999,WCB / McGraw-Hill, Boston
Other support books :-
David Byrnes and Mark Middlebrook, AutoCAD® 2007 For Dummies , Wiley Publishing, Inc
5-2001 الرسم بمساعدة الحاسوب أ.م علي حسين علي م. فادي جنان جبرائيل م. وليد يوسف شهاب

Course Objectives : at the end of the semester the student should be able to :-

1- The students can use AutoCAD program and produce 2D and 3D chemical engineering drawings.
2- Enable students to draw designed equipment in AutoCAD program.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	Introduction, Drawing program screen components, Setting drawing limits, Units, Grid and snap, Zoom, Orthogonal, Osnap, UCS. 2D drafting: Cartesian system coordinate, AutoCAD drawing command:	**1 hr**
2	Point, Line: line, multi-line, construction line, drawing line by using: absolute coordinate, polar coordinate, relative coordinate, Example	**1 hr**
3	Continuous line drawing: Rectangle, Polygon, Poly line with their options, Example	**1 hr**

4	Curves drawing: Arc, Circle, point –SP line, Ellipse with their options, Example.	1 hr
5	Hatching, text command: text, mtext, Example	1 hr
6	Dimension creation and editing, Example	1 hr
7	Region, block, insert block, Example	1 hr
8	Modify command: 1-coy tool: copy, mirror, offset, array. 2- Erase tool: erase, trim, break .3-move tool: move, rotate .4- Change tool: stretch, Lengthen, Extend, Scale, Chamfer and Fillet 5-Explode, Example	1 hr
9	Layers: Create a new layer ,rename layer, active layer, run and extinguishing layers freezing layers, Lock and open layers, the color Font type Line width Example	1 hr
10	3D drawing methods: Surfaces drawing: box, Wedge, Pyramid, Dome, Sphere, Cone, Torus, Dish, Example	1 hr
11	3D drawing methods: Solids: box, Cylinder, Sphere, Cone, Wedge, Torus, Example	1 hr
12	Composite solid: Union, Subtraction, Intersection, Example	1 hr
13	Examples of chemical engineering drawing and exercises	1 hr
14	Examples of chemical engineering drawing and exercises	1 hr
15	Examples of chemical engineering drawing and exercises	1 hr

Practical: (AutoCAD. lab.)

No.	Experiments
1-	**Drawing rectangular using lines in absolute coordinate, polar coordinate, relative coordinate**
2-	**Drawing line, rectangular, polygon**
3-	**Drawing Arc, Circle, point –SP line, Ellipse**
4-	**Drawing of geometry shape and applied Hatching, text command**
5-	**Drawing simple 2D shape and applying Modify commands such as copy, mirror, offset, array , trim, move, rotate , stretch, Lengthen, Extend, Scale, Chamfer, and Fillet**
6-	**Drawing a simple 2D chemical engineering drawing and applied layers.**
7-	**Drawing chemical engineering Applications**
8-	**Drawing chemical engineering Applications**

Universityof Technology
Department of Chemical Engineering

Program	***Chemical Engineering and Oil Pollution***					
Course Code	**CES.E.128**	Credits hr				Units
Course Title	Engineering Mechanics and Strength of Materials					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Physics for environmental	**2**	**-**	**1**	**3**	**2**

Course Description

This class focuses on the following topics, including principles of equilibrium of a force system, Moment of a force, Centroid and center of gravity, Analysis of internal force, Strain, Stress-strain diagram, Hook's law, Shearing deformation, Poisson's ratio, Volumetric strain, Thin-walled cylinders, Thermal stress, Shear and bending moment in the beam.

Course Text

1- Engineering Mechanic-Statics and Dynamics volume 1; Higdon, A. and Stiles, W.B., 3^{ed} Edition, Prentice-Hall, India, (1968).
2- Strength of Materials; Singer, F.L. and Pytel, A., 3^{ed} Edition, Harper and Row, London, (1980).
3. Hibbeler, R. C. (2016). Engineering Mechanics: Statics, 14th SI Edition.

Course Objectives: at the end of the semester, the student should be able to:-

3. This class is designed to study the effects of external forces on a group of solid objects.
4. This class is designed to study the resistance of materials and their applications in chemical engineering.

Topics Covered (Syllabus)/ Engineering Mechanics and Strength of Materials

No.	Contents	Duration
1	**Equilibrium of rigid bodies**	**3 hr**
2	**Moment of a Force** Moment about a point, Resultant moment of multiple forces, Moment of Couple	**3 hr**
3	**Centroid and Center of Gravity**	**3 hr**
4	**Introduction Force in Rigid Bodies:** Definitions of Stress and Strain, Stress-Strain Diagrams	**2 hr**
5	**Proportional Limits:** Elastic limit, Stiffness elasticity, Plasticity, Hardness and working stress.	**4 hr**
6	**Hook's Law**	**3 hr**
7	**Poisson Ratio, Composite Stresses:** Volumetric Stress, Bulk Modulus, Thin-Walled Cylinders	**4 hr**
8	**Thermal Stress**	**4 hr**
9	**Shear and Bending Moments in Beam**	**4 hr**

Program	Chemical Engineering and Oil Pollution					
Course Code	CES.E.116	Credits hr				Units
Course Title	Human Rights & Democracy					
Term	2^{st} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	None	2	-	-	2	2

Course Description

The concept of human rights Characteristics of human rights _ Human rights groups _ The relationship between human rights and other concepts.and
The study of the democracy concept and history and is relationship to religions and relationwith development also the advantages and the disadvantages of democracy

Course Text

1. عبد الكريم خليفة، القانون الدولي لحقوق الإنسان، بدون طبعة الإسكند رية: دار الجامعة الجديدة، 2013
2. مبادئ و قواعد عامة في حقوق الأنسان , د. صلاح حسن مطرود
3. د. محمد علي الشجيري ، حقوق الأنسان بين الأسلامي و العالمي
4. د. زكريا أبراهيم ، مشكلة الحرية
5. د. ماهر صلاح الجبوري ، حقوق الأنسان و الديمقراطية
6. د.سعدون هليل. الطبقة الوسطى والتحول الديمقراطي.
7. د.جورج طرابيشي. الديمقراطية والحداثة.

Course Objectives : at the end of the semester the student should be able to :-

1-Define the concept of human rights and their characteristics
2-To promote the culture of human rights in society

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	Introduction to Human Rights Human Rights and Secularism	2 hr
2	The concept of human rights Positions of the Arab intellectual currents of human rights	2 hr
3	Characteristics of human rights The future of human rights	2 hr
4	Human Rights and Islam Human Rights Classification	2 hr
5	Human Rights in Ancient Civilizations Human rights between universality and privacy	2 hr

6	Human rights sources and Human Rights and Globalization	**2 hr**
7	Universal Declaration of Human Rights Human rights and political parties	**2 hr**
8	Human Rights and the Constitution of the Republic of Iraq 2005	**2 hr**
9	The concept of democracy. Characteristics and Categories forms of democracy	**2 hr**
10	The historical development of democracy Democratic systems of government	**2 hr**
11	Democracy between challenges and external pressures ideological democracy	**2 hr**
12	Democracy between privacy and universality Pros and cons of democracy	**2 hr**
13	Voting in democracies Democracy and the phenomenon of globalization	**2 hr**
14	Political freedom and the state The role of the middle class in democracies	**2 hr**
15	The relationship between the intellectual and the authority Democracy between capitalism and socialism	**2 hr**

University of Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical Engineering and Oil Pollution</td></tr>
<tr><td>Course Code</td><td>CES.E.221</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Mathematics III</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Mathematics I,
-Mathematics II</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td></tr>
</table>

Course Description

This course describes the evaluation of double, triple integrals, area and volume.Provide knowledge and skills in writing a periodic function in its Fourier series form and on their applications. Develop skills for applying this course in the future on various chemical engineering applications.

Course Text

Text book:

1. Higher Engineering Mathematics by Dr.B.S.Grewal, Khanna Publishers, 40th Edition, 2007.

Reference book:

1. Advanced Engineering Mathematics by Erwin Kreyszig, 8th edition, 2007.

Course Objectives: at the end of the semester the student should be able to:-

1. Able to evaluate double, triple integrals and the area, volume by double & triple integrals respectively.
2. Understand the concept of Fourier-series representation of periodic functions and their applications.

Topics Covered (Syllabus)/ Mathematics III

No.	Contents	Duration
1	**Multiple Integrals:** Double Integral, Area, Volume, Double Integral in polar coordinates, Triple Integral in rectangular coordinates, physical application of double and triple integration.	**12 hr**
2	**Function and definite Integrals:** The error function, the gamma function, the beta function, factorial function.	**6 hr**
3	**Infinite Sequences and Series:** Sequences, Convergence, Geometric series, nth partial sum, tests of convergence, alternating series, power and Taylor's series.	**6 hr**
4	**Fourier series:** Periodic functions, Fourier series, Even and odd functions, Half range expansion.	**6 hr**

<table>
<tr><td>Program</td><td colspan="6">Chemical Engineering and Oil Pollution</td></tr>
<tr><td>Course Code-</td><td>CES.E.231</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course title</td><td>Chemical Engineering Principles II</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Chemical Engineering Principles I</td><td>2</td><td>–</td><td>1</td><td>3</td><td>2</td></tr>
</table>

Course Description

Understanding the basic concepts and expressions in chemical engineering and learning calculations related to chemical reactions, material balance, gases and vapours.

Course Text

- D.M.Himmelblau and J.B.Riggs ,Basic Principles and Calculations in Chemical Engineering ,7th Edition , 2004 .
- R.M.Felder and R.W.Rousseau ,Elementary Principles of Chemical Processes ,3rd Edition ,2005 .

Other support books :-

Skogestad, S. (2008). Chemical and energy process engineering. CRC press.

Course Objectives: at the end of the semester the student should be able to:-

1- Have a deep knowledge, wide scope and improved understanding of the mechanisms in heat balance as well as a better insight into analytical and empirical methods applied in analysis of material balance related problems.
2- Gain knowledge for applying the material (equation) balance in chemical engineering problems.
3- To provide experience for students to solve material balance for different process

University of Technology
Department of Chemical Engineering

Topics Covered (Syllabus)

No.	Contents	Duration
1	**Systematic steps of solving material balance problems:** ➢ Material balances without chemical reactions. ➢ Material balances with chemical reactions. ➢ Species Material Balances ➢ Processes Involving a Single Reaction ➢ Processes Involving Multiple Reactions ➢ Element Material Balances ➢ Material balances on combustion processes	4 hr
2	**Material Balances for Processes Involving Chemical Reaction** ➢ Species Material Balances ➢ Processes Involving a Single Reaction ➢ Processes Involving Multiple Reactions ➢ Element Material Balances	10 hr
3	**Material Balance Problems Involving Multiple Units, Material balances involving recycle, bypass and purge streams:** ➢ Process flow sheet ➢ Recycle without Chemical Reaction ➢ Recycle with Chemical Reaction ➢ Bypass and Purge	8 hr
4	**Gases and Vapors** ➢ Ideal gas law. ➢ Ideal gas mixtures. ➢ Real gas relationships.	4 hr
5	**Introduction to Energy Balance**	4 hr

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.233**	Credits hr				Units
Course Title	Fluid Flow I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematic I & II, Chemical Engineering Principles I	**2**	**2**	**1**	**5**	**3**

Course Text

14. Coulson, J.M and Richardson J.F. "Chemical Engineering, volume 1", Fifth edition 2002, Elsevier Science, Linacre House, Jordan Hill, Oxford
15. Coulson, J.M and Richardson J.F. "Chemical Engineering, volume 2", Fifth edition 2002, Elsevier Science, Linacre House, Jordan Hill, Oxford
16. F.A. Holland and R. Bragg "Fluid Flow for Chemical Engineers", 2nd Ed. (1995) Elsevier Ltd.

<u>Other support books :-</u>

7. DARBY. R., M. Dekker "Chemical Engineering Fluid Mechanics", 2ndEd. (2001)
8. James O. Wilkes "Fluid Mechanics for Chemical Engineers", Prentice Hall PTR, New Jersey, USA, 1999.
9. De Nevers, N. "Fluid Mechanics for Chemical Engineers", (1991) McGraw-Hill, Singapore.

Streeter and Wylie "Fluid Mechanics", McGraw-Hill, (1981).

Course Objectives : at the end of the semester the student should be able to :-

1. Recognize the incompressible fluid flow, single- and two-phase flow, fluid statics and dynamics, Newtonian and non-Newtonian fluids and essential basic hydrodynamics.

2. Define the problems in fluid dynamics in various engineering applications. Distinguish the energy variation and its applications spatially the frictional energy losses calculations and the required energy for fluid pumping.

3. Define the necessary fluid parameters of full scale projects by performing simple model experiments and share ideas and work in a team in an efficient and effective manner under controlled supervision or independently.

University of Technology
Department of Chemical Engineering

Topics Covered (Syllabus) Fluid Flow I

No.	Contents	Time
1	Introduction Definition of a fluid, and fluid mechanics. Physical properties of fluids: Density, specific gravity, viscosity, kinematic viscosity, surface tension and capillarity, bulk modulus of elasticity, Pressure & Shear stress, Newton's law of viscosity, Types of Fluids, Newtonian, non-Newtonian fluids ideal and real fluids	**3 hr**
2	Dimensional Analysis Fundamental dimensions, dimensional homogeneity, dimensionless numbers. Methods of dimensional analysis, 1- Rayleigh's method (power series) 2- Buckingham's Π- method / Theorem.	**3 hr**
3	Fluid Statics Basic concept of fluid statics, Pressure terminology, pressure (head) of liquid. Measurement of pressure: (Piezometer, Manometers, types of Manometers, Mechanical Gauges).	**3 hr**
4	Fluid Dynamics Fluid kinematics: Types of fluid flow (steady and unsteady flows, uniform and non-uniform flows, one, two, and three dimensional flows, Rotational and irrotational flows, laminar and turbulent, compressible and incompressible flows, Boundary layer, Continuity equation. General energy equation. Bernoulli's equation, equation of motion, derivation of Euler's equation of motion, modified Bernoulli's equation.	**6 hr**
5	Newtonian's Fluid (Incompressible flow in Pipes and Channels) Reynolds experiment, Pressure drop (head losses) in pipes (Skin friction), Velocity distribution, Hagen-Poiseuille's equation and Darcy equation. Pressure drop (head losses) in fittings, valves and any obstruction, (Form friction). Hydraulic diameter for flow in non-circular pipes, Boundary layer, Unsteady state examples, Two-phase (gas-liquid) flow definitions.	**6 hr**
6	Non-Newtonian Fluids in Pipes Definition, types of fluid depended on time, calculation of friction and pressure drop for general time independent in laminar and turbulent flow, Velocity profile of power law fluid flow.	**3 hr**
7	Pumping of Liquids Total and pump heads, Cavitation & NPSH, Horse Power and, Pumping Efficiencies, Pump Characteristics curves, Pump specific speed Types of the pumps, Pumps selection Priming the pump. Centrifugal pump relations, homologous centrifugal pump, centrifugal pumps in series and in parallel	**6 hr**
Total hours		**30**

Practical: (Fluid Flow lab.)

No.	Experiment Name.
1	Calibration Of Bourdon Tube Pressure Gauge
2	Impact Of Jet
3	Reynolds Experiment
4	Energy Losses In Pipes
5	Friction Losses In Piping Systems
6	Centrifugal Pump Characteristics
7	Gear Pump
8	Non-Newtonion Fluids

University of Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical Engineering and Oil Pollution</td></tr>
<tr><td>Course Code</td><td>CES.E.235</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Physical Chemistry I</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-.Chemical Engineering Principles I
-Chemistry</td><td>2</td><td>2</td><td>0</td><td>4</td><td>3</td></tr>
</table>

Course Description

Physical Chemistry Is the application of the methods of physical to chemical problems. It includes the qualitative and quantitative study. Both experimental and theoretical of the general principles determining the behavior of matter.

Course Text

1. J. Laidler, Physical Chemistry and Collide Science, Bosten; Houghton M, ffl.n company, 1999.
2. G. Mortimer, Physical Chemistry and Collide Science , San Francisco; Altarcourt science and technology company, 2000.

Course Objectives : at the end of the semester the student should be able to :-

1. Be able to solve problems involving the collision theory of gas-phase reactions.
2. Understand the molecular basis of catalysis.
3. Be able to solve problems involving activities and activity coefficients in nonideal solutions.
4. Understand how the thermodynamics of a non simple system is applied to electrochemical cells.
5. Be able to calculate cell voltages for standard conditions and other conditions using standard reduction potentials.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Chemical Kinetics:** Rate of consumption and formation, rate of reaction, empirical rate Equation, order of reaction (zero, 1st, 2nd, 3ed) , reactions having no order, rate constants and rate coefficients, enzyme reactions kinetics , analysis of kinetic results.	**10 hr**
2	**Surface chemistry:** Adsorption, adsorption isotherms, surface tension and capillary rise, solid- liquid interfaces, colloidal systems, electrical properties of	**10 hr**

	colloidal systems, gels, emulsions.	
3	**PhaApplications of the equations of ideal gases:** The PVT behaviour of pure substances, the ideal gas, the constant volume process, the constant pressure process, the adiabatic process, the polytropic process.	10 hr

Practical: (Phy. Chem. lab.)

