University of Basrah
College of Engineering
Department of Chemical Engineering

Syllabus Description

For

Department of Chemical Engineering

College of Engineering

University of Basrah

Basrah- Iraq

1. Introduction:

1.1 Overview of Department of Chemical Engineering

The Chemical Engineering Program in the College of Engineering at the University of Basrah was first accredited in 1980 and has maintained accreditation since that time. We have continued to make appropriate revisions in the curriculum to better serve student needs and to ensure success in their chosen careers. The chemical Engineering department curricular assessment and revision process has had a positive impact on the Chemical Engineering Program. The undergraduate study at the department is four years in length; from the moment of receiving the freshman year students whose average grades qualify them to join it up till to the graduation of the senior year students where they get their Bachelor of Science degree in Chemical engineering.

1.2 Program Educational Objective:

The Chemical Engineering curriculum requirements is designed to provide its graduates a solid educational foundation on which they can build successful and sustainable careers in chemical engineering or a related field. In particular, all graduates of the Chemical Engineering curriculum requirements will be prepared to do the following:

1. Graduates will be able to use chemical engineering principles to solve problems of practical importance to industry.
2. An ability to apply knowledge of mathematics, science, and engineering.

3. Graduates will be productive and informed citizens of society as well as of their professional community and will be positioned for a lifetime of success.

4- To be employed or pursuing an advanced degree in the field of chemical engineering or other related disciplines.

1.3 Program Curriculum

The Bachelor of Science (B.Sc.) in Chemical Engineering approved by the Department, and the student can choose it by the competition in the average of primary school. Throughout the first and second years all student take a general subject with the electrical and electronics engineering, and specialties starting from the third year of study by adding a pure specialties subjects.

1.4 Program Outcomes

The Chemical Engineering Student Outcomes are characteristics that a successful chemical engineer should have at the time of graduation, and are listed below.

1- Each graduate will have the ability to apply knowledge of mathematics, science and engineering fundamentals.

2- Each graduate will have the ability to design and conduct experiments, and to analyze and interpret experimental results.

3- Each graduate will have the ability to design systems, components, or processes to meet specified objectives within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability in chemical engineering.

4- Each graduate will have the ability to work as a member of multidisciplinary teams, and have an understanding of team leadership

5- Each graduate will have the ability to identify, formulate, and solve chemical engineering problems.

6- Each graduate will have the ability to communicate effectively in written, oral, and graphical forms.

7- Each graduate will have the ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

8- Each graduate will have a thorough grounding in chemistry and a working knowledge of advanced chemistry, including organic and physical and either inorganic or analytical, depending upon their individual educational goals.

9- Each graduate will have a working knowledge of chemical process safety.

1.5 Program Outcomes (ABET):

As an integral aspect of this outcome, each graduate will demonstrate a working knowledge, including safety and environmental aspects, of material and energy balances applied to chemical processes; thermodynamics of physical and chemical equilibria; heat, mass, and momentum transport; chemical reaction engineering; continuous and stage wise separation operations; process dynamics and control; and chemical engineering economics.

a. an ability to apply knowledge of mathematics, science, and engineering.
b. an ability to design and conduct experiments, as well as to analyze and interpret data.
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability .
d. an ability to function on multi-disciplinary teams.
e. an ability to identify, formulate, and solve engineering problems.
f. an understanding of professional and ethical responsibility.
g. an ability to communicate effectively.
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context .
i. a recognition of the need for and an ability to engage in life-long learning.
j. a knowledge of contemporary issues; and.
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice .

2. Course Description

The units are calculated such as, the theory hours (1 hour per semester = 1 unit), practical hours (2-3 hours per semester = 1 unit), and the tutorial hours (units = 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 started by the letter **U**
2- Engineering College requirement is started by the letter **E**
3- Department Requirement **(C**hemical Engineering) is started by the letters **CHE**

Course code started by capital letters followed by number of 3-digits as following:

1st digit represents the class number

2nd digit represents the semester number

3rd digit represents the subject number

For examples:

Example: U112 represents University requirements, first year, first semester, and third subject.

Example: E212 represents Department Requirements, second year, first semester, and second subject.

3-Graduation Requirements:

Requirements	Units	Total hours/Year
University Requirements	6	90
College Requirements	22	420
Department Requirements	128	2535
Total	156	3045

4-University Requirements: 6 Units

Subject Code	Subject	Units	Weekly hours		
			Th.	Prac.	Tut.
U111	Technical English I	2	2	-	-
U121	Technical English II	2	2	-	-
U211	Human Rights& Democracy	2	2	-	-
Total		6	6		

5- College Requirements: 22 Units

No.	Subject Code	Subject	Units	Weekly hours		
				Th.	Prac.	Tut.
1	E112	Mathematics I	3	3	-	1
2	E122	Mathematics II	3	3	-	1
3	E116	Engineering Drawing I	1	-	2	-
4	E113	Workshop Technology	1	-	2	-
5	E123	Physics	2	2	-	-
		Total for 1st Year	***10***	***8***	***4***	***2***
6	E212	Applied Mathematics I	3	3	-	1
7	E222	Applied Mathematics II	3	3	-	1
		Total for 2nd Year	***6***	***6***	***0***	***2***
		Total for 3rd Year	***0***	***0***	***0***	***0***
8	E411	Engineering Project I	2	-	2	-
9	E421	Engineering Project II	2	-	2	-
10	E422	Projects Management	2	-	-	2
		Total for 4th Year	***6***	***-***	***4***	***2***
		Total	22	14	8	6
				28		

6- Department Requirements: 128 Units

Subject Code	Subject Title	Units	Weekly hours		
			Th.	Prac.	Tut.
CHE114	Computer Programming /	3	2	2	-
CHE115	Analytical Chemistry	3	2	2	-
CHE117	Chemical Engineering Principles /	3	3	-	1
CHE118	Engineering Mechanics	2	2	-	-

CHE124	Organic Chemistry	3	2	2	-
CHE125	Process Flow Sheeting	1	-	2	-
CHE126	Chemical Engineering Principles II	3	2	--	1
CHE127	Strength of Materials	2	2	-	-
	Total for 1st Year	20	15	8	2
CHE213	Fluid Mechanics I	3	3	-	1
CHE214	Physical Chemistry	3	2	2	1
CHE215	Electrical Technologies	3	2	2	-
CHE216	Chemical Engineering Principles III	2	2	-	1
CHE217	Engineering Statistics	2	2	-	-
CHE218	Virtual BASIC	3	2	2	-
CHE222	Fluid Mechanics II	4	3	2	1
CHE223	Chemical Eng. Thermodynamics I	3	3	-	1
CHE224	Physical Chemistry II	2	2	-	1
CHE225	Fuels and Sustainable Energy	2	2	-	-
CHE226	Chemical Engineering Principles IV	2	2	-	1
CHE227	MATLAB Engineering	3	2	2	-
CHE228	Environmental Pollution	2	2	-	-
	Total for 2nd Year	34	29	10	7
CHE311	Chemical Engineering Mathematics I	3	3	-	1
CHE312	Heat Transfer I	4	3	2	1
CHE313	Mass Transfer I	3	3	-	1
CHE314	Chemical Eng. Thermodynamics II	3	3	-	1
CHE315	Engineering Materials Properties	3	2	2	-
CHE316	Petrochemical Engineering	2	2	-	-
CHE317	Water Technologies	2	2	-	-