No.	Experiment Name
1	**Hydrolysis of Hydrogen Peroxide at the Presence of Catalyst**
2	**Saponification of Ethyl Acetate**
3	**Surface Chemistry Adsorption by Solid from Solution**
4	**Determination of the Surface Tension for Liquids**
5	**Viscosity**
6	**Three component system**

Universityof Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical Engineering and Oil Pollution</td></tr>
<tr><td>Course Code</td><td>CES.E.223</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Computer Programming I</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Basic Principles of Chemical engineering I.
-Mathematics I.
-Computer programming I</td><td>1</td><td>2</td><td>1</td><td>4</td><td>2</td></tr>
</table>

Course Description

To introduce chemical engineering students to modern calculating tool used in the practice of engineering by being able to construct plots, fit data, and use built-in functions in MATLAB.

Course Text

1. Rudra Pratap: Getting started with MATLAB 7, Oxford Press (Indian edition),2006.
2. Desmond J. Higham and Nicolas J. Higham: Matlab Guide, SIAM, 2000.

Other support books :-

1. Duane Hanselman and Bruce Littlefield: Mastering Matlab-6: A Comprehensive Tutorial and Reference, Prentice Hall, 2001.
2. Schilling R. J., Harries S.L., Applied Numerical Methods for Engineers using MATLAB & C, Thomson Books, 2002.

Course Objectives: at the end of the semester the student should be able to :-

1. Develop the confidence necessary to successfully solve Mathematical problems with a computer.
2. Formulate and write structured code in MATLAB.
3. Understand the foundation behind the basic numerical methods for Matrix manipulations.

Topics Covered (Syllabus)/CourseTitle

No.	Contents	Duration
1	**StartingWithMatlab:** MATLAB windows , Menus and the toolbar, Working in the commandwindow , Arithmetic operations with scalars , Display formats , Elementarymathbuilt-infunctions,Usefulcommandsformanagingvariables,Script Filesand the Editor Debugger, Matlab Help System	**2hr**

2	**Algebra:** Symbolicobjects,andsymbolicexpressions,Changingtheformofanexistingsymbolicexpression,Solvingalgebraicequations,Differentiation, Integration, Solving anordinary differential equation.	2 hr
3	**Vector:** Only one row and a column vector has only one column. Entering Vectors and Matrices,ColumnVectors,Transposing,Vectors Addition and subtraction,Vectorsmultiplication,element-wise operation,The Colon Operator,The Colon Operator,Other Operations on Vectors(length,size,find,sum,max,min,mean,sort,all,abs)	2 hr
4	**Interpolation :** One-Dimensional Interpolation(interp1), Two-Dimensional Interpolation(interp2)	2 hr
5	**Polynomials in Matlab :** Roots,PolyVal, Polyfit	2 hr
6	**Matrices:** Entering matrices, Transpose, Matrix operations Addition and subtraction, Matrix multiplication, Matrix division, Element-wise operation, The Colon Operator, Referencing elements, Matrix Inverse, Predefined Matrix, Other Operations on Matrix	2 hr
7	**Matrix Algebra:** Introduction, Solving Linear Equations Using Matrix Algebra.	2 hr
8	**Condition:** If Statement, Loop(For loop, While Loop), Break statement	2 hr

Practical: (Comp. Prog. lab.)

No.	Experiment Name
1	**Startingwithmatlab**
2	**Algebra**
3	**Vector**
4	**Interpolation**
5	**Polynomials In Matlab**
6	**Matrices**
7	**Matrix Algebra**
8	**Condition**

University of Technology
Department of Chemical Engineering

Program	*Chem Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.237**	Credits hr				Units
Course Title	Princibles of Sustainability					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Chemistry -Bio-Chemistry	**2**	**0**	**1**	**3**	**2**

Course Description

Sustainability involves meeting basic human needs without undermining human communities, culture, or natural enviroments. This difficult goal requires recognition of the complex interrelationships to technology, natural resources, natural science, human develop nmet and/or local to global politics. Students will be introduced to a verity of topics including climate change and environmental pollution, local and global strategies, agriculture and sustainable food production, environmental ethics and history, and social justice. The course facilitates deeper student exploration of complex interrelationships among contemporary environmental, problems and the solutions to overcome them. In addition, it will help students articulate personal philosophies to guid more sustainable lifestyles (i.e. choices for resource use and other behaviors)

Course Text

Text book:-

1. Sustainability: A Comprehensive Foundation, Collection, Editor: Tom Theis and JonthanTomkin, Editors,**http://cnx.org/content/coll 1325/1.45/**

Other support books :-

1. Living in Enviroment Concepts, Connections, and Solutions SIXTEENTH EDITION, G, TYLER MILLER, JR. SCOTT E. SPOOLMAN, Brooks/Cole 10 Davis Drive Belmont, CA 94002-3098 USA
2. Sustainability: A Comprehensive Foundation, Collection, Editor: Tom Theis and JonthanTomkin, CONNEXIONS, Rice University, Houston, Texas, 2012. (Referred in Weekly Schedule as SUS)

Course Objectives : at the end of the semester the student should be able to :-

Upon completion of this course, student will be able to:

1. Define sustainability and understand how concepts of sustainability are connected to issues of social justice, the environment, and the economy at local, regional, and global levels.
2. Demonstrate knowlage of key concepts related to the study of sustainability, including planetary carrying. Climate change, and ecological footprint.
3. Explain how sustainability relates to their lives and their values, and how their actions impact issures of sustainability at the individual, and at local, regional, and global levels.
4. Use the scientific method of inquiry to investigate the environmental worldviews, politics and economics driving the human impact.
5. Use appropriate verbal and writing skills to communicate details of scientific methods including hypotheses, results and analyses.

Topics Covered (Syllabus)/ Princibles and Sustainability

No.	Contents	Duration
1	Environmental Systems	2 hr
2	Sustainability Development Goals	4 hr
3	Global Climate Change	2 hr
4	Carbon Foot Print	6 hr
5	Green Chemistry	4 hr
6	Renewable and Non-renewable Energy Sources	4 hr
7	Environmental Impact Assessment	4 hr
8	National and International Laws	4 hr

Program	Chemical Engineering and Oil Pollution					
CourseCode	**CES.E238**	Creditshr.				Units
CourseTitle	Fuel’s and Clean Eng.					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemistry	**2**	**2**	**0**	**4**	**3**

CourseDescription

Introduction to fuels technology (solid, liquid, and gases).Procedure and characterization in terms of physic-chemical properties of these fuels. Clean energy.

CourseText

6. Speight, J.G, Handbook of petroleum product analysis, JohnWilley&Sons, 2002.
7. Speight, J.G.and Ozum, B; Petroleum Refinery processes, MacelDekker, NewYork, 2002.
8. SpeightJ.G.,Thechemistry and Technology of petroleum, 3rdEdition.MarcelDekker,NewYork 1999
9. Petroleum Fuels Manufacturingh and book; Surinder Parkash, McGraw-Hillcompanies, 2010.
10. Fundamentals of Petroleum and Petrochemical Engineering, Uttam Ray Chaudhuri, Taylor & Francis Group, 2011

Topics Covered (Syllabus)/Fuel’s and Clean Eng.

No.	Contents	Duration
1	**Introduction**: History of fuels, history of solid fuel, history of liquid fuels and gases fuels, Fundamental definition, properties of liquid and gaseous fuels,various measurement.	**2 hr**
2	**Coal:** Classification, Composition and basis, coal preparation and washing, combustion of coal and coke and making, coal tar distillation coal liquefaction, coal gasification.	**4 hr**
3	**Crude Petroleum:** Exploration of crude Petroleum, Evaluation of crude, distillation cracking, thermal cracking catalytic cracking, reforming of naphtha, hydrotreatment, dewaxing deasphalting, refinery equipment.	**6 hr**
4	**Natural gas and LPG:** Producer gas, water gas, other fuel gases.	**4 hr**

5	**Combustion air Calculation:** Calculation of calorific value of fuels, flame properties, combustion burners, combustion furnaces.	6 hr
6	**Clean Energy:** Alternate Energy Sources**:** Solar energy: Radiation measurement, applications and types of collectors and storage, Wind power, Geothermal energy, Tidal energy, Nuclear power, Fuel cells, Biogas, Biomass	8 hr

Practical: (Fuel's & Clean Eng lab.)

No.	Experiment Name.
1	**ASTMdistillationexp.**
2	**Densityand specificgravityexp**
3	**Viscosity&viscosityindexexp.**
4	**Salt contentin crude oil**
5	**Gum and gums tability**
6	**Flash&firepoint**
7	**Ashcontentforpetroleumproducts**
8	**Conrad Son Carbon residue of petroleum**

University of Technology
Department of Chemical Engineering

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.222**	Credits hr				Units
Course Title	Mathematics IV					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematics I, II, III	**2**	**-**	**1**	**3**	**2**

Course Description

This course describe the providing of knowledge on solving ordinary differential equations and applications of first order ordinary differential equations and chemical engineering applications of the theory portion covered will be emphasized.

Course Text

Text book:

1. Higher Engineering Mathematics by Dr.B.S.Grewal, Khanna Publishers, 40th Edition, 2007.

Reference book:

1. Advanced Engineering Mathematics by Erwin Kreyszig, 8th edition, 2007.

Course Objectives: at the end of the semester the student should be able to:-

1. Understand methods of solving First order and Higher order ordinary differential equations along with some physical applications.
2. Demonstrate the relevance of the mathematical methods learnt to chemical engineering.

Topics Covered (Syllabus)/ Mathematics IV

No.	Contents	Duration
1	**Application of Ordinary Differential Equations:** Representation problems of 1st and 2nd ordinary differential equations (linear and nonlinear, homogeneous …etc.).	**5 hr**

2	**Ordinary Differential Equations:** • Introduction, • **First Order Ordinary Differential Equations:** • Variable Separable Equation • Homogenous Equation • Exact Equation • Linear Equation • Bernoulli, s Equation. • **Second Order Ordinary Differential Equations:** • Non-Linear Differential Equations • Equations with Dependent Variable Missing • Equations with Independent Variable Missing • Homogenous Equation • Linear Differential Equations • Equations with Constant Coefficient • Equations with Coefficients as a Function of the Independent Variable • **Higher Order Ordinary Differential Equations.** • Simultaneous Differential Equations. • Series Solution of Differential Equations.	10 hr
3	**Solution by Series:** • Infinite series by Taylor theorem, • Method of Frobenius (Case I, II, IIIa, and IIIb), • Bessels's and Modified Bessel's Equation, • Properties of Bessel Functions, • Applications in chemical engineering, • Tubular Gas Preheater, • Reaction in axisymmetric Spherical and Cylindrical pellets.	15 hr

Universityof Technology
Department of Chemical Engineering

Program	**Chemical Engineering and Oil Pollution**					
Course Code-	**CES.E.232**	Credits hr				Units
Course title	Chemical Engineering Principles III					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemical Engineering Principles I, Chemical Engineering Principles II	**2**	**-**	**1**	**3**	**2**

Course Description

Understanding the basic concepts and expressions in chemical engineering and learning calculations related to chemical reactions, energy balance,

Course Text

- D.M.Himmelblau and J.B.Riggs, Basic Principles and Calculations in Chemical Engineering, 7^{th} Edition, 2004.
- R.M.Felder and R.W.Rousseau, Elementary Principles of Chemical Processes ,3rd Edition ,2005 .

Other support books :-

Skogestad, S. (2008). Chemical and energy process engineering. CRC press.

Course Objectives: at the end of the semester the student should be able to:-

1- Have a deep knowledge, wide scope and improved understanding of the mechanisms in heat balance as well as a better insight into analytical and empirical methods applied in analysis of energy balance related problems.
2- Gain knowledge for applying the energy (equation) balance in chemical engineering problems.
3- To provide experience for students to solve energy balance for different process

Topics Covered (Syllabus)

No.	Contents	Duration
1	**Introduction, Basic concept and definitions** ➢ First law of thermodynamics ➢ Temperature integral heat capacity (mean heat capacity) ➢ - Latent heat temperature dependence	2hr
2	**General Energy Balance Without Chemical Reaction** ➢ Energy Balance on Closed System ➢ -Energy Balance on open System ➢ -Heat Capacity ➢ -Sensible & latent heat principles	8hr
3	**Calculation of Enthalpy Change** ➢ Enthalpy Change Without Change in Phase ➢ Enthalpy Change Including Phase Transition	8hr
4	**General Energy Balance With Chemical Reaction** ➢ Standard Heat of Formation ➢ Standard Heat of consumption ➢ Standard Heat of Reaction ➢ Heat of reaction temperature dependence ➢ Heat effects of industrial reactions	12hr

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.234**	Credits hr				Units
Course Title	Fluid Flow II					
Term	2^{nd}Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Fluid Flow I, -Chemical Engineering -Principles II, -Physical Chemistry I	**2**	**2**	**1**	**5**	**3**

Course Description

Define and show the student what about related with fluid flow measurements types and principles. Course material includes an introduction to the concepts and applications of compressible fluid flow and compressors, analysis of engineering applications of liquid mixing with their power consumption. Fluid flow though packed bed fluidization and transportation of particles.

Course Text

17. Coulson, J.M and Richardson J.F. “Chemical Engineering, volume 1”, Fifth edition 2002, Elsevier Science, Linacre House, Jordan Hill, Oxford
18. Coulson, J.M and Richardson J.F. “Chemical Engineering, volume 2”, Fifth edition 2002, Elsevier Science, Linacre House, Jordan Hill, Oxford
19. F.A. Holland and R. Bragg “Fluid Flow for Chemical Engineers”, 2^{nd} Ed. (1995) Elsevier Ltd.

<u>Other support books :-</u>

10. DARBY. R., M. Dekker “Chemical Engineering Fluid Mechanics”, 2^{nd}Ed. (2001)
11. James O. Wilkes “Fluid Mechanics for Chemical Engineers”, Prentice Hall PTR, New Jersey, USA, 1999.
12. De Nevers, N. “Fluid Mechanics for Chemical Engineers”, (1991) McGraw-Hill, Singapore.

Course Objectives: at the end of the semester the student should be able to :-

1. Recognize the compressible fluid flow, pumping tools of the compressible fluid flow, fluid flow measurements, liquid mixing and its power consumptions, flow through packed columns, fluidization and particles transportation.
2. Define the problems in fluid dynamics in various engineering applications. Distinguish the energy variation and its applications spatially the frictional energy losses calculations and the required energy for fluid pumping.
3. Define the necessary fluid parameters of full scale projects by performing simple model experiments and share ideas and work in a team in an efficient and effective manner under controlled supervision or independently.

Topics Covered (Syllabus)/ Fluid Flow I

No.	Contents	Time
1	Flow Measurement Flow in closed channels: Pitot tubes, Orifice meter, Venturi meter, Nozzle meter, Rotameters, special flow measurements Hot wire and other types of flow meters, Flow in open channels and weirs: Rectangular, Triangular and Trapezoidal notches with unsteady state applications;	6 hr
2	Flow of Compressible Fluid General energy equation, Sonic velocity and Mach No., Isothermal, and Adiabatic flow of an ideal gas in pipes, maximum fluid velocity. Compressible fluid flow through converging-diverging nozzle. Types of gas pumping equipment, Compressors & gas compression cycle (ideal and real, single and multistage) with total work done.	8 hr
3	Liquid Mixing Stirring and mixing types, Stirred vessels (power consumption, power curves, scaled-up), Equation of motion for rotational flow (vortex).	6 hr
4	Motion of Particles in a Fluid Drag force on a particle, terminal falling velocities of fine and coarse particles	4 hr
5	Flow of Fluid through Granular Bed and Packed Columns Pressure drop in granular beds (fixed packed columns): Packings types and specification, Pressure drop relations (Darcy, Kozeny and Kozeny - Carmen equations)	4 hr
6	Fluidization and Particles transportation Minimum fluidization velocity, Pressure, Pressure drop, Ergun equation, bed expansion and transport of particles.	2 hr
Total hours		**30**

Practical: (Fluid Flow lab.)

No.	Experiment Name
1	Bernoulli's Theorem Demonstration
2	Discharge Through An Orifice
3	Flow Through Venturi Meter
4	Open Chanel Flow Over Weir
5	Flow Of Compressible Fluid
6	Forced Vortex
7	Fluidization

University of Technology
Department of Chemical Engineering

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.236**	Credits hr				Units
Course Title	Physical Chemistry II					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Physical Chemistry I	**2**	**0**	**0**	**3**	**2**

Course Description

Physical Chemistry Is the application of the methods of physical to chemical problems. It includes the qualitative and quantitative study. Both experimental and theoretical of the general principles determining the behavior of matter.

Course Text

1. J. Laidler, Physical Chemistry and Collide Science, Bosten; Houghton M, ffl.n company, 1999.
2. G. Mortimer, Physical Chemistry and Collide Science, San Francisco; Altarcourt science and technology company, 2000.