CHE321	Chemical Engineering Mathematics //	3	3	-	1
CHE322	Heat Transfer //	3	3	-	1
CHE323	Mass Transfer //	3	3	-	1
CHE324	Corrosion Engineering	2	2	-	-
CHE325	Engineering Economics	2	2	-	-
CHE326	Chemical Industries	2	2	-	-
CHE327	Reactor design /	3	3	-	1
	Total for 3rd Year	38	36	4	8
CHE412	Unit Operation	4	3	2	1
CHE413	Process Dynamics	3	3	-	1
CHE414	Equipment Design /	2	2	-	1
CHE415	Reactor Design //	3	3	-	1
CHE416	Petroleum Refinery /	3	3	-	1
CHE417	Numerical Methods	3	2	2	-
CHE423	Transport Phenomena	3	3	-	1
CHE424	Process Control and Instrumentation	4	3	2	1
CHE425	Equipment Design //	2	2	-	1
CHE426	Catalytic Reactor Design	2	2	-	-
CHE427	Petroleum Refinery //	4	3	2	1
CHE428	Simulation &Optimization	3	2	2	-
	Total for 4th Year	36	31	10	9
TOTAL		128	111	32	26
			169		

7- CHE Program: Curriculum

Typical degree program is shown in the following Tables for Chemical Engineering, where recommended CHE course plan by semester is presented.

First Year

First Semester

No	CODE	SUBJECT	Hours/Week			Units
			Th.	Prac.	Tut	
1	U111	Technical English I	2	-	-	2
2	E112	Mathematics I	3	-	1	3
3	E113	Workshop Technology	-	2	-	1
4	CHE114	Computer Programming I	2	2	-	3
5	CHE115	Analytical Chemistry	2	2	-	3
6	CHE116	Engineering Drawing	-	2	-	1
7	CHE117	Chemical Engineering Principles I	3	-	1	3
8	CHE118	Engineering Mechanics	2	-	-	2
Total			14	8	2	18
			24			

Second Semester

No	CODE	SUBJECT	Hours/Week			Units
			Th.	Prac.	Tut	
1	U121	Technical English II	2	-	-	2
2	E122	Mathematics II	3	-	1	3
3	E123	Physics	2	-	-	2
4	CHE124	Organic Chemistry	2	2	-	3
5	CHE125	Process flow sheeting	-	2	-	1
6	CHE126	Chemical Engineering Principles II	3	-	1	3
7	CHE127	Strength of Materials	2	-	-	2
Total			14	4	2	16
			20			

Second Year

First Semester

No	CODE	SUBJECT	Hours/Week			Units
			Th.	Prac.	Tut.	
1	U211	Human Rights& Democracy	2	-	-	2
2	E212	Applied Mathematics I	3	-	1	3
3	CHE213	Fluid Mechanics I	3	-	1	3
4	CHE214	Physical Chemistry	2	2	1	3
5	CHE215	Electrical Technologies	2	2	-	3
6	CHE216	Chemical Engineering Energy Balance	2	-	1	2
7	CHE217	Engineering Statistics	2	-	-	2
8	CHE218	Virtual BASIC	2	2	-	3
Total			18	6	4	21
			28			

Second Semester

No	CODE	SUBJECT	Hours/Week			Units
			Th.	Prac.	Tut.	
1	E221	Applied Mathematics II	3	-	1	3
2	CHE222	Fluid Mechanics II	3	2	1	4
3	CHE223	Chemical Eng. Thermodynamics I	3	-	1	3
4	CHE224	Physical Chemistry II	2	-	1	2
5	CHE225	Fuels and Sustainable Energy	2	-	-	2
6	CHE226	Materials and Energy Balance	2	-	1	2
7	CHE227	MATLAB Engineering	2	2	-	3
8	CHE228	Environmental Pollution	2	-	-	2
Total			19	4	5	21
			28			

Third Year

First Semester

No	CODE	SUBJECT	Hours/Week			Units
			Th.	Prac.	Tut	
1	CHE311	Chemical Eng. Analysis I	3	-	1	3
2	CHE312	Heat Transfer I	3	2	1	4
3	CHE313	Mass Transfer I	3	-	1	3
4	CHE314	Chemical Eng. Thermodynamics II	3	-	1	3
5	CHE315	Engineering Materials Properties	2	2	-	3
6	CHE316	Petrochemical Engineering	2	-	-	2
7	CHE317	Water Technologies	2	-	-	2
Total			18	4	4	20
			26			