Course Objectives: at the end of the semester the student should be able to :-

1. Be able to solve problems involving ideal mixture and dilute solutions.
2. Understand the principles govering phase diagrams and the able to interpret phase diagrams for various kinds of systems.
3. Be able to solve problems related to the macroscopic equilibrium properties of gases and liquid.
4. Be able to calculate cell voltages for standard conditions and other conditions using standard reduction potentials and the nerst equation.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Phase Equilibria:** Equilibrium between phases, one component systems, binary systems involving vapor, liquid vapor equilibria of two component system, liquid vapor equilibrium in system not obeying Raoults law, temperature composition diagram (boiling point curves), distillation, azeotropes, solubility of gases in liquids.	**10 hr**
2	**Solutions of electrolytes :** Electrical units, Faradays laws of electrolysis, molar conductivity, weak electrolytes, strong electrolytes, activity and ionic strength, determination of activity coefficient from solubility, the Debye-Hackle theory, acid- base catalysis and their dissociation constant.	**10 hr**

3	**Electrochemical cells:** Electromotive force (EMF) of a cell, measurements of EMF- the potentiometer, the polarity of electrodes, the cell reactions and reversible cells, free energy and reversible cells, typical of half-cell's classification EMF, standard electrode potentials, standard free energy and energy of aqueous ions, calculation of EMF of cell, oxidation reduction reactions, concentrations cells, electrolysis.	**10 hr**

Universityof Technology
Department of Chemical Engineering

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.224**	Credits hr				Units
Course Title	Computer Programming II					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Basic Principles of chemical engineering I. -Mathematics I. -Computer Programming I	**1**	**2**	**1**	**4**	**2**

Course Description

To introduce chemical engineering students to modern calculating tool used in the practice of engineering by demonstrating an ability to create small structured programs in a MATLAB programming environment and understanding how user written functions interact with numerical methodsroutines.

Course Text

1- Rudra Pratap: Getting started with MATLAB 7, Oxford Press (Indian edition),2006.

2- Desmond J. Higham and Nicolas J. Higham: Matlab Guide, SIAM, 2000.

Other support books :-

1- Duane Hanselman and Bruce Littlefield: Mastering Matlab-6: A Comprehensive Tutorial and Reference, Prentice Hall, 2001.

2- Schilling R. J., Harries S.L., Applied Numerical Methods for Engineers using MATLAB & C, Thomson Books, 2002.

Course Objectives: at the end of the semester the student should be able to:-

1. Solve sets of linear and nonlinear equations using numerical methods as well as in-built MATLAB functions.
2. Apply numerical methods and MATLAB functions to differentiate and integrate a function or a set of discrete points.
3. Apply explicit and implicit numerical methods and MATLAB functions to integrate single and multiple sets of initial value problems

Topics Covered (Syllabus)

Duration	Contents	No.
1	**Two-dimensional plot:** The plot command, Using the plot Command, Line styles, Markers, and Colors Adding Grids, Labels, Text, or a Legend, Customizing Axes Plotting multiple graphs in the same plot, Multiple figure windows (subplot command) , Plots with special graphics the fplot, ezplot command area bar barh, stairs semilogx semilogy,log log, errorbar stem, plotyy Histograms Polar Pie erf.	**2 hr**

2	**Three dimensional plot :** plot3, Meshgrid , mesh , surf, ezmesh, ezplot3, ezsurf, cylinder, sphere	1 hr
3	**Functions :** Functions types: local function, Nested function, Anonymous function, function Handle ,Creating and calling a local function file ,Structure of a local function file ,Local and global variables in local function, Saving a local function file, Examples of simple local function (user-defined functions), Comparison between script files and function files, Add local functions, Sub-local functions, Nested functions ,Anonymous Functions, Multiple Anonymous Functions, Anonymous Functions with No Inputs ,Anonymous Functions with Multiple Inputs or Outputs ,Function Handle, What Is a Function Handle?, Creating Function Handles, Create handles to anonymous functions, Saving and Loading Function	4 hr
4	**Introduction to Numerical analysis:** Numerical solution of of Differential Equations, Ordinary Differential Equation, Euler's Method	2 hr
5	**Differential Equations:** Numerical solution of multi simultaneous differential equations, Runge-KuttaMethod, Integration two or more coupled first-order ODE's, MATLAB Built-In Routines for solving ODES	2 hr
6	**Partial differential equations:** Numerical solution of partial differential equations,Higher order ode's,Non-Linear Equation Solving MATLABs built-in function: (fsolve).	2 hr
7	**Numerical Analysis applications in Chemical Engineering:** Solving chemical engineering problems	2hr

Practical: (comp. Prog lab.)

No.	Experiment Name
1	**Two-dimensional plots**
2	**Three dimensional plots**
3	**Functions**
4	**Introduction to Numerical analysis**
5	**Differential Equations**
6	**Partial differential equations:**
7	**Numerical Analysis applications in Chemical Engineering**

University of Technology
Department of Chemical Engineering

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.225**	Credits hr				Units
Course Title	Materials Eng.					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Mech. Eng. &Strength of Material -Chemistry	**2**	**2**	**1**	**4**	**3**

Course Description

Introduction to classification of materials and the atomic structure of it, Study the mechanical, thermal and electrical properties of materials and Crystal structure and imperfection in solid materials.

Course Text

1-Donaled R. Askeland, The science and engineering of materials, international student edition, 2006 .
2-William D. Callister, Jr. , Materials science and engineering, Fifth edition, 2000.
3-Lawrence H. Vanvlack , Elements of materials science and engineering, Fifth edition, 1987.

Course Objectives : at the end of the semester the student should be able to :-

1. Describe and solve problems on atomic arrangement and geometry of imperfections.
2. Describe and solve problems on mechanical, thermal and electrical properties of materials.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Classification of Materials** Classification of materials, classification of materials based on structure, advanced materials	**4 hr**
2	**Mechanical Properties of Materials** Stress-strain behavior, ductility, brittleness, toughness, modulus of resilience, poison's ratio, hardness, effect of temperature.	**6 hr**
3	**Atomic structure** The structure of atom, atomic bonding, bonding energy and inter-atomic spacing	**6 hr**
4	**Atomic order in solids** Types of atomic or ionic arrangements, crystal structure, lattice, unit cells, metallic crystal structure, crystal systems, crystal direction and crystal planes , diffraction techniques for crystal structure analysis	**8 hr**
5	**Thermal and electrical properties of materials** Heat capacity, thermal expansion, thermal conductivity, thermal stresses, Glass transition temperature, Creep resistance, electrical conductivity, electron mobility, electrical resistivity of metals	**6 hr**

Practical: (Materials Eng. lab.)

No.	Experiment Name
1	**Tension test**
2	**Hardness Testing**
3	**Bending Test**
4	**Creep Test**
5	**Abrasion Test**
6	**Impact Test**
7	**Moisture Measurement in Engineering Materials**
8	**Determination of Linear Thermal Expansion for a Solid**
9	**Microstructure Examination of pb-Sn alloys using the metallurgical microscope**

Universityof Technology
Department of Chemical Engineering

Program	Chemical Engineering and Oil Pollution					
Course Code	**CES.E.226**	Credits hr				Units
Course Title	Statistics					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematics I Mathematics II	**2**	**0**	**1**	**3**	**2**

Course Description

The subject is to be given in one semester its consists of organization of data & summarized in a frequency distribution table which is graphically represented, and determination of dispersion & center measurement, study of continuous & discrete probability distribution, curve fitting and least square method & the study of chi square distribution. Use of statistical methods in relation to applications of environmental engineering sciences, analysis of industrial problems and oil pollution

Course Text

1. Statistics, Murray R. Spiegel, 7 Ed. 2009
2. Statistical methods for technologists, C.G. Paradise.2005
3. Statistical Methods in Analytical Chemistry, Peter C. Meier and Richard E. Zund, 2 Ed, A Wily-Intercedence Publication,2000

Course Objectives: at the end of the semester the student should be able to: -

We are teaching students how to use statistical methods.
Application of statistical methods in description and analysis of data.
Use statistics to solve different problems and Comprehension measurement instruments'fundamental principles.

Topics Covered (Syllabus)/ statistics

No.	Contents	Duration
1	Introduction, statistics population, descriptive and inductive statistics. Tutorial	**2 hr**
2	Frequency distribution table, types of frequency.Tutorial of frequency distribution table. Tutorial	**2 hr**
3	Graphical representation of frequency distribution table. Tutorial	**2 hr**
4	Measures of Location, Mode, Median, Arithmetic Mean, and Other Mean Measures.	**2 hr**
5	Measures of Dispersion Mean Absolute Deviation, Standard Deviation, Variation, Coefficient of Variation, Properties of Z, Tutorial. First exam	**2 hr**
6	Probability distribution, Discrete Prob. Distribution, continuous & discrete probability dist., normal dist., table of the area under normal dist., Tutorial	**2 hr**

7	Tutorial and the binomial distribution, Approximation of binomial dist., normal & Poisson dist., Tutorial.	**2 hr**
8	The chi-square test, confidence intervals, Test of independence	**2 hr**
9	degree of a significant test، Test of hypothesis، Chi-square test for goodness of fit, Tutorial	**2 hr**
10	Second exam Curve fitting, least squares method, variance, and correlation coefficient.	**2 hr**
11	Tutorial of the least square methods.	**2 hr**
12	Multiple and partial correlations.	**2 hr**
13	Normal equations for the least square regression, Tutorial.	**2 hr**
14	Coefficient of correlation. Tutorial in partial correlation.	**2 hr**
15	Tutorial	**2 hr**

University of Technology
Department of Chemical Engineering

rogram	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.331**	Credits hr				Units
Course Title	Thermodynamics I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Chemical Engineering Principle II, -Physical Chemistry -Fluid Flow I&II	**2**	**0**	**1**	**3**	**2**

Course Description

The course of chemical engineering thermodynamics I comprises the study of volumetric properties of pure fluids; Entropy and second law analysis of engineering systems; Thermodynamic properties of fluids; Applications of thermodynamics to flow processes.

Course Text

5- J. M. Smith,H.C.Van Ness, Introduction to chemical engineering thermodynamics, 6th edition (International Edition), Mc-Graw Hall, 2008.

Other support books :-

6- K.V.Narayanan, Atext book of chemical engineering thermodynamics, prentice Hall of India, New Delhi, 2011.

7- B.G.Kyle, Chemical and process thermodynamics ,(3rd Edition), prentice Hall Inc.New Jersey, 1984.

8- J. Rayner, Basic engineering thermodynamics inSI units, printed in great Britain,1971.

Course Objectives : at the end of the semester the student should be able to :-

1-To familiarize the students with basic concepts of the first and second laws of thermodynamics and their applications in engineering problems.
2. Develop a practical ability to solveChemical Engineering Principle II problems, minimum work.
3- Students will demonstrate basic understanding of basics and definitions of thermodynamics and properties of pure substances.
4-Describe the reversible and irreversible processes (macroscopic description of ideal and real processes).

Topics Covered (Syllabus)/ Course Title

No.	Content	Duration
1	**Introduction** Basic definitions, work, energy, heat, types of systems, extensive and intensive properties, thermodynamic processes, zero law of thermodynamics, 1st law of thermodynamic, energy balance for open and close system	2 hr
2	**Volumetric properties of pure fluids** Review on virile equation of state, cubic equation of state, generalized correlations for gases and for liquids.	6 hr
3	**The 2nd law of thermodynamics** Review on the 2nd law and Carnot heat engine, entropy balance for open system, calculation of ideal work, lost work.	6 hr
4	**Heat capacity** Heat effect, heat capacity calculations, sensible heat, latent heat, standard heat of reaction, heat effect of industrial reactions.	4hr
5	**Thermodynamic properties of fluids** Review on the property relations (ΔH, ΔS, ΔUandΔG□ residual properties, two phase systems, thermodynamic diagrams and tables, generalized property correlations for gases.	6hr
6	**Applications of thermodynamics to flow processes** Duct flow of compressible fluids, pipe flow, nozzles, throttling process, turbines, compression processes compressors, ejectors	6 hr

Universityof Technology
Department of Chemical Engineering

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.321**	Credits hr				Units
Course Title	Numerical Analysis					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Computer Programming I , II	**2**	**2**	**1**	**5**	**3**

Course Description

This course introduces students to: Error analysis; Finding roots of a non-linear function; Approximation and interpolation; Numerical integration and differentiation; direct and indirect solution of systems of linear equations; Solution of systems of nonlinear equation; solving ordinary differential equations and partial differential equations. All examples within the course concerning with principles of chemical engineering.

Course Text

1- "Numerical Methods for Engineers", Steven C. Chapra, Raymond P. Canale, McGraw Hill, 6th edition, 2010.
2- "Numerical Methods for Engineers and Scientists", Joe Hoffman, McGraw-Hill Book Company,1993.
3- "Applied Numerical Analysis", Gerald,C.F. and Wheatley, P.O., 6th Edition, Pearson Education, 2006.
4- "Numerical Methods for Chemical Engineers with MATLAB Applications", AlkisConstantinides, NavidMostoufi, Prentice Hall, 1999.

Course Objectives: at the end of the semester the student should be able to:-

To solve chemical engineering problems with numerical analysis techniques.

Topics Covered (Syllabus)/Numerical Analysis

No.	Contents	Duration
1	**Introduction to Numerical Analysis:** Numerical Solution, type of errors; relative error, absolute error, percentage error, truncation error, round off error. Floating point.	2 hr
2	**Interpolation and Polynomials Approximation:** Lagrangian Polynomials (Linear, Quadratic, and General Form). Newton's Divided differences (Linear, Quadratic, and General Form). Cubic spline interpolating polynomials.	3 hr
3	**Curve Fitting** Linear regression, Polynomial Models, Nonlinear Data.	2 hr
4	**Root Finding:** Roots of polynomials, Bisection method, Secant method, Newton-Raphson method .	3 hr
5	**Numerical Differentiation and Numerical Integration:**	6 hr

	Forward, backward and central difference approximation. Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rules. Double integrals using trapezoidal and Simpson's rules.	
6	**Solving System of Equations:** Solution of linear system of equations by direct methods (Gaussian elimination and Gauss-Jordon). Solution of linear system of equations by Iterative methods (Jacobi and Gauss-Seidel). Solution of non-linear system of equations by Newton-raphson.	4 hr
7	**Solution of ordinary Differential Equations:** Initial value problems. Solution of first-order ordinary differential equations using Taylor', Eular, Runge-Kutta and Predictor-corrector methods. Solution of simultaneous ordinary differential equations.	4 hr
8	**Solution of Partial Differential Equations:** Types of Partial Differential Equations: Elliptic (Poisson) equation, Parabolic (heat) equation, Hyperbolic (wave) equation. Finite difference solution of Partial Differential Equations. Numerical solution of partial differential equations using explicit, implicit and Crank-Nicolson methods elliptic (Laplace) equation.	6 hr

Practical: (Numerical Analysis lab.)

No.	Contents
1	**Review of properties of Matlab programming language.**
2	**Bisection method and Secant method.**
3	**Newton-raphson method.**
4	**Lagrange interpolation.**
5	**Newton's forward and backward difference formulas.**
6	**Trapezoidal rule.**
7	**Simpson's 1/3 and 3/8 rules.**
8	**Solution of linear system of equations by direct methods (Gaussian elimination and Gauss-Jordon).**
9	**Solution of linear system of equations by Iterative methods (Gauss-Seidel and Jacobi).**
10	**Solution of differential equation using Euler's method.**
11	**Solution of differential equation using Runge-Kutta method.**
12	**Solution of partial differential equations using explicit and implicit methods.**
13	**Solution of partial differential equations using Crank-Nicolson method.**
14	**Solution of steady state diffusion through catalyst**
15	**Solution of un-steady state diffusion through catalyst**

Universityof Technology
Department of Chemical Engineering

Program	***Chemical Engineering and Oil Pollution***					
Course Code	**CES.E.333**	Credits hr				Units
Course Title	Mass Transfer					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Chemical engineering -principles II &III, -Fluid flow I & II	**2**	**2**	**1**	**5**	**3**

Course Description

This course covers diffusion and mass transfer in binary& multi-components, molecular diffusion in fluids, convective mass transfer, mass transfer coefficients, mass transfer correlations, interphase mass transfer, mass transfer theories.

Course Text

1- Coulson, J. M & Richardson J. F. (2006). “Chemical engineering, Volume 1”, 3rd Edition, Robert Maxwell. M. C.
2- Dutta Binary K. (2007), “Principles of Mass Transfer & Separation Process”, Bvt. Ltd. Prentice Hall, ISPN 8-1203-2990-2.

Other support books:-

1- Treybal Robert E. (1975), “Mass transfer Operation” 2nd Edition, Mc-Graw-Hill Book.
2- McCabe, W., Smith, J., Harriott, P. (2004), “Unit Operations of Chemical Engineering”, Mc-Graw-H Co., 7th Edition, ISBN0072848235.

Course Objectives: at the end of the semester the student should be able to:-

1- Understand the basics of diffusion as applicable to mass transfer phenomena.
2- Estimate Molar fluxes in convective and inter phase mass transfer.
3- Explain the concept of diffusion theories.
4- Applying the convective mass transfer correlations to calculate mass transfer rates in many units operation.

Topics Covered (Syllabus)/ Mass transfer

No.	Contents	Duration
1	**Introduction** Fundamentals of mass transfer processes, concentrations, velocities, mass & molar fluxes.	**2 hr**
2	**Diffusion in binary gaseous** Fick’s first law of diffusion. Diffusion in gas mixtures, Equimolecular diffusion, diffusion in stationary layer. Correlations to calculate diffusivity, correcting diffusivity	**6 hr**

3	**Diffusion in multi component mixtures** Multi-component gas phase systems, effective diffusivity. Maxwell's law of diffusion	**4 hr**
4	Diffusion in liquids.	**2 hr**
5	Diffusion in solids.	**2 hr**
6	**Diffusion theories** Diffusion across phase boundary, Film theory, two film theory, Mass transfer coefficients (individual & overall) in laminar and turbulent flow.	**4 hr**
7	**Diffusion resistances** Calculating the resistance to mass transfer in both phases. Calculating intermediate concentrations.	**4 hr**
8	**Unsteady state mass transfer** Introduction to unsteady state mass transfer, mass transfer accompanied by a chemical reaction.	**6 hr**

Practical: (Mass Transfer lab.)

No.	Experiment Name
1	**Liquid-Liquid diffusion**
2	**Absorption**
3	**Batch Distillation Column**
4	**Fluid Mechanics of Packed Bed**
5	**Sieve Analysis**
6	**Gas Solid Fluidization**

University of Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical Engineering and Oil Pollution</td></tr>
<tr><td>Course Code</td><td>CES.E.335</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Chemical Reaction Kinetics</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Physical Chemistry II</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td></tr>
</table>

Course Description

Theory,Kinetic parameters and rate law, multiple reactions, yield and selectivity, stoichiometric considerationsand collection and analysis of rate data
.

Course Text

1-Octave Levenspiel (1999), CHEMICAL REACTOR ENGINEERING, 3rd edition, John Wiley & Sons Inc., USA ISBN: 9780471254249.

2-J.M. Smith (1987), CHEMICAL ENGINEERING KINETICS, 3rd edition, McGraw-Hill International Editions, Singapore. ISBN: 9780070587106

Other support books :-

1-Ronald W. Missen; Charles A. Mims; Bradley A. Saville (1999), INTRODUCTION TO CHEMICAL REACTION ENGINEERING AND KINETICS, 1stedition, John Wiley & Sons Inc.,USA.

Course Objectives: at the end of the semester the student should be able to :-

This course aims to establish fundamental knowledge for the students in chemical reaction kinetics. At the end of this course, students should be able to:

(i) Interpret and analyse chemical reaction kinetics data.
(ii) Apply reaction kinetics principles in chemical reaction.
(iii) Identify and formulate problems in chemical reaction kinetics and find appropriate solutions**.**

Topics Covered (Syllabus)/ Chemical Reaction Kinetics

No.	Contents	Duration
1	**Introduction to reactor design:** L1: Interpretation of rate data, scale-up, and design L2: Classification of reactors.	**2 hr**
2	**Kinetic parameters and rate law:** L3: Definition in terms of reacting compounds and reaction extent; irreversible and reversible reactions, homogeneous catalyticreactions, conversion, yield. L4: Rate laws, stoichiometry, reaction order and elementary reactions. L5: Reaction rate constants, Arrhenius equation andvan't Hoff equation and Heat of reaction. L6: Temperature and pressure effects on reaction rates.	**8 hr**

3	**Reactors design and Stoichiometry:** L7: Mole Balances. L8: Batch Reactor Design Equations. L9: Design of Continuous Stirred-Tank Reactor. L10: Design of Plug Flow Reactor. L11: Stoichiometry in batch systems. L12: Stoichiometry in flow systems. L13: Reversible Reactions and EquilibriumConversion.	**10 hr**
4	**Multiple reactions, yield and selectivity:** L14: Types of multiple reactions. L15: Definitions of yield and selectivity. L16: Analysis of parallel, series, consecutive reactions. L17: Effect of pressure and temperature on multiple reactions. L18: The Denbigh reaction and its special cases.	**10 hr**

University of Technology
Department of Chemical Engineering

<table>
<tr><td rowspan="2">Program</td><td colspan="6">Chemical Engineering and Oil Pollution</td></tr>
<tr></tr>
<tr><td>Course Code</td><td>CES.E.337</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Heat transfer I</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Fluid Flow II
-Math III & IV</td><td>2</td><td>0</td><td>1</td><td>3</td><td>2</td></tr>
</table>

Course Description

The course will introduce the fundamental concepts of various modes of heat transfer. Additionally, it will elaborate these concepts with theories and applications to solve practically relevant chemical engineering problems. Moreover, this course will help students formulate the models necessary to study, analyze and design heat transfer systems by applying these principles. Furthermore, this course will focus on developing problem-solving skills, which are essential to good heat transfer engineering practice in real-world applications.

Course Text

1-Holman, J.P. (2009) Heat Transfer. 10th Edition, McGraw-Hill, New York.

Other support books: -

2-Harker, J. H., J. R. Backhurst, and J. F. Richardson. Chemical Engineering Volume 1. Vol. 1. Elsevier, 2013

3-Incropera, Frank P., David P. DeWitt, Theodore L. Bergman, and Adrienne S. Lavine. Fundamentals of heat and mass transfer. Vol. 6. New York: Wiley, 1996.

Course Objectives: at the end of the semester the student should be able to:-

1. Understand the fundamental laws of heat transfer.
2. Account for the consequence of heat transfer in thermal analyses of engineering systems.
3. Analyze problems involving steady-state heat conduction in simple geometries.
4. Develop solutions for transient heat conduction in simple geometries.
5. Understand the fundamentals of the convective heat transfer process.
6. Evaluate heat transfer coefficients for forced convection over exterior surfaces.
7. Evaluate heat transfer coefficients for forced convection inside tubes and ducts.
8. Contribute to the ability of the student to identify, formulate, and solve engineering Problems.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction** • Cover syllabus and introduction to class • Temperature scales • Conduction Heat Transfer • Thermal Conductivity • Convection Heat Transfer • Radiation Heat Transfer	**4 hr**

2	**Steady State Heat Conduction in One Dimension:** • The Plane Wall • Heat conduction through a composite wall • Radial Systems • The Overall Heat-Transfer Coefficient • Critical Thickness of Insulation • Heat-Source Systems • Cylinder with Heat Sources • Conduction-Convection Systems • Extended surfaces (Fins)	10 hr
3	**Unsteady-State Conduction** • Introduction • Lumped-Heat-Capacity System	4 hr
4	**Principles of Convection:** • Viscous Flow • Inviscid Flow • Laminar Boundary Layer on a Flat Plate • Energy Equation of the Boundary Layer • The Thermal Boundary Layer • Calculation of the heat transfer coefficient for flow over a flat plate • The Relation Between Fluid Friction and Heat Transfer	8hr
5	**Empirical and Practical Relations for Forced-Convection Heat Transfer** • Introduction • Empirical Relations for Pipe and Tube Flow • Flow Across Tube Banks	4 hr

University of Technology
Department of Chemical Engineering

Program	***Chemical Engineering and Oil Pollution***					
Course Code-	**CES.E.339**	Credits hr				Units
Title	Air Pollution Control Engineering					
Term	1^{st} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Bio-Chemistry	**2**	**-**	**1**	**2**	**2**

Course Description

Introduction to sources of air pollution, basic meteorological processes, air quality modeling. Technology for air pollution control (Equipment of unit operation). Understanding of air pollution control and health problems, risk assessment, and global atmospheric changes.

Course Text

Textbook:-

K. Wark, C.F. Warner & W.T. Davis,"Air Pollution Control: its Origin and Control. Addition-Wesley, (1998)

Other support books :-

1. De Vevers, N., "Air Pollution Control Engineering", MC, Graw-Hill, Inc. (200)
2. D. Vallero, "A fundamental of Air Pollution "Amesterdam, 4^{th} edition, (2008).
3. L. Theodore, " Air Pollution Control Equipment Calculation" Willy, (228).

Course Objectives : at the end of the semester the student should be able to :-

1- To apply your knowledge of mathematic engineering, science and unit operation to identify and to solve air pollution problems.
2- To describe effect of air pollution on environment and dispersion..
3- To present group project report in the class in order to develop communication skills.

Topics Covered (Syllabus)

No.	Contents	Duration
1	**Introduction** Air pollution definition, ; Classification of air pollutants;Type and Sources of air pollutants; Particulate matter; Air born particulate;gaseous pollutants;Effectof air pollution on human beings and environmental	**2 hr**
2	**The atmosphere of earth** The atmosphere of Earth; Atmosphere composition; Layers of atmosphere; chemical reactions in the atmosphere. Urban Smog: photochemical smog.	**4 hr**
3	**Regional Global Issue** greenhouse gases; Greenhouse effects and its importance.; Global issues: 1) Global warming: definition, effect and control 2) Ozone layer dispersion: Definition of ozone layers, Importance and formation, Definition of ozone layer depletion and its formation with	**2 hr**

	chemical reaction, Chemicals causes ozone layer dispersion. 3) Acid rain: Definitions, Chemical reaction of acid rain formation, Effects and controls of acid rain. 4) International action to reduce global warming and acid rain: Kyoto protocol, Montreal protocol, Paris agreement.	
4	**Meteorological Factors Influencing Dispersion of Air Pollutants** Introduction, wind direction and speed, Atmospheric stability, Lapse rate: 1) atmospheric lapse rate , 2) Adiabaticlapse rate: dry and wet adiabatic lapse rate; Temperature inversion; Plume behavior; The Gaussian plume model; Estimation of plume rise. Stack height.	**8 hr**
5	**Air pollution control equipment: selection and operation: Part I :** **Control of particulate matter:** Factor effecting selection of particulate control equipment. Particulate control Equipment: Gravitational settling chamber, Centrifugal separators (cyclone separators), Wet scrubbers, Fabric filters, Electrostatic precipitators. Design and calculation of Collection efficiency of some particulate equipment.	**2 hr**
6	**Design and calculation of collection efficiency of some air pollution control equipment:** Gravitational settling chamber: single tray and multi trays; Cyclones	**6 hr**
7	**Air pollution control equipment: selection, design, operation:** **Part II: Control of Gaseous Pollutants:** Mechanisms to remove gaseous contamination from gas stream, Absorption by liquids, adsorption by solids, combustion.	**4 hr**
8	**Control of specific gaseous pollutants (4 hr).** Control of sulfur dioxide emission (SO_2), Control of nitrogen oxide (NO_x), Control of carbon monoxide (CO), volatile organic compounds (VOCs).	**2 hr**

University of Technology
Department of Chemical Engineering

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.3310**	Credits hr				Units
Course Title	**Industrial Safety**					
Term	1st semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemistry, Fluid flowI	**2**	**-**	**-**	**2**	**2**

Course Description

.Introduction to industrial safety, Risk Assessment & Hazard IdentificationFire and explosion, Toxicology, Leaks and leakage , Safety in process design

Course Text

1- Crowl D.A. and Louvar J.F., "Chemical Process Safety: Fundamentals with Applications", 2nd Ed., Prentice Hall.2001.
2. Fawcett, H..and Wood, "Safety and Accident Prevention in Chemical Operations" Wiley inters, Second Edition.
3. David B., "Engineering Safety", McGraw-Hill UK, Copyright 1992.

Course Objectives : at the end of the semester the student should be able to :-

1. The course attainted to give the student the knowledge about the risk of chemical processes
2. The student be capable to use safety policy to eliminate accidents

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction to industrial safety** Important of industrial safety, History and development of safety movement Need for safety, Safety legislation: Acts and rules, Safety standards and codes, Safety policy: safety organization and responsibilities and authorities of different levels.Accident sequence theory, Causes of accidents, Accident prevention and control techniques, Plant.	**6 hr**
2	**Risk Assessment & Hazard Identification** Risk definition, Risk analysis, Major hazard control, Identification of hazard, Categorization methods for elimination of hazard, Mechanical hazards, machine guarding, Pressure vessel hazards and their control, Safety in material handling: hazards and safe Practices, safety with storage of materials, Electrical hazards: classification, safe work practices, Chemical hazards: laboratory safety, bulk handling of chemicals,	**4 hr**
3	**Fire and explosion** Introduction-Industrial processes and hazards potential, mechanical electrical, thermal and process hazards. Safety and hazards regulations, Industrial hygiene. Shock wave propagation, vapour cloud and boiling	**6 hr**

	liquid expanding vapoursexplosion , mechanical and chemical explosion, multiphase reactions, transport effects and global rates. Fire and explosion hazards, Fire detection, Prevention, control, and extinguishments, Industrial layout, Industrial waste management.	
4	**Toxicology** Hazards identification-toxicity, fire, static electricity, noise and dust concentration; Material safety data sheet, hazards indices- Dow and Mond indices, hazard operability (HAZOP) and hazard analysis (HAZAN).	4 hr
5	**Leaks and leakage** Spill and leakage of liquids, vapors, gases and their mixture from storage tanks and equipment; Estimation of leakage/spill rate through hole, pipes and vessel burst; Isothermal and adiabatic flows of gases, spillage and leakage of flashing liquids, pool evaporation and boiling; Release of toxics and dispersion.	4 hr
6	**Safety in process design and pressure system design** Design process, conceptual design and detail design, assessment, inherently safer design chemical reactor, types, batch reactors, reaction hazard evaluation, assessment, reactor safety, operating conditions, unit operations and equipments, utilities. Pressure system, pressure vessel design, standards and codes- pipe works and valves- heat exchangers- process machinery- over pressure protection, pressure relief devices and design, fire relief, vacuum and thermal relief, special situations, disposal- flare and vent systems failures in pressure system.	6 hr

University of Technology
Department of Chemical Engineering

Program	Chemical Engineering and Oil Pollution					
Course Code	**CES.E.3311**	Credits hr				Units
Course Title	Equipment Design					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Fluid Flow I & II -Principles of Chemical Eng. I, II, III.	**2**	**0**	**1**	**3**	**2**

Course Description

The course content process planning, piping and pumps network , gas-gad separation ,solid handling, hear and mass transfer equipments

Course Text

-Sinnott R. and Towler C; 2013 " chemical Engineering Design" 5th edition Butterworth-Heinemann
-Coke,A.K ;2007"Ludwig s Applied Process Design of Chemical and petrochemical Plant" vol. 1 4th edition Gulf professional Publisher

Course Objectives : at the end of the semester the student should be able to :-

The ability to apply the design equation and equipments specifications as practical

To prepare students to be able to read and understand chemical engineering plants drawing

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Process planning:** Introduction, Nature of design ,the organization of a chemical engineering projects Scheduling .Standards and codes. Flow sheet design, flow sheet types and designation .Block diagram .Process flow sheet .Piping and instrumentation diagram .Utilities, Computer aided drafting ,process simulation programs .Layout and plot plan .Project evaluation and cost estimation	10 hr
2	**Piping network, Pumps and compressors** Valves selection . Piping design standards and codes. Pipe size selection .Mechanical design of piping system. Pump type, pump specifications, and pump data sheet	6 hr
3	**Vessels and tanks** Types of vessels. Criteria in vessel design, stress considerations. Materials of construction commonly used in vessels tanks. Design of tall vertical vessels. Pressure vessels Design. Vessels supports and foundations	10 hr
4	**Solid Handling** Screening Classification with Streams of Air or Water Air Classifiers. Size Reduction. Equipment for Size Reduction Particle Size Enlargement Extrusion Processes	4 hr

Universityof Technology
Department of Chemical Engineering

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.332**	Credits hr				Units
Course Title	Thermodynamics II					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mass Transfer, Thermodynamics I	**2**	**2**	**1**	**5**	**3**

Course Description

The course discuss the study of Power cycles; Refrigeration and liquefaction process; Theory and application of solution thermodynamics ;Vapor/liquid equilibrium in both: binary and multi-components; Ideal and non-ideal solutions are discussed using Raoult's and modified Raoult's law; Fugacity and fugacity coefficient definitions; Chemical reaction equilibriumandThermodynamic analysis of processes.

Course Text

1- J. M.Smith,H.C.Van Ness, Introduction to chemical engineering thermodynamics, 6th edition (International Edition), Mc-Graw Hall, 2008.

Other support books :-

1-K.V.Narayanan, Atext book of chemical engineering thermodynamics, prentice Hall of India, New Delhi, 2011.

2- B.G.Kyle, Chemical and process thermodynamics, (3rd Edition), prentice Hall Inc.New Jersey, 1984.

3-J. Rayner, Basic engineering thermodynamicsinSIunits, printed in great Britain,1971.

Course Objectives: at the end of the semester the student should be able to :-

3-Apply the laws of thermodynamics to power, refrigeration and liquefaction cycle.

4-Establish thermodynamic constraint that apply to VLE, and explain qualitatively the VLE diagram.