Second Semester

No	CODE	SUBJECT	Hours/Week			Units
			Th.	Prac.	Tut	
1	CHE321	Chemical Eng. Analysis II	3	-	1	3
2	CHE322	Process Heat Transfer	3	-	1	3
3	CHE323	Mass Transfer II	3	-	1	3
4	CHE324	Corrosion Engineering	2	-	-	2
5	CHE325	Engineering Economics	2	-	-	2
6	CHE326	Chemical Industries	2	-	-	2
7	CHE327	Reactor design I	3	-	1	3
Total			18	-	4	18
			22			

*Evaluation of Industrial training carried out by students after the second semester is to be evaluated.

Fourth Year

First Semester

No	CODE	SUBJECT	Hours/Week			Units
			Th.	Prac.	Tut	
1	E411	Engineering Project Ⅰ	-	2	-	2
2	CHE412	Unit Operation	3	2	1	4
3	CHE413	Process Dynamics	3	-	1	3
4	CHE414	Equipment Design Ⅰ	2	-	1	2
5	CHE415	Reactor Design Ⅱ	3	-	1	3
6	CHE416	Petroleum Refinery Ⅰ	3	-	1	3
7	CHE417	Numerical Methods	2	2	-	3
Total			16	6	5	20
			27			

Second Semester

No	CODE	SUBJECT	Hours/Week			Units
			Th.	Prac.	Tut	
1	E421	Engineering Project Ⅱ	-	2	-	2
2	E422	Projects Management & Ethics	2	-	-	2
3	CHE423	Transport Phenomena	3	-	1	3
4	CHE424	Process Control &Instrumentation	3	2	1	4
5	CHE425	Equipment Design Ⅱ	2	-	1	2
6	CHE426	Catalytic Reactor Design	2	-	-	2
7	CHE427	Petroleum Refinery Ⅱ	3	2	1	4
8	CHE428	Optimization and Simulation	2	2	-	3
Total			17	8	4	22
			29			

COURSES SUMMARY

Class	Semester I				Semester II			
	Th.	Prac.	Tut.	Units	Th.	Prac.	Tut.	Units
First Year	14	8	2	18	14	4	2	16
Second Year	18	6	4	21	19	4	5	21
Third Year	18	4	4	20	18	-	4	18
Fourth Year	16	6	5	20	17	8	4	22
Total	66	24	15		68	16	15	
	105			79	99			77
Total Units = (79+77)= 156								

Summer Training

The **Chemical Engineering** curriculum requires students to complete one month of summer training at private industries or governmental firms. This training is a compulsory component of graduation requirements. It is supervised by the Summer Training Committee of the department.

8- CHE Curriculum / Units Requirements

- 4 - Years Program (Full - Time Study)
- 154 Units for the **Chemical Engineering** included**:**

  -Mathematics and basic Science: 18 Units

  - Engineering Topics: 98 Units.

  -General Education: 12 Units.

9- How the Curriculum Aligns with the Program Educational Objectives

The faculty has complete authority to define, revise, implement, and achieve program educational objectives. Input is required from the students, alumni, and the

employers of our alumni in the implementation of program objectives. The major role of the faculty is to create, revise, and evaluate subjects for the program as well as define and revise program educational objectives and ensure achievement of student outcomes. Therefore, the above process ensures alignment of the curriculum with Program Educational Objectives as shown in various tables.

The **Chemical Engineering** department insures that the students receive all the engineering analysis within the context of engineering program. At our faculty meetings, the discussion is possible subjects to be introduced in the different subjects and brainstorm on ways to bring engineering program and open-ended problems into our subjects.