3. Apply thermodynamics to VLE of pure components and solutions in terms of fugacity and fugacity coefficients.

4. Apply equilibrium criteria to chemical reactions and evaluate the effect of temperature.

5. Revision for thermodynamic analysis of processes.

Topics Covered (Syllabus)/ Thermodynamics II

No.	Content	Duration
1	**Solution thermodynamics: theory** Fundamental property relations, the chemical potential and phase equilibrium, ideal gas mixtures, fugacity and fugacity coefficient, the fundamental residual property relations, the ideal solutions.	**4 hr**
2	**Vapor\liquid equilibrium; introduction :** The nature of equilibrium, the phase rule, Duhem,s theorem, diagrams for vapor liquid equilibrium, simple models for VL equilibrium: Rault,s law, dew point and bubble point calculations, Henrys law, VLE by modified Raults law, VLE from K value correlations, flash calculations.	**8 hr**

3	**Chemical Reaction equilibrium:** The reaction coordinate, standard Gibbs energy change and equilibrium constant, effect of temperature on equilibrium constant, evaluation of equilibrium constant, liquid phase reactions, equilibrium conversion for single reactions.	**8 hr**
4	**Production of power from heat**: The steam power plant, Rankin cycle, the regenerative cycle, internal combustion engines Otto engine, diesel engine, gas turbine engine.	**4 hr**
5	**Refrigeration and liquefaction:** The Carnot refrigerator, the vapor compression cycle, the choice of refrigerant, absorption refrigeration, the heat pump, liquefaction processes	**4 hr**
6	**Thermodynamic analysis of processes:** Second law relation for steady state flow processes, calculation of ideal work, thermodynamic analysis of steady state flow processes.	**2 hr**

Practical: (Thermodynamics lab.)

No	Name of Experiment
1	**Pressure and Temperature relationship for steam**
2	**Liquid -vapor equilibrium Isotropic Mixtures**
3	**Boyles' law**
4	**Refrigeration**
5	**Hydrolysis of methyl acetate**
6	**Regulating and charging battery**
7	**Measurement of the solar irradiation**
8	**Alternating current solar installation**

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.322**	Credits hr				Units
Course Title	Applied Mathematics in Environmental Engineering					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Mathematics III and IV Numerical Analysis	**2**	**-**	**1**	**3**	**2**

Course Description

This course introduces students to: Solve ordinary differential equations: apply Laplace transform to solve various systems of ordinary differential equations: Solve different types of partial differential equations. At the end of the course students should be able to apply these methods to tackle all kinds of problems that appear in chemical engineering.

Course Text

1- “Mathematical Methods in Chemical Engineering”, Jenson. V.J. and Jeffereys, G.V, 2^{nd} Edition, Academic Press New York, 1977.

2- “Applied Mathematics and Modeling for Chemical Engineers”, Rice R G. and. Do D. D., John Wiley and Sons, New York, 1995.

3- “Applied Mathematical Methods for Chemical Engineers”,Loney, Norman W., 2^{nd} edition, CRC Press

4- Taylor & Francis Group, Boca Raton, 2007.

Course Objectives: at the end of the semester the student should be able to:-

Apply different analytical methods to solve chemical engineering problems.

Topics Covered (Syllabus)/Applied Mathematics in Environmental Engineering

No.	Contents	Duration
1	**Review: (Ordinary Differential Equations):** L1: First Order Ordinary Differential Equations. L2: Second Order Ordinary Differential Equations. L3: Higher Order Ordinary Differential Equations.	**6 hr**
2	**Partial Differential Equations:** L1: Method of Direct Integration. L2: Separation of Variables (Forier Transforms). L3: Combination of Variables (Variation of Parameters). L4: Laplace Transforms.	**8 hr**

3	**Laplace Transforms** L1: Definitions (Laplace Transforms of Some Elementary Functions, Rules of Laplace Transforms). L2: The First Shifting Theorem, Multiplicity by X or X^n. L3: The Inverse of Laplace Transforms (Completing the Square in the Denominator, By Partial Fractions, By Convolution Integral, By Conversion Integral) L4: Laplace Transform of Derivatives L5: Solution of Ordinary Differential Equations (Ordinary Differential Equations with Constant Coefficient, Ordinary Differential Equations with Variable Coefficient). L6: Partial Differential Equations. L7: The Unit Step Function, The Unit Impulse Function. L8: The Second Shifting Theorem	**8 hr**
4	**Formulation of Chemical Engineering Problems (Modeling):** L1: Storage Tanks. L2: Mixing Tanks. L3: Chemical Reaction Vessels. L4: Heat Transfer Problems. L5: Mass Transfer Problems. L6: Momentum Transfer Problems. L7: Process Control System. L8: Another Problem.	**8 hr**

University of Technology
Department of Chemical Engineering

Program	*Chemical Eengineering and Oil Pollution*					
Course Code	**CES.E.334**	Credits hr				Units
Course Title	Unit Operations I					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Chemical Engineering Principles I, II Mass Transfer	**3**	**0**	**1**	**4**	**3**

Course Description

This course covers three main operations, gas absorption, stripping, distillation for binary and multi component mixtures and boundary layer. Concepts to design mass transfer equipment.The course aims to provide deeper knowledge, a wide scope and improved understanding of the mechanisms in mass transfer as well as a better insight into analytical and empirical methods applied in analysis and synthesis of mass transfer related problems.

Course Text

3- Coulson, J. M & Richardson J. F. (2006). “Chemical engineering”, Volume 2, 3rd Edition, Robert Maxwell. M. C.

4- Dutta Binary K. (2007), “Principles of Mass Transfer & Separation Process”, Bvt. Ltd. Prentice Hall, ISPN 8-1203-2990-2.

Other support books:-

2- Treybal Robert E. (1975), “Mass transfer Operation” 2nd Edition, Mc-Graw-Hill Book.

3- McCabe, W., Smith, J., Harriott, P. (2004), “Unit Operations of Chemical Engineering”,Mc-Graw-Hill Co., 7th Edition, ISBN0072848235.

Course Objectives: at the end of the semester the student should be able to:-

6- Understand the basics of gas absorption, stripping and distillation.

7- Design absorbers, strippers and distillation columns.

8- Find Operating lines, feed line and No. of trays or amounts of packing required.

9- Calculate columns efficiency.

10- Derive basic momentum equation models from first principles for the boundary layer.

Topics Covered (Syllabus)/ Unit Operation I

No.	Contents	Duration
1	**Introduction to separation processes:** General separation techniques. The mechanism of absorption and stripping processes. Flow regimes.	3 hr
2	**Absorption in packed bed columns**: Constructions, mass transfer coefficients & specific area, capacity, height of columns based on gas film, liquid film, and based on overall conditions, operating line, the transfer units, the importance of gas and liquid flow rates.	6 hr
3	**Absorption in Tray towers :** Types of trays, number of trays analytically and graphically. How to calculate the tray and column efficiency.	6 hr
4	**Introduction to distillation process:** Partial pressure, Dalton's, Raoult's& Henry's laws. Relative volatility, non ideal systems. Method of diffusion, binary mixtures, batch distillation, flash distillation, steam distillation. Fractionating column.	6 hr
5	**Fractionating process**: Number of plates required importance of reflux ratio, location of feed point, multiple feeds and side streams.	3 hrs
6	**Multi-component Distillation :** Key components. Components distributions, equilibrium data, feed & product compositions, minimum reflux ratio, calculation number of trays required, relation between reflux ratio & number of plates.	9 hr
7	**Plate & packed distillation columns:** General designed methods, column efficiency	3 hr
8	**Reynolds Analogy**: Mass transfer with bulk flow, flow over a plane surface, flow in a pipe.	9 hr

University of Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical Engineering and Oil Pollution</td></tr>
<tr><td>Course Code</td><td>CES.E.336</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Bio Chemical Reactor Eng.</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>Chemical Reaction Kinitics</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td></tr>
</table>

Course Description

To introduce and develop an understanding of reaction rate kinetics and apply this understanding to design a Fermenter(Batch, CSTR,PFR ,) for a certain duty either single or multiple once.

Course Text

4- Octave Levenspiel (1999), CHEMICAL REACTOR ENGINEERING, 3rd edition, John Wiley & Sons Inc., USA ISBN: 9780471254249.

Other support books :-

1- Smith, J. Chemical Engineering Kinetics. 3rd ed. New York, NY: McGraw-Hill, 1981. ISBN: 9780070587106

2- H. S. Fogler, Elements of Chemical Reaction Engineering, 4th Ed (2006), Prentice Hall,NewYorK.

Course Objectives : at the end of the semester the student should be able to :-

This course aims to establish fundamental knowledge for the students in biochemical reactor engineering. At the end of this course, students should be able to:

(i) Develop a deep understanding of issues related to the reaction step(s) in a chemical process and important role it plays in the success of the process both economically and environmentally.

(ii) Apply quantitative methods to Specify and size reactors for simple chemical reaction schemes (isothermal, non-isothermal and adiabatic operation) to achieve production goals for processes involving homogeneous or heterogeneous reaction systems.

(iii)Provide practice at developing critical thinking skills, solving open ended problems and to work in teams.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction :** The reaction rate and reaction mechanisms: Definition in terms of reacting compounds and reaction extent; rate laws, Arrhenius equation, elementary, reversible, non-elementary, catalytic reactions.Reaction mechanisms and rate laws: Reactive intermediates and steady state approximation in reaction mechanisms. Rate-limiting step.Chainreactions.Pyrolysis reactions. Reaction stoichiometry, lumped stoichiometries in complex systems such as bioconversions and cell growth (yields); extent of reaction, independence of reactions, measures of concentration. Single reactions and reaction networks, bioreaction pathways.	**6hr**

2	**Enzyme Fermentation:** Michaelis-Menten Kinetics (M-M Kinetics), Batch Or Plug Flow Fermenter, Mixed Flow Fermenter, Inhibition By A Foreign Substance-Competitive And Noncompetitive Inhibitio	**6 hr**
3	**Isothermal reactors for homogeneous reactions:** Design procedure: Batch reactor (constant volume and constant pressure) Design procedure: Continuous stirred-tank reactors (Single and multiple reactions) Design procedure: Tubular-flow reactors Comparison of stirred-tank and tubular-flow reactors.	**6 hr**
4	**Non-isothermal reactors:** L11: Energy conservation equations L12: Batch stirred-tank reactors L13: Continuous stirred-tank reactors	**6 hr**
5	**Multiple reactor System:** L14: Plug flow reactors in series and/or parallel L15: Equal- size mixed flow reactors in series (first order and second order reactions) L16: Mixed Flow Reactors of different sizes in series. L17: Best arrangement of a set of ideal reactors	**6 hr**

University of Technology
Department of Chemical Engineering

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.338**	Credits hr				Units
Course Title	Heat transfer II					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Heat transfer I	**2**	**2**	**1**	**5**	**3**

Course Description

This course will focus on the following topics:

- Learning about the heat exchanger and its types.
- Presenting the methods of predicting heat-exchanger performance.
- Discussing the methods that may be used to estimate the heat exchanger size and type
- necessary to accomplish a particular task.
- Understanding the phenomena of boiling and condensation process.
- Estimating the heat transfer for pool boiling and condensation process.
- Introducing the industrial furnaces and their types, and what are the design
- Considerations.
- Learn about the different types of renewable energies.

Course Text

1- Holman, J.P. (2009) Heat Transfer. 10th Edition, McGraw-Hill, New York.
Other support books: -
2- Harker, J. H., J. R. Backhurst, and J. F. Richardson. Chemical Engineering Volume 1. Vol. 1. Elsevier, 2013.
3- Incropera, Frank P., David P. DeWitt, Theodore L. Bergman, and Adrienne S. Lavine. Fundamentals of heat and mass transfer. Vol. 6. New York: Wiley, 1996.

Course Objectives: at the end of the semester the student should be able to:-

1- Process principles of heat transfer in chemical process industry.
2- Practical heat exchanger design.
3- The students must understand the processes involved in boiling and condensation to design the appropriate heat-transfer equipment.
4- Define and solve problems in boiling and condensation heat transfer.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Heat Exchangers:** • Introduction • Types of Heat Exchangers • The Overall Heat-Transfer Coefficient • Fouling Factors • The Log Mean Temperature Difference	**10 hr**

	• Design of heat exchanger by the conventional and Effectiveness-NTU • methods • Heat-Exchanger Design Considerations	
2	**Shell and Tube Exchanger** • Presenting a complete design of shell and tube heat exchanger. • Types and various specifications, design calculations by conventional and by effectiveness (NTU) methods and optimum design calculation.	**6 hr**
3	**Condensation and Boiling Heat Transfer:** • Introduction • Condensation Heat-Transfer Phenomena • The Condensation Number • Film Condensation Inside Horizontal Tubes • Boiling Heat Transfer • Simplified Relations for Boiling Heat Transfer with Water.	**6 hr**
4	**Radiation and Furnace design:** • Radiation properties, shape factor, heat exchange for nonblack bodies, parallel planes, shields, gas tradition. • Introduction about the types of furnaces	**4 hr**
5	**Renewable Energy:** • Solar radiation • Solar water heater • Solar air heaters • Heat exchangers for ocean thermal energy • Heat storage and transmits	**4 hr**

Practical: (Heat transfer lab.)

No.	**Experiment Name**
1	**Conductive Heat Transfer in Steady State.**
2	**Coil Heat Exchanger.**
3	**Determination of overall Heat Transfer Coefficient under different Air Velocity conditions**
4	**Heat transfer in fluidized bed reactor**
5	**Graphite Heat Exchanger**
6	**Extended Surface Heat Transfer**
7	**Film and dropwise condensation experiment**

University of Technology
Department of Chemical Engineering

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.3312**	Credits hr				Units
Course Title	Equipment Design in Environmental Engineering Using CAD					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Thermodynamics heat and mass transfer	**2**	**2**	**1**	**5**	**3**

Course Description

The aim of the subject is to engaged students with chemical plants by explain the main items of plants design by computer software ,and also supervise students design of heat exchangers and gas-liquids column by traditional design procedures

Course Text

1- Sinnott R. and Towler C; 2013 " chemical Engineering Design" 5th edition Butterworth-Heinemann

2- Coke,A.K ;2007"Ludwig s Applied Process Design of Chemical and petrochemical Plant" vol. 1 4th edition Gulf professional Publisher

Course Objectives : at the end of the semester the student should be able to :-

1- 1-Provide practice at developing critical thinking skills, solving open ended problems and to work in teams.
2- The student be able to use computer software packages to perform design activity beside the conventional methods
3- The student should have the necessary skills to design equipments

Topics Covered (Syllabus)/ Equipment Design in Environmental Engineering Using CAD

No.	Contents	Duration
1	Applied Design for Pressure vessels ,pumps and compressors flash drum, gas-liquid separator, liquid-liquid separator, gas movers and compressors manually and with computer aided	**6 hr**
2	Applied Design for heat equipments (shell And tube heat exchanger, plate heat exchanger , coiltype exchanger, condenser, vaporizer, air cooler …….etc) manually and with computer aided	**12 hr**
3	Applied Design for mass transfer equipments (distillation column, absorber column, leaching equipment, scrubber…………..etc) manually and with computer aided	**12 hr**

Practical: (Equip.Design in Enviro. Eng. Using CAD lab.)

No.	Experiment Name
1	Introduction
2	Equation of state & stream
3	Rotating Equipment (3.1 Compressor, 3.2 Expander, 3.3 pump)
4	Separation Operations (Separator , 3-Phases Separator , 4.3 Tank)
5	Heat Transfer Equipment (Heater & Cooler, Heat Exchanger, LNG,Air Cooler)
6	Column distillation (Column Installation, Column Property View, Column-Specific Operations and Running the Column)
7	Reactors(CSTR, General Reactor, Gibbs, Equilibrium, conversion)
8	Logical Operations (Adjust, Balance, Recycle, Set)
9	Process plant involving reaction and separation
10	Examination lab

Universityof Technology
Department of Chemical Engineering

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.3313**	Credits hr				Units
Course Title	Solid Waste Managment					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Principles of Sustainability	**2**	**-**	**--**	**2**	**2**

Course Description

Solid wastes arising from all kind of industrial and human activities, their impacts on human health and environment, their classification and handling, as well as international concerns on solid wastes will be elaborated.

ourse Text

Srinivasan D ; Environmental Engineering " PHI learning 2012
Ramachaudra T V "Management of Municipal Solid Waste ' Commonwealth of learning Canada 2006 .

Course Objectives: at the end of the semester the student should be able to :-

1. Under stands waste classification that involve students in the management and treatment of waste for disposal ,take in consider the environmental and human health risks.
2. .Provide steps for effective new applications technology to reduce waste disposal

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction to solid waste management** Definition; Classification, and Composition of solid waste; Sources of solid waste, type of material recovery from the solid waste.	**4 hr**
2	**Characteristics of solid waste** Physical; Chemical, and Biological properties of solid waste.	**2 h**
3	**Treatment and Disposal of SolidWastes from Industry** Definition of industrial solid waste;Methods of treatment of solid waste: thermal treatment, dump and landfills, biological treatment; Disposal of solid waste	**6 hr**
4	**Land filling with solid waste design and operation**	**4 hr**
5	**Incineration and Energy Recovery** Definition, Type of waste treated by incineration; Planning of Incineration facility; Incineration technology;Energy recovery	**6 hr**
6	**Waste Reduction, Recovery and Recycling** Waste hierarchy, Benefits of waste hierarchy; Component of waste hierarchy: 1.Waste prevention, 2. Reuse, 3.Recycling, 4.Recovery; 5.Disposal; Planning of recyclingprogram.	**4 hr**
7	**Hazardous waste characterization and treatment** Definition and Classification of hazardous waste; Hazardous waste treatment methods; Hazardous waste minimization	**4 hr**

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.421**	Credits hr				Units
Course Title	Project I					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	chemical engineering Principles I,II.III Thermodynamics I & II	**1**	**2**	**---**	**3**	**2**

Course Description

The course includes the design aspects and design considerations for plant of chemical industry.

Course Text

Sinnott R.K. "Chemical Engineering Design", Coulson and Richardson's. Chemical Engineering, Volume 6, Fourth edition, (2005).

Other support books :-

1-Peters M. S., Timmerhaus K.D. and West R.E. Plant Design and Economics for Chemical Engineering, Fifth edition, (2003).

Course Objectives: at the end of the semester the student should be able to:-

To learn the students the basic information's of designing the chemical plants and the economic and engineering aspects

Topics Covered (Syllabus)/ Project I

No.	Contents	Duration
1	**Introduction to Design** The anatomy of chemical manufacturing process, general overall design considerations, development of design data base, process creation, types of process design.	**5 hr**
2	**Design Information and Data** Source of information of physical properties , predication of physical properties (density, viscosity, thermal conductivity , etc)	**5 hr**
3	**Material andChemical Engineering Principle II** Review of material andChemical Engineering Principle II, flow sheet symbols, PFD information in flow diagram	**5 hr**

Project Requirements

No.	Contents	Duration
1	**Chapter One** Introduction, Historical Profile, Physical and Chemical Properties, Applications for chemical material production.	4 hr
2	**Chapter Two** Production Methods, Comparison between Processes, Selected the optimum Process, Physical properties of raw materials and by products, Production Capacity.	4 hr
3	**Chapter Three** Material balance for the plant process.	10 hr
4	**Chapter Four** Chemical Engineering Principle II for the plant process, Process flow diagram (PFD).	10 hr
5	**Poster and Oral Presentation**	2 hr

University of Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical Engineering and Oil Pollution</td></tr>
<tr><td>Course Code-</td><td>CES.E. 431</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course title</td><td>Unit Operation II</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Chemical Engineering Principle II &III
-Fluid FlowI, II
-Thermodynamics I, II,
-Unit operation I,
-Heat Treansfear I &II,</td><td>2</td><td>2</td><td>1</td><td>5</td><td>3</td></tr>
</table>

Course Description

Theory, applications and design of unit operations which are mostly employed in the chemical industry, drying of solid, humidification, dehumidification and cooling tower and liquid evaporation and crystallization.

Course Text

1- Coulson ,J.M and Richardson J.F. "Chemical Engineering , Volume 1, 3rd edition ,Robert Maxwell.M.C.

2- Coulson J.M, and Richardson J.F. "Chemical Engineering, Volume 2, 3rd edition, Robert Maxwell.M.C.

Other support books :-

- Perry,J.H, "Chemical engineering handbook ",Mc-Graw –Hill Bookcom.1975.
- Binay.K.Dutta "Mass transfer and separation process" 2007.
- Trebal Robert E., "Mass transfer operation"2nd edition, Mc-Graw –Hill Book com.1975.

Course Objectives: at the end of the semester the student should be able to:-

1- To provide an understanding of the general principles of separation processes to allow students to make sensible options given a separation task (Humidification, Dehumidification and Cooling tower, Evaporation, crystallization, and Wet Solid Drying).

2- A comprehensive understanding of the transport processes related to chemical engineering operations, with focus on both theory and applications.

3- Ability to select of appropriate equipment for the separation of materials in process plant.

4- Provide practice at developing critical thinking skills, solving open ended problems and to work in teams.

Topics Covered (Syllabus)

No.	Contents	Duration
1	**Drying of Solids** Introduction Drying of Solids....General Principles. Wet Solid Group.Terminology and Definitions. Humidity Measurement. Humidity Data for Air – Water system. Temperature –Humidity Chart (Psychometric Chart). Uses of Humidity Chart. Rate of Drying. Calculation method of Drying Rate and Time. Drying Rate. Drying Time. Mechanism of Moisture Movement in Wet Solid. Material and Heat Balance for Continuous Dryers. Rate of Drying for continuous Direct Heat Driers. Drying at High Temperature. Drying at Low Temperature. Drying Equipment.	6 hr
2	**Humidification, dehumidification and Cooling towers** Introduction. Humidification Operations. Adiabatic Operations. Non-Adiabatic Operations. Mixing of Humid Streams. Mixing of Two Stream of Humid Gas. Addition of Liquid or Vapor to a Gas. Humidification Processes Theory. Cooling Tower Principles and Operations. Cooling Tower Classification. Design Cooling Tower. Adiabatic Humidification — Cooling. Dehumidification Tower	9 hr
3	**Evaporation** Introduction, Types of Evaporations, Evaporation Equipment, Heat transfer in Evaporation Process, single, double and Multi effect Evaporators, Design of evaporators, Comparison of Forward, backward and Parallel effect evaporators, boiling Point rise.	9 hr
4	**Crystallization** Crystallization fundamentals, cooling crystallizer, Evaporating crystallizer, Batch and continuous crystallization Crystallizer selection.	6 hr

Practical: (Unit Operation lab.)

No.	Experiment Name
1	**Tray Dryer**
2	**Plate and Frame Filtration**
3	**Rotary Drum Filtration**
4	**Design of Cooling Tower**
5	**Sedimentation**
6	**Liquid - Liquid Extraction**

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E. 433**	Credits hr				Units
Course Title	Process Dynamics					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Chemical Engineering Principles II & III -Applied Mathmatics in Chem. Eng	**2**	**-**	**1**	**3**	**2**

Course Description

Study of dynamics characteristics of open-loop Chemical Engineering processes to formulate transfer function and analysis response of the system to design and select closed-loop controlscheme.

Course Text

1. D.R. Coughanowr and S. LeBlanc, Process Systems Analysis and Control, McGraw-Hill, 3rd edition, 2008.
2. Stephanopoulos G., "Chemical Process Control-An Introduction to Theory and Practice, "Prentice -Hall, New Jersey, 1984.

Other support books :-

1. Luyben W. L., "Process Modeling, Simulation and Control for Chemical Engineers," McGraw-Hill, New York, 2nd Ed., 1990.
2. Process Dynamics: Modeling, Analysis and Simulation, by Wayne Bequette.

Course Objectives : at the end of the semester the student should be able to :-

1. Study of dynamic analysis of chemical processes to allow students to identify the system under different operating conditions.
2. Understanding of formulate transfer function of the system.
3. Testing and selecting of critical process variables.
4. Developing of skills, solving open ended problems and to work in teams.

Topics Covered (Syllabus)/ Process Dynamic

No.	Contents	Duration
1	**Linear Open-Loop Systems** Transfer function**,** Transient Response,ForcingFunctions:Step Response **,**Impulse Response Ramp Response Sinusoidal Response.	**10 hr**
2	**Applications of First Order Systems** Liquid –level system, heating system, Mass transfer system, Reactors, absorber, pressure vessel, Linearization.	**8 hr**
3	Response of First-Order Systems in Series Non-interacting System, Interacting System.	**4 hr**
4	**Higher-Order Systems** Second-Order: Under-damped, Critical and over-damped, Transportation Lag	**8 hr**

University of Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical Engineering and Oil Pollution</td></tr>
<tr><td>Course Code</td><td>CES.E 435</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Water and Wastewater Treatment Engineering I</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Unit Operation I,
-Equipment Design</td><td>2</td><td>2</td><td>1</td><td>5</td><td>3</td></tr>
</table>

Course Description

1-Classification, significance and concentration ranges of impurities in water and wastewater.
2-Physical and chemical treatment methods.

Course Text

1. Metcalf & Eddy, "Wastewater Engineering, Treatment & Reuse" McGraw-Hill, 4th Ed. 2003.

Other Support Boks:

1. Vesilind, P.A., & Jeffrey, J.P., "Environmental Engineering" Ann Arbor As. Publishers, 1982.
2. Hammer, M. J., "Water& Wastewater Technology", John Wiley & Sons, 1977.
3. Mackenzie, L.D., "Water & Wastewater Engineering, Desighn Principles & Practice", McGraw-Hill INTERNATIONAL Ed., 2011.

Course Objectives : at the end of the semester the student should be able to :-

1- Understand the nature of impurities in water and wastewater, their concentrations.
2- Understand the basic principle of conventional chemical and physical treatment processes.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction:** Terminology inwastewater,constituents'wastewater,characteristics of Wastewater, component of wastewater flow.	**6 hr**
2	**Physical treatment** Principle of physical treatment screening and grit removal, sedimentation and filtration,flotation, aeration system.	**12 hr**
3	**Chemical treatment:** Principle of chemical treatment, precipitation, coagulation and flocculation, chemical oxidation, disinfection.	**12 hr**

Practical: (Chem. lab.)

No.	Experiment Name
1	Coagulation, Flocculation and sedimentation of river water treatment by jar-test
2	Sedimentation of suspended solid
3	Wastewater treatment
4	Ion -Exchange
5	Removal heavy metals by adsorption
6	Flotation
7	Desalination by membrane
8	Sludge- treatment

Universityof Technology
Department of Chemical Engineering

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E 437**	Credits hr				Units
Course Title	Industrial and Petroleum Pollution Control					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Air Pollution Control Engineering, - Solid waste managment	**2**	**-**	**1**	**3**	**2**

Course Description

The course contents Petroleum refinery and petrochemicals, Soap and detergents, Paint and dyes, Soap and detergents, Pesticide

Course Text

1. Nanley , N., and Bhatia, S.C.,"Pollution control in Chemical and Allied Industries", CBS Publisher and Distributors Pvt. Ltd. 1st ed. 2010.
2. Rao C.S.," Environmental Pollution and Control engineering", Willy Eastern Limited 1993.

Course Objectives : at the end of the semester the student should be able to :-

1. The course attainted to give the student the knowledge about the different chemical processes flow sheets
2. The student be capable to eliminate or reduce the negative environmental effects of chemical process

Topics Covered (Syllabus)/ Industrial and Petroleum Pollution Control

No.	Contents	Duration
1	**Petroleum refinery and petrochemicals:** Refining of petroleum, Waste generation in petroleum refinery, Wastewater from refinery, Control of air emissions in refinery, Petrochemical and allied products, Solid waste pollution in petrochemical industries, Control of air emission in petrochemicals.	**10 hr**
2	**Soap and detergents:** Classification of surfactants, Source of detergent in water and wastewater, Impact on wastewater treatment processes, Industrial operation and wastewater, Soap manufacture and processing, detergent manufacture and waste stream, wastewater control and treatment, Airemissions	**4 hr**
3	**Paint and dyes:** Manufacture process, Air pollution, Wastewater generation, Dye and dye intermediates.	**4 hr**
4	**Sugar, Distiller and Fermentation products:** Sugar, Distillery industry, Fermentation products.	**4 hr**
	Textile: Water pollution from Boilers, Water pollution from water treatment plants, Operations involved in finishing characteristics of texture wastewater treatment of textile wastewaters.	**4 hr**
6	**Pesticide:** Classification of pesticides, Pollution prevention and control, wastewater generation and treatment technique.	**4 hr**

University of Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical Engineering and Oil Pollution</td></tr>
<tr><td>Course Code</td><td>CES.E. 438</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course Title</td><td>Catalysis & Catalytic Engineering</td></tr>
<tr><td>Term</td><td>1st Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Mass Transfer
-Heat Transfer,
-Fluid Flow I
-Thermodynamics II
-Reactor Design</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td></tr>
</table>

Course Description

This course includes definition of catalysis and catalyst, classification of catalysis processes with examples, mechanisms of catalysis, studying properties of porous catalysts,kinetics of heterogeneous catalytic reactions, studying the types of catalysts, preparation of supported catalysts and catalyst deactivation, characterization techniques of catalysts and studying applications of catalysts in catalytic processes.

Course Text

1. H. Scott Fogler, Elements of Chemical Reaction Engineering, 5th edition, 2016.
2. Chorkendorff, J. W. Niemantsverdriet, Concepts of Modern Catalysis and Kinetics, 2003.
3. Jens Hagen, Industrial Catalysis, 2006
4. Calvin H. Bartholomew, Robert J. Farrauto, Fundamentals of Industrial Catalytic Process, 2nd edition, 2006.
5. Julian Ross, Heterogenous Catalysis, 2012.
6. Robert L. Augustine, Heterogenous Catalysis for the Synthetic Chemist, 1996.
7. Yoshio Ono, Hideshi Hattori, Solid Base Catalysis, 2011.

Course Objectives : at the end of the semester the student should be able to :-

1. Understand the catalysis processes and acknowledge the different types.
2. Know the types of catalysts, properties of catalysts, how to make a catalyst and how catalysts lose their activities (studying the types of catalyst deactivation).
3. Suggest mechanisms and determine which step of heterogenous reaction is limiting and find the rate law in addition to understand how to analyze the heterogeneous data and design the heterogenous reactor.
4. Prepare the catalysts and improve the catalysts by reducing the deactivation of catalysts.
5. Test the catalysts using different characterization techniques to study the structural and functional properties of catalysts.

Topics Covered (Syllabus)/ Catalysis and Catalytic Engineering

No.	Contents	Duration
1	**Introduction** Definition, classification of catalysis processes with examples, mechanisms of catalysis.	3 hr
2	**Kinetics of Heterogeneous Catalytic Reactions** Studying the steps of catalytic reaction, synthesizing a rate law, mechanism, and rate-limiting step, analyzing the heterogeneous data (experimental data) for reactor design, and designing the heterogenous reactor.	12 hr
3	**The Properties of Porous Catalysts** Studying properties of porous catalysts (i.e. mechanical strength, stability, activity, and selectivity), pore size, solid density and porosity calculations, pore volume distribution…..etc, and studying the operating condition effects (i.e. temperature, pressure, residence time; *W/F*) and catalyst performance.	6 hr
4	**Types of catalysts, Preparation of Supported Catalysts and Catalyst Deactivation**	6 hr
5	**Applications of catalysts in catalytic processes**	3 hr

University of Technology
Department of Chemical Engineering

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E- 423**	Credits hr.				Units
Course Title	Industrial Management & Ethics					
Term	1st Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	—	**2**	**–**	**1**	**3**	**2**

Course Description

Theory and applications, of Industrial Engineering Management which are mostly employed in The chemical industry Industrial Engineering Management; ,Industrial organization, Maintenance Work Measurement Techniques, Engineering Ethics, Quality Control, ISO and Safety Requirements.

Course Text

T.R. Banga and S.C. Sharma “Industrial Engineering Management” including Production Management, Eleventh Edition:2008.

M.S. Peters, K.D. Timmerhaus and R.E. West “Plant Design and Economics for Chemical Engineers” Fifth Edition: 2003.

Course Objectives: at the end of the semester the student should be able to:-

To helps and learn in the optimum use of plant, equipment, efforts towards productivity improvement, establishing the most efficient and effective utilization of human effort and synchronizing various resources like men, machine and material as well as Engineering Ethics.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Management** Principle of management, types and classifications, management responsibility, organization responsibility.	**2 hr**
2	**Industrial organization** Site, Feasibility study, Development of efficient work method (plant layout, flow of material, material handling), Workstations, Inputs and Outputs, Production planning (types of Productions).	**2 hr**
3	**Maintenance** Classification, Cost, Machine replacements, Case studies and examples.	**2 hr**
4	**Network Analysis** Principles and applications, Critical path method (CMP), Gant Chart, Pert techniques (examples and case studies).	**2 hr**

5	**Work Measurement Techniques** Time and Motion study.	2 hr
6	**Engineering Ethics:** Engineering has a direct and vital impact on the quality of life for all people. Engineering is an important and learned job. Engineers are expected to exhibit the highest standards of honesty and integrity. Accordingly, the services provided by engineers require honesty, impartiality, fairness, and equity, and must be dedicated to the protection of the public health, safety, and welfare. Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct.	10 hr
7	**Quality Control:** Standardization, Specification, Sampling techniques, Inspection- analysis of results. Quality costs (preventive cost, appraisal cost and failure cost). Application of quality control chart-examples, Reliability.	4 hr
8	**ISO:** Requirements, applications, ISO series, Quality management system (QMS), Total Quality management (TQM), Requirements and applications.	3 hr
9	**8-Safety Requirements:** Hazards (type's e.g. industrial hazards, pollution (air pollution, water pollution, industrial pollution). Industrial by products and industrial waste, Safety requirements of industrial sites, Requirements of suitable work environment (examples with particular emphasis in chemical industry).	3 hr

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E. 422**	Credits hr				Units
Course Title	Project II					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Mass Transfer -Unit OperationI & II -Heat Transfer I & II -Equipment Design -Catalysis Eng. and Reactor Design	**1**	**2**	**---**	**3**	**2**

Course Description

The course includes the design aspects and design considerations for plant of chemical industry.

Course Text

Sinnott R.K. "Chemical Engineering Design", Coulson and Richardson's. Chemical Engineering, Volume 6, Fourth edition, (2005).
Other support books :-
1-Peters M. S., Timmerhaus K.D. and West R.E. Plant Design and Economics for Chemical Engineering, Fifth edition, (2003).