Program Outcomes: For the purpose of achieving its objectives, the electrical engineering department has developed eleven Program Outcomes (POs) as an initial set of POs. These outcomes are, in effect, what the students expected to know and achieve post-graduation. The following Table shows these program outcomes:

OUTCOMES	Code
PO1: an ability to apply knowledge of mathematics, science, and engineering fundamentals.	a
PO2: an ability to outline and conduct experiments as well as analyze and interpret data.	b
PO3: an ability to design an integrated system and its various components and processes, within realistic economic, environment, social, political, ethical, health and safety, manufacturability, and sustainability constraints.	c
PO4: an ability to function on multi-disciplinary teams to analyze and solve problems.	d
PO5: an ability to identify, evaluate and solve engineering problems.	e
PO6: an understanding of the responsibility of engineers to practice in professional and ethical manner at all times.	f
PO7: an ability to communicate effectively using oral, written, and graphic forms.	g
PO8: the broad education necessary to understand the potential impact of engineering solutions on society and the environment.	h
PO9: an understanding of the need for up-to-date engineering tools and other knowledge acquired through life-long learning.	i
PO10: knowledge of contemporary issues related to engineering.	j

PO11: an ability to use modern engineering tools, skills and design techniques necessary for the practice of engineering.	k

First Year

First Semester

Subject: Human Rights and Democracy	**Theoretical: 2 hr/wk**
Code: U111/1st Semester	**Practical: ---**
Class: 1st Year	**Tutorial: ---**
Pre-requisite: None	**Units: 2**

Course Syllabus

1	Introduces students to the philosophic and political background of the concept of human rights	
2	Discusses important documents as part of the history of the development of human rights theories.	
3	Examines important issues in current political and ethical debates about human rights.	
4	Reviews core legal documents and the work of the most important governmental and nongovernmental institutions currently involved in human rights protection and promotion	
5	Examines at least one current problem area in human rights protection.	

References:

1-

First Year

First Semester

Subject: Mathematics I	**Theoretical: 3 hr/wk**
Code: U111/1st Semester	**Practical: ---**
Class: 1st Year	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus :

1	General review (Coordinates ,slop, straight line, equation of circle, conic section).	
2	Composition of functions, function of largest integer, sign of function.	
3	Inequalities, absolute values, inverse functions .	
4	Composite numbers (addition, subtraction, multiplication, root, graph)	
5	Function differentiation (1^{st}, 2^{nd}, chain differentiation) .	
6	Implicit differentiation and application of derivatives .	
7	Graph of maxima and minima, Continuity, range and domain .	
8	Limits , 1 Hopital's rule .	

References:

1-Erwin Kreysig, *Advanced Engineering Mathematics, 8e,* John Wiley and Sons,

2- Wylie C.R and L.C. Barrett, *Advanced Engineering Mathematics*, McGraw Hill

First Year

First Semester

Subject: Computer Programming I	**Theoretical: 2 hr/wk**
Code: CHE114/1st Semester	**Practical: 2**
Class: 1st Year	**Tutorial: -**
Pre-requisite: None	**Units: 3**

Course Syllabus :

1	Definition of the computer, components, method of operation, simple diagram of the components and units of the computer	
2	Files: definition, types, coding, explanation of the dos system and its internal and external orders.	
3	Introduction to the Windows system: desktop, use of the mouse, computer, closing of the windows, temporary closing, minimizing and maximizing any window, creation of new folder, selection of a folder, finding a file or a folder, copy from a file to another .	
4	Program: how to start, printing, shut down, delete of the disk, arrangement of the icons, run, help.	

الكتب المنهجية والمساعدة

تعلم الحاسب الشخصي للمؤلف د. حسن هادي الزيادي

First Year

First Semester

Subject: Analytical Chemistry	**Theoretical: 2 hr/wk**
Code: CHE115/1st Semester	**Practical: 2**
Class: 1st Year	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus :

1	Stoichiometric calculations of chemical analysis Mass relations in the chemical equation, chemical coefficient, calculation in relation to the concentrations of solutions, polarity, normality, titration, density	
2	Equilibrium in the acids and bases, pH for the acidic solutions, graphs of titration, indicators of bases and acids, choice of indicaters and buffer solutions .	
3	Equilibrium in precipitation, solubility, precipitation and partial precipitation.	
4	Systems with comparative equilibrium, how to remove precipitates	
5	Analysis using oxidation and reduction, equations of oxidation and reduction , indicators of oxidation and reduction .	
6	Equilibrium in the oxidation and reduction reactions, electromotive force, use of the half cell potentials, effect of concentration on the potential of the cell (Nernst eq.), measure of concentration by potential of the cell .	