Course Objectives: at the end of the semester the student should be able to:-

To learn the students the basic information's of designing the chemical plants and the economic and engineering aspects

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Choice of Plant Location and Layout Standard**	3 hr
2	**Piping and Instrumentation** Pipes, valves, Pumps, Mechanical design and control	4 hr
3	**Cost and Project Evaluation**	3 hr
4	**Safety and Loss Prevention**	2 hr
5	**Design with Computer Aided**	3 hr

Project Requirements

No.	Contents	Duration
1	**Chapter Five** Design main equipment by design equation with mechanical design, cost evaluation, control andcomputer aided using Hysys software	14 hr
2	Design supported equipment with mechanical design, cost evaluation and control.	6 hr
3	**Chapter Six** Environmental effect for raw materials, products and by products	6 hr
4	**Poster and Oral Presentation**	4 hr

Universityof Technology
Department of Chemical Engineering

<table>
<tr><td>Program</td><td colspan="6">Chemical Engineering and Oil Pollution</td></tr>
<tr><td>Course Code-</td><td>CES.E. 432</td><td colspan="4" rowspan="2">Credits hr</td><td rowspan="3">Units</td></tr>
<tr><td>Course title</td><td>Unit Operation III</td></tr>
<tr><td>Term</td><td>2nd Semester</td><td>Theoretical</td><td>Practical</td><td>Tutorial</td><td>Total</td></tr>
<tr><td>Prerequisite(s)</td><td>-Engineering Principle II & III
-Fluid Flow I,& II,
-Thermodynamics I,& II
-Mass Transfer
-unit operation I ,& II
-Heat t Transfer I,& II</td><td>3</td><td>0</td><td>1</td><td>4</td><td>3</td></tr>
</table>

Course Description

A comprehensive understanding of the transport processes related to chemical engineering operations with focus on theory, design and applications of Solid–liquid filtration, Sedimentation, liquid - liquid extraction, Leaching and Washing.

Course Text

- Coulson, J.M and Richardson J.F. "Chemical Engineering" , Volume 1, 3rd edition, Robert Maxwell.M.C.
- Coulson,J.M and Richardson J.F. "Chemical Engineering" , Volume 2, 3rd edition , Robert Maxwell.M.C.

Other support books :-

- De Sinha and Parameswar De "Mass Transfer: Principles and Operations", ParameswarDe , New Delhi, 2012
- Binay.K.Dutta "Mass transfer and separation process" 2007.
- Trebal Robert E., "Mass transfer operation"2nd edition, Mc-Graw –Hill Book com.1975.

Course Objectives: at the end of the semester the student should be able to :-

1- Basic information, concepts and terminology of the general principles of separation processes of Solid –liquid filtration, Sedimentation, liquid - liquid extraction, Leaching and Washing.
2- Demonstrating a broad and integrated knowledge and a deep understanding of issues related to separation processes in a chemical process and important role it plays in the success of the process both economically and environmentally.
3- Ability to select of appropriate equipment for the separation of materials in process plant.
4- An ability to apply effective, creative and innovative solutions, both independently and cooperatively, to current and future problems in separation processes and transport phenomena.

Topics Covered (Syllabus)

No.	Contents	Duration
1	**Filtration:** Type of Filters, Filtration theory, Plate and frame filter press, leaf filter, filtration at Constant ΔP, Filtration at Constant rate, washing Time.	12 hr
2	**Sedimentation:** Introduction, Settling and Sedimentation in particle fluid separation, Sedimentation and thickening design, equipment for settling and Sedimentation.	9 hr
3	**Liquid - Liquid Extraction and Leaching:** Definition, Extraction process, Equilateral Triangular coordinates (Ternary Diagram), system of three liquid _ one pair partially soluble, choice of solvent, Equipment in extraction cross _ current extraction, multi stage Cross Current extracting cross current for insoluble Liquid , Continuous Counter current extraction , Continuous Counter Current in Soluble , Liquid , Minimum Solvent . General principles, Equipment for leaching	18 hr
4	**Membrane** Introduction , classification of membrane processes , general membrane equation , liquid permeation membrane processes , gas permeation membrane processes reverse osmosis , reverse osmosis with water treatment plant , ultra filtration membrane processes , micro filtration membrane processes	6 hr

University of Technology
Department of Chemical Engineering

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E. 434**	Credits hr				Units
Course Title	Process Control					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Process Dynamic	**2**	**2**	**1**	**5**	**3**

Course Description

Analysis ofclosed-loop Chemical Engineering processes system to design and select closed-loop controlscheme that will operate the plant with stable conditions.

Course Text

1. D.R. Coughanowr and S. LeBlanc, Process Systems Analysis and Control, McGraw-Hill, 3nd edition, 2008.
2. Stephanopoulos G., "Chemical Process Control-An Introduction to Theory and Practice, "Prentice -Hall, New Jersey, 1984.

Other support books :-

1. Luyben W. L., "Process Modeling, Simulation and Control for Chemical Engineers," McGraw-Hill, New York, 2nd Ed., 1990 .
2. Process Dynamics: Modeling, Analysis and Simulation, by Wayne Bequette.

Course Objectives: at the end of the semester the student should be able to :-

1- To enhancement the ability of students for the analysis of closed-loop system and response of controlled system under different operating conditions.
2- Constructions of transfer function of the closed system for different schemes.
3- Provide practice of tuning of controller parameters and limiting of stable operating conditions.
4- Motivation and encourage the students for solving open ended problems.

Topics Covered (Syllabus)/ Process Control and Instrumentation

No.	Contents	Duration
1	**Instrumentation** Sensors: pressure, temperature, level, flow and concentration. Control valve. Dynamics characteristics of Instruments.	**6 hr**
2	**Linear Closed-Loop Systems** The Control System, Controllers and Final Control Elements, Block Diagram of Controlled System, Overall Closed-Loop Transfer Functions.	**4 hr**
3	Characteristics of the Closed Loop System Transient Response of Simple Control Systems, Stability	**7 hr**
4	**Frequency Response Methods** Introduction to Frequency Response Bode Diagrams, Control System Design by Frequency Response, Ziegler-Nichols Controller Settings.	**7 hr**
5	**Computer Control of Chemical process** Analog Computer, Digital Computer, Computer Control Loops.	**3 hr**
6	**Control of Complex Processes** Distillation Column, Absorber, Chemical Reactor.	**3 hr**

Universityof Technology
Department of Chemical Engineering

Practical: (Process Control lab.)

No.	Experiment Name
1	**Feedback Control**
2	**Dynamic Behavior of Second order under Damped System (Orifice)**
3	**Flow rate Control**
4	**Level Control in the Tank**
5	**Pressure Control**
6	**Dynamic Behavior of Second order over Damped System (Stirred Tanks)**
7	**Dynamic Behavior of Second order over Damped System (Stirred Tanks Heater)**
8	**Temperature Control**
9	**PH Control**
10	**Control of Water Treatment Unit**

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.436**	Credits hr				Units
Course Title	Water and wastewater treatment Eng. II.					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Water and Wastewater treatment Eng. I	**2**	**0**	**0**	**2**	**2**

Course Description

1- Biological processes for wastewater treatment.
2- Examples of flow sheet in treatment plants.

Course Text

1. Waste water Engineering Treatment and Reuse: Mc Graw Hill, G. Tchobanoglous, FI Biston, 2002.
2. Industrial Waste Water Management Treatment and Disposal by Waste Water Mc Graw Hill III Edition 2008.

Course Objectives: at the end of the semester the student should be able to :-

1- Understand the basic principle of biological treatment methods.
2- Understand the advanced wastewater treatment methods.
3- Select appropriate process, depending in nature of the impurities to be removal.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Biological treatment:** Principle of biological treatment,Microbial metabolism – Bacterial growth and energetic,Aerobic biological oxidation – Anaerobic fermentation and oxidation,Combined aerobic processes, Biological Reaction Kinetics, Stabilization Ponds, Activated Sludge film packing, Trickling Filters, Rotating Biological Contactors, Nutrient Removal	**10 hr**
2	**Advanced wastewater treatment:** Tertiary treatment – ion exchange, Membrane separation Techniques: Filtration. Reverse osmosis principle, Membrane materials, electro chemical techniques: electro dialysis, electro coagulation, Adsorption,Advanced oxidation process, photo catalysis.	**8 hr**

3	**Industrial Wastewater Treatment** Sources, Characteristics, methodology and process for the treatment of industrial wastes of sugar industry- beverage industry – tannery industry – textile mill waste industry – fertilizer plant – steel plant – oil refinery – paper and pulp mill. Legislation, Cleaner technologies: Water conservation.	4 hr
4	**Sewage Treatment and Disposal** Introduction, importance of sewage, Characteristics of sewage, Sampling and analysis of sewage, Sewage treatment and disposal: Skimming, Grit chamber, Sedimentation tanks, Septic tank, Secondary treatment-types of filters, rate of filter loading, Activated sludge process, sludge digestition, Sludge disposal.	6 hr
5	**Types of residuals** Sources; Conventional residual management systems; Residual management: Concentration, Stabilization, Conditioning, Dewatering	2 hr

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E.424**	Credits hr				Units
Course Title	Optimization					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	-Numerical Analysis -Mathematics III, IV -Unit Operation.I&II	**2**	**-**	**1**	**3**	**2**

Course Description

The subject is to be given in one semester. studying the formulation of objective the theory of optimization of single variable using analytical and numerical methods. Determination in the solution of multi variables problems .studying and solving the linear programming problems (LP).

Course Text

1) Optimization, Greirg D.M. Longmangroup limited London.
2) Optimization, converse A.O ,Holt, Reinhart, and Winston.

Other support books :-

1) Numerical methods for unconstrained optimization, Murrayw. Academic press.
2) Constrained optimization by direct search Swann, W.H. Gill and Murray.

Course Objectives : at the end of the semester the student should be able to :-

1- To formulate many problems arising in widely different situations.
2- Ability for finding optimum. Minimum, or maximum in unconstrained or constrained single or multi variables functions..
3- Deals with the special case of linear programing (functions and constraints are linear).
4- Provide practice to deal with industrial optimization problems.

Topics Covered (Syllabus)/ Optimization

No.	Contents	Duration
1	**Introduction to optimization.**	**2 hr**
2	**Recognizing an optimization problem and their solution.** - Formulation of optimization problems. - Unconstrained and constrained problems.	**4 hr**
3	**Optimization methods for single variable problems.** - Analytical methods; constrained and unconstrained. - Graphical method. - Numerical methods. Unconstrained functions; fixed step method, DSC method, Newton method. Constrained functions; sequential search, Dichotomous search; Fibonacci search, Golden ratio search.	**6 hr**

4	**Determining the solution to multivariable optimization problems.** Unconstrained minimization and maximization strategy. - Solving linear and non-linear equations using matrices. - Optimality conditions for unconstrained problems. - Lagrangian criteria. - Simplex method direction step length calculation. Solution of constrained multivariable problems. - Analytical solution. - Lagrangian duality. - Linearization of nonlinear optimization problems. - Simplex method. - Pivot table formulation. Linear programming (LP) formulation. - Solving linear system. - Basic solution of (LP) problems. - Graphical interpretation.	6 hr
5	**Applications of Optimization**: - Heat Transfer and Energy Conservation. - Separation Processes. - Fluid Flow Systems. - Chemical Reactor Design and Operation. - Optimization in Large-Scale Plant. Design and Operations. - Integrated Planning. Scheduling. And Control in The Process Industries.	8 hr
6	**Introduction to:** - Machine learning. - Deep learning - Neural network. - Artificial Intelligence.	4 hr

University of Technology
Department of Chemical Engineering

Program	*Chemical Engineering and Oil Pollution*					
Course Code	**CES.E. 439**	Credits hr				Units
Course Title	Petroleum Refinery Processing					
Term	2^{nd} Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Fuel and Clean Energy	**2**	**0**	**1**	**3**	**2**

Course Description

An introduction to petroleum feedstocks, refining processes, and how refined products are made. Design of atmospheric and vacuum columns for petroleum fractionation will be explained. Refinery processes will be explained in terms of their objectives, feedstocks, products and catalysts.

Course Text

1. W.L..Nelson" Petroleum Refining Engineering " 4th Edition. McGraw Hill, New York, 1985
2. M.A. Fahim, T.A. Al-Sahhaf, and A.S. Elkilani," Fundamentals of Petroleum Refining", Elsevier, 2010.
3. J.H. Gary and G. E. Handwerk and M.J. Kaiser, "Petroleum Refining Technology and Economics", 5th Ed. CRC Press, 2007.

Course Objectives : at the end of the semester the student should be able to :-

1. Become knowledgeable in composition, properties and classification of crude oil or petroleum.
2. Become familiar with the overall refinery processes including physical separation operations and chemical conversion processes.
3. Become knowledgeable about impurities in crude oil and how to remove them from products.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction to the Petroleum Industry**: History and origin and occurrence of crude oil. Exploration, recovery and transportation of crude oil.	2 hr
2	**Feedstock and Products Compositions, Properties and Specifications** Composition and classification of crude oil. Physical properties such as gravity, pour point and impurities level in petroleum. Specific Gravity, Boiling Point Curves.Typical fraction cuts and boiling ranges for atmospheric and vacuum still fractions.	6 hr
3	**Heating of Crude oil:** Types of pipe still heaters, calculations of radiant absorption rates	2 hr

4	**Crude Distillation:** Desalting Crude Oils, Atmospheric distillation tower: types of refluxes. Energy balance in a topping tower and calculations involve estimation of top, side, bottom draw tray temperatures	**6 hr**
5	**Thermal and Catalytic Cracking:** Process variables, products propertied and yields. Process descriptions and review – delayed coking, flexicoking, fluid coking, visbreaking.	**4 hr**
6	**Catalytic Reforming:** Objectives, process, Reactions, catalysts and effect of process variables.	**2 hr**
7	**Isomerization, Alkylation and Polymerization:** Objectives, process, Reactions, catalysts and effect of process variables.	**2 hr**
8	**Hydrotreating and Hydrodesulfurization:** Chemistry and catalysis of hydrotreating reactions for sulfur and nitrogen removal. Unit configurations, process variables	**4 hr**
9	**Supporting processes:** Hydrogen Production, Gas Processing Unit, Acid Gas Removal, Sulfur Recovery Processes.	**2 hr**

University of Technology
Department of Chemical Engineering

Program	***Chemical Engineering and Oil Pollution***					
Course Code	**CES.E.-4310**	Credits hr				Units
Course Title	Corrosion and Degradation					
Term	2nd Semester	Theoretical	Practical	Tutorial	Total	
Prerequisite(s)	Material Engineering	**2**	**-**	**-**	**2**	**2**

Course Description

Definition of corrosion ,why metal corrode, classification of corrosion ,forms of corrosion ,polarization ,measurement of corrosion rate, protection methods.

Course Text

1. Principles and Prevention of Corrosion (2nd Edition) By Denny A. Jones Prentice Hall, 1995.
2. Environmental Degradation of Materials, R Balasubramaniam, Cengage International, 2010.
3. Corrosion and Corrosion Control, H.H. Uhlig and W. Revie, Wiley, New York, 2007.
4. Corrosion Science and Technology, By David Talbot, James Talbot, CRC Press, 1998.
5. Corrosion Engineering By Mars. G. Fontana, Third ed., TMH.
6. Corrosion Basics: An Introduction By Pierre R. Roberge, 2nd Edition, NACE Press Book, 2 2006.

Additionalreadings

1. Electrochemical Techniques in Corrosion Science and Engineering By R. G. Kelly, CRC Press, 2002.
2. ASM Handbook Volume 13A: Corrosion: Fundamentals, Testing, and Protection, ASM International 2003

Course Objectives : at the end of the semester the student should be able to :-

1. To introduce and develop and understanding the material that are precious resources, how these resources are destroyed by corrosion and how they must be preserved by applying corrosion protection technology.
2. Inspect the corrosion process, and the form of corrosion.
3. Determine the corrosion rate, and electrochemical behavior of the metals.
4. Applying the corrosion prevention technology.

Topics Covered (Syllabus)/ Course Title

No.	Contents	Duration
1	**Introduction:** Definitions, Different forms of environmental degradation, Cost of corrosion, Electrochemical consideration.	2 hr
2	**Thermodynamics:** Process at interface, Free energy and electrode potential, EMF series, Nernst relationship, Cell potential, Reference electrodes, Advanced thermodynamics (E-pH) diagrams.	4 hr
3	**Kinetics of aqueous corrosion:** Current density and corrosion rate, Corrosion rate expressions, Exchange current density, Polarization, Experimental techniques.	4 hr
4	**Mixed potential theory:** Postulates, Applications to active metals.	2 hr
5	**Passivity:** Polarization behavior, Application of mixed potential theory environmental effects.	2 hr
6	**Forms of corrosion different factors:** Metal purity, Crystal defects, Grain structure, Concentration cells, Velocity, Temperature, Humidity, Stress, Microbial effect, Liquid metal effect.	2 hr
7	**Forms of corrosion:** Uniform, Galvanic, Intergranular, Crevice, Pitting, Dealloying, Erosion, Stress related corrosion.	2 hr
8	**Corrosion control:** Material selection, Coating, inhibitors, Cathodic protection, Anodic protection.	4 hr
9	**High temperature oxidation:** Reactions, Thermodynamics, Oxide structure, Oxide growth, Hot corrosion	2 hr
10	**Degradation of Polymeric materials:** Swelling and dissolution, Bond rupture, Weathering, Other processes, Polymer cycling and degradation	2 hr
11	**Pourbaix diagram** Equilibrium diagram, Advantage and Disadvantage of Pourbaix diagram.	2 hr
12	**Corrosion of composite materials:** Galvanic effects, Matrix nature, Reinforcement nature, Prevention	2 hr

المرحلة الاولى

هندسة العمليات الكيمياوية

تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
		الفصل الاول				
1	CES.P.111	اللغة الانكليزية I	2	0	0	2
2	CES.P.121	الرياضيات I	2	0	1	2
3	CES.P.123	الكيمياء I	2	2	0	3
4	CES.P.125	الفيزياء	2	0	1	2
5	CES.P.126	الرسم الهندسي	1	2	0	2
6	CES.P.113	علم الحاسوب	1	2	0	2
7	CES.P.114	المعامل I	0	6	0	-
		المجموع	10	12	2	**13**
		ساعة/ اسبوع	**24**			

تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
		الفصل الثاني				
1	CES.P.112	اللغة الانكليزية I I	2	0	0	2
2	CES.P.122	الرياضيات I I	2	0	1	2
3	CES.P.131	مبادئ الهندسة الكيمياوية I	3	0	1	3
4	CES.P.124	الكيمياء I I	2	2	0	3
5	CES.P.127	الاوتوكاد	1	2	0	2
6	CES.P.128	الميكانيك الهندسي ومقاومة المواد	2	0	1	2
7	CES.P.115	المعامل I I	0	6	0	-
8	CES.P.116	الديموقراطية وحقوق الانسان	2	0	0	2
		المجموع	14	10	3	16
		ساعة/اسبوع	**27**			

المرحلة الثانية

هندسة العمليات الكيمياوية

تسلسل	الفصل الاول					
	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
1	CES.P.221	الرياضيات III	2	0	1	2
2	CES.P.231	مبادئ الهندسة الكيمياوية II	2	0	1	2
3	CES.P.233	جريان الموائع I	2	2	1	3
4	CES.P.235	الكيمياء الفيزياوية I	2	2	0	3
5	CES.P.223	برمجة الحاسوب I	1	2	1	2
6	CES.P.225	هندسة المواد I	2	0	1	2
7	CES.P.237	هندسة الوقود والطاقة.	2	2	0	3
		المجموع	13	8	5	17
		ساعة / اسبوع	26			

الفصل الثاني						
تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
1	CES.P.222	الرياضيات IV	2	0	1	2
2	CES.P.232	مبادئ الهندسة الكيمياويةIII	2	0	1	2
3	CES.P.234	جريان الموائع II	2	2	1	3
4	CES.P.236	الكيمياء الفيزياوية II	2	0	0	2
5	CES.P.224	برمجة الحاسوب II	1	2	1	2
6	CES.P.226	هندسة المواد II	2	2	1	3
7	CES.P.227	الاحصاء	2	0	1	2
		المجموع	13	6	6	16
		ساعة / اسبوع	**25**			

المرحلة الثالثة

هندسة العمليات الكيمياوية

الوحدات	تمارين	عملي	نظري	المادة	رمز المادة	تسلسل
				الفصل الاول		
2	1	0	2	ديناميك الحرارة I	CES.P.331	1
3	1	2	2	التحليلات العددية	CES.P.321	2
3	1	2	2	انتقال الكتلة	CES.P.333	3
2	1	0	2	حركية التفاعل الكيمياوي	CES.P.335	4
2	1	0	2	انتقال احرارة I	CES.P.337	5
2	1	0	2	هندسة البيئة والسلامة الصناعية	CES.P.339	6
2	0	0	2	الهندسة الكيميائية الاحيائية	CES.P.3310	7
2	1	0	2	تصميم المعدات	CES.P.3311	8
18	7	4	16	**المجموع**		
	27			ساعة / اسبوع		

الوحدات	تمارين	عملي	نظري	المادة	رمز المادة	تسلسل
				الفصل الثاني		
3	1	**2**	2	ديناميك الحرارةII	CES.P.332	1
2	1	0	2	الرياضيات التطبيقية في الهندسة الكيمياوية	CES.P.322	2
3	1	0	3	وحدات التشغيل I	CES.P.334	3
2	1	0	2	تصميم المفاعل	CES.P.336	4
3	1	2	2	انتقال الحرارة II	CES.P.338	5
3	1	2	2	تصميم المعدات باستخدام الحاسوب	CES.P.3312	6
2	0	0	2	الدقائق وتكنولوجيا النانو	CES.P.3313	7
18	6	6	15	**المجموع**		
	27			ساعة / اسبوع		

المرحلة الرابعة
هندسة العمليات الكيمياوية

		الفصل الاول				
تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
1	CES.P.421	المشروع I	1	2	0	2
2	CES.P.431	وحدات التشغيل II	2	2	1	3
3	CES.P.433	حركية العمليات	2	0	1	2
4	CES.P.435	عمليات تصفية البترول	2	0	1	2
5	CES.P.436	المفاعلات الغير متجانسة والعوامل المساعدة	2	0	1	2
6	CES.P.423	الادارة الصناعية واخلاقيات المهنة	2	0	1	2
7	CES.P.437	العمليات الصناعية الكيمياوية I	2	3	0	3
		المجموع	13	7	5	**16**
		ساعة / اسبوع		**25**		

		الفصل الثاني				
تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
1	CES.P.422	المشروعII	1	2	0	2
2	CES.P.432	وحدات التشغيل III	3	0	1	3
3	CES.P.434	سيطرة العمليات	2	2	1	3
4	CES.P.438	العمليات الصناعية الكيمياوية II	2	0	0	2
5	CES.P.424	طرق الاختيار الافضل	2	0	1	2
6	CES.P.439	هندسة التاكل	2	0	0	2
7	CES.P.4310	الصناعات البتروكيمياوية	2	0	1	2
		المجموع	14	4	4	16
		ساعة / اسبوع		**22**		

المرحلة الاولى

الهندسة الكيمياوية وتكرير النفط

	الفصل الاول					
تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
1	CES.R.111	اللغة الانكليزية I	2	0	0	2
2	CES.R.121	الرياضيات I	2	0	1	2
3	CES.R.123	الكيمياء	2	2	0	3
4	CES.R.125	الفيزياء	2	0	1	2
5	CES.R.126	الرسم الهندسي	1	2	0	2
6	CES.R.113	علم الحاسوب	1	2	0	2
7	CES.R.114	المعامل I	0	6	0	-
		المجموع	10	12	2	13
		ساعة / اسبوع	24			

	الفصل الثاني					
تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
1	CES.R.112	اللغة الانكليزية I I	2	0	0	2
2	CES.R.122	الرياضيات I I	2	0	1	2
3	CES.R.131	مبادئ الهندسة الكيمياوية I	3	0	1	3
4	CES.R.124	كيمياء البترول	2	2	0	3
5	CES.R.127	الاوتوكاد	1	2	0	2
6	CES.R.128	الميكانيك الهندسي ومقاومة المواد	2	0	1	2
7	CES.R.115	المعامل I I	0	6	0	-
8	CES.R.116	الديموقراطية وحقوق الانسان	2	0	0	2
		المجموع	14	10	3	16
		ساعة / اسبوع	27			

المرحلة الثانية

الهندسة الكيمياوية وتكرير النفط

الوحدات	تمارين	عملي	نظري	المادة	رمز المادة	تسلسل
				الفصل الاول		
2	1	0	2	الرياضيات III	CES.R.221	1
2	1	0	2	مبادئ الهندسة الكيمياوية II .	CES.R.231	2
3	1	2	2	جريان الموائع I	CES.R.233	3
3	0	2	2	الكيمياء الفيزياوية I	CES.R.235	4
2	1	2	1	برمجة الحاسوب I	CES.R.223	5
2	1	0	2	هندسة المواد I	CES.R.225	6
3	0	2	2	تكنولوجيا الوقود	CES.R.237	7
17	5	8	13	المجموع		
	26			ساعة / اسبوع		

الوحدات	تمارين	عملي	نظري	المادة	رمز المادة	تسلسل
				الفصل الثاني		
2	1	0	2	الرياضيات IV	CES.R.222	1
2	1	0	2	مبادئ الهندسة الكيمياوية III	CES.R.232	2
3	1	2	2	جريان الموائع II	CES.R.234	3
2	0	0	2	الكيمياء الفيزياوية II	CES.R.236	4
2	1	2	1	برمجة الحاسوب II	CES.R.224	5
3	1	2	2	هندسة المواد II	CES.R.226	6
2	1	0	2	الاحصاء	CES.R.227	7
16	6	6	13	**المجموع**		
	25			ساعة / اسبوع		

المرحلة الثالثة

الهندسة الكيمياوية وتكرير النفط

تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
		الفصل الاول				
1	CES.R.331	ديناميك الحرارة I	2	0	1	2
2	CES.R.321	التحليلات العددية	2	2	1	3
3	CES.R.333	انتقال الكتلة	2	2	1	3
4	CES.R.335	حركية التفاعل الكيمياوي	2	0	1	2
5	CES.R.337	انتقال احرارة I	2	0	1	2
6	CES.R.339	الاحتراق	2	0	0	2
7	CES.R.3310	المواد الكيمياوية من البترول	2	0	1	2
8	CES.R.3311	تصميم المعدات	2	0	1	2
		المجموع	16	4	7	**18**
		ساعة / اسبوع	27			

تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
		الفصل الثاني				
1	CES.R.332	ديناميك الحرارة II	2	2	1	3
2	CES.R.322	الرياضيات التطبيقية في الهندسة الكيمياوية	2	0	1	2
3	CES.R.334	وحدات التشغيل I	3	0	1	3
4	CES.R.336	تصميم المفاعل	2	0	1	2
5	CES.R.338	انتقال الحرارة II	2	2	1	3
6	CES.R.3312	تصميم المعدات باستخدام الحاسوب	2	2	1	3
7	CES.R.3313	العمليات الحقلية للنفط والغاز	2	0	0	2
		المجموع	15	6	6	18
		ساعة / اسبوع	27			

المرحلة الرابعة

الهندسة الكيمياوية وتكرير النفط

تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
		الفصل الاول				
1	CES.R.421	المشروع I	1	2	0	2
2	CES.R.431	وحدات التشغيل II	2	2	1	3
3	CES.R.433	حركية العمليات	2	0	1	2
4	CES.R.435	هندسة تصفية النفطI	2	2	1	3
5	CES.R.423	ادارة المصافي واخلاقيات المهنة	2	0	1	2
6	CES.R.437	المفاعلات الغير متجانسة والعوامل المساعدة	2	0	1	2
7	CES.R.438	التلوث البيئي والسلامة في مصافي النفط	2	0	1	2
		المجموع	13	6	6	**16**
		ساعة / اسبوع		**25**		

تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
		الفصل الثاني				
1	CES.R.422	المشروعII	1	2	0	2
2	CES.R.432	وحدات التشغيل III	3	0	1	3
3	CES.R.434	سيطرة العمليات	2	2	1	3
4	CES.R.436	هندسة تصفية النفط II	2	0	1	2
5	CES.R.424	طرق الاختيار الافضل	2	0	1	2
6	CES.R.439	هندسة التاكل في مصافي النفط	2	0	0	2
7	CES.R.4310	اقتصاديات مصافي النفط	2	0	0	2
		المجموع	14	4	4	16
		ساعة / اسبوع		**22**		

المرحلة الاولى

الهندسة الكيمياوية والتلوث النفطي

تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
	الفصل الاول					
تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
1	CES.E.111	اللغة الانكليزية I	2	0	0	2
2	CES.E.121	الرياضيات I	2	0	1	2
3	CES.E.123	الكيمياء	2	2	0	3
4	CES.E.125	فيزياء هندسة البيئة	2	0	1	2
5	CES.E.126	الرسم الهندسي	1	2	0	2
6	CES.E.113	علم الحاسوب	1	2	0	2
7	CES.E.114	المعامل I	0	6	0	-
		المجموع	10	12	2	13
		ساعة / اسبوع		24		

تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
	الفصل الثاني					
تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
1	CES.E.112	اللغة الانكليزية I I	2	0	0	2
2	CES.E.122	الرياضيات I I	2	0	1	2
3	CES.E.131	مبادئ الهندسة الكيمياوية I	3	0	1	3
4	CES.E.124	الكيمياء الاحيائية	2	2	0	3
5	CES.E.127	الاوتوكاد	1	2	0	2
6	CES.E.128	الميكانيك الهندسي ومقاومة المواد	2	0	1	2
7	CES.E.115	المعامل I I	0	6	0	-
8	CES.E.116	الديموقراطية وحقوق الانسان	2	0	0	2
		المجموع	14	10	3	16
		ساعة / اسبوع		27		

المرحلة الثانية

الهندسة الكيمياوية والتلوث النفطي

تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
		الفصل الاول				
1	CES.E.221	الرياضيات III	2	0	1	2
2	CES.E.231	مبادئ الهندسة الكيمياوية II .	2	0	1	2
3	CES.E.233	جريان الموائع I	2	2	1	3
4	CES.E.235	الكيمياء الفيزياوية I	2	2	0	3
5	CES.E.223	برمجة الحاسوب I	1	2	1	2
6	CES.E.237	مبادئ الاستدامة	2	0	1	2
7	CES.E.238	هندسة الوقود والطاقة النظيفة	2	2	0	3
		المجموع	13	8	5	17
		ساعة / اسبوع	26			

تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
		الفصل الثاني				
1	CES.E.222	الرياضيات IV	2	0	1	2
2	CES.E.232	مبادئ الهندسة الكيمياوية III	2	0	1	2
3	CES.E.234	جريان الموائع II	2	2	1	3
4	CES.E.236	الكيمياء الفيزياوية II	2	0	0	2
5	CES.E.224	برمجة الحاسوب II	1	2	1	2
6	CES.E.225	هندسة المواد	2	2	1	3
7	CES.E.226	الاحصاء	2	0	1	2
		المجموع	13	6	6	16
		ساعة / اسبوع	25			

المرحلة الثالثة
الهندسة الكيمياوية والتلوث النفطي

تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
		الفصل الاول				
1	CES.E.331	ديناميك الحرارة I	2	0	1	2
2	CES.E.321	التحليلات العددية	2	2	1	3
3	CES.E.333	انتقال الكتلة	2	2	1	3
4	CES.E.335	حركية التفاعل الكيمياوي	2	0	1	2
5	CES.E.337	انتقال احرارة I	2	0	1	2
6	CES.E.339	هندسة السيطرة على تلوث الهواء	2	0	1	2
7	CES.E.3310	السلامة الصناعية	2	0	0	2
8	CES.E.3311	تصميم المعدات	2	0	1	2
		المجموع	16	4	7	18
		ساعة / اسبوع	27			

تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
.		**الفصل الثاني**				
1	CES.E.332	ديناميك الحرارة II	2	2	1	3
2	CES.E.322	الرياضيات التطبيقية في الهندسة الكيمياوية	2	0	1	2
3	CES.E.334	وحدات التشغيل I	3	0	1	3
4	CES.E.336	تصميم المفاعلات الكيميائية الاحيائية	2	0	1	2
5	CES.E.338	انتقال الحرارة II	2	2	1	3
6	CES.E.3312	تصميم المعدات في الهندسة البيئية باستخدام الحاسوب	2	2	1	3
7	CES.E.3313	ادارة المخلفات الصلبة	2	0	0	2
		المجموع	15	6	6	18
		ساعة / اسبوع	27			

المرحلة الرابعة
الهندسة الكمياوية والتلوث النفطي

تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
		الفصل الاول				
1	CES.E.421	المشروع I	1	2	0	2
2	CES.E.431	وحدات التشغيل II	2	2	1	3
3	CES.E.433	حركية العمليات	2	0	1	2
4	CES.E.435	هندسة معالجة المياه I	2	2	1	3
5	CES.E.437	السيطرة على التلوث النفطي والصناعي	2	0	1	2
6	CES.E.438	هندسة العوامل المساعدة	2	0	1	2
7	CES.E.423	الادارة واخلاقيات المهنة في الهندسة البيئية	2	0	1	2
		المجموع	13	6	6	**16**
		ساعة / اسبوع		**25**		

تسلسل	رمز المادة	المادة	نظري	عملي	تمارين	الوحدات
		الفصل الثاني				
1	CES.E.422	المشروعII	1	2	0	2
2	CES.E.432	وحدات التشغيل III	3	0	1	3
3	CES.E.434	سيطرة العمليات	2	2	1	3
4	CES.E.436	هندسة معالجة المياه II	2	0	0	2
5	CES.E.424	طرق الاختيار الافضل	2	0	1	2
6	CES.E.439	عمليات تصفية النفط	2	0	1	2
7	CES.E.4310	التاكل والتحلل	2	0	0	2
		المجموع	14	4	4	16
		ساعة / اسبوع		**22**		