References:

1- Quantitative analysis ,by Edward

2- Quantitive analytical chemistry,by flaschka.

First Year

First Semester

Subject: Engineering Drawing	**Theoretical: - hr/wk**
Code: E116/1st Semester	**Practical: 2 hr/wk**
Class: 1st Year	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 1**

Course Syllabus :

1	Introduction to the drawing tools and how to use them.	
2	Composition of the engineering drawings.	
3	Lettering numbers, dimensions	
4	Projection	
5	Sectioning	
6	Isometric drawing	

References:

1- Engineering Drawing, by A.W.Bound.

First Year

First Semester

Subject : Chemical Engineering Principles I		**Theoretical: 3 hr/wk**
Code: CHE117/1st Semester		**Practical: ---**
Class: 1st Year		**Tutorial: 1 hr/wk**
Pre-requisite: None		**Units: 3**
Course Syllabus :		
1	Introduction to engineering calculations, units, dimensions, basis. Units, dimensions and conversions, Temperature and Pressure scales, Composition of mixtures, Principles of stoichiometric combination	
2	Composition of mixtures, Principles of stoichiometric combination. Nature of balances: Concept of a balance. Input-output relationships. Steady-state considerations. Black box approach. Sub-systems and interconnections. Familiarization with flow sheets.	
3	Mass balances for items of plant, Choice of basis/datum for balances. Overall and component balances, Limiting and excess reactants	
4	Balances for systems with recycle, purge and by-pass streams.	
5	Mass balances for reactive processes. Mass balances for unit operations .Conversion, yield , selectivity, purge, percent of completion in chemical reactions	
6	Balances for batch and continuous plant.	

References:

1- Elementary principle of chemical Processes. by ,Richard M. Felder

2- Basic principles and calculation in chemical engineering. David. m.Himmelblau

First Year

First Semester

Subject : Engineering Mechanics	**Theoretical: 2 hr/wk**
Code: CHE118/1st Semester	**Practical: ---**
Class: 1st Year	**Tutorial: -**
Pre-requisite: None	**Units: 2**

Course Syllabus :

1	Principles of statics, introduction	
2	Resultant of force systems, systems with two dimensions .	
3	Resultant of force systems, momentum and coupled momentum.	
4	Resultant of force systems, resultant of forces.	
5	Equilibrium of force systems, equilibrium of forces in two directions .	
6	Equilibrium of force systems, equilibrium of forces	
7	Force system in space, systems with three dimension	
8	Force system in space, resultant forces	
9	Force system in space, equilibrium.	
10	Friction, forces of friction.	
11	Friction.	
References:		

1- Millard F. Beatty**.** Principles of Engineering Mechanics: Volume 1: Kinematics	

First Year

Second Semester

Subject: Technical English	**Theoretical: 2 hr/wk**
Code: U121/2nd Semester	**Practical: ---**
Class: 1st Year	**Tutorial: ---**
Pre-requisite: None	**Units: 2**

Course Syllabus :

1	This course is designed to enable the students to achieve academic oral and written communication to the standard required at university level. The course integrates all the language skills with emphasis on writing, and it stimulates students' imagination, and promotes personal expression. Students, in this course, are trained to apply critical thinking skills to a wide range of challenging subjects from diverse academic disciplines. Course activities include writing various types of academic essays, acquiring advanced academic vocabulary, and getting involved in group discussions and debates. In addition, the course also includes other skills to consolidate the main skills, such as further readings and use of the Blackboard Suite.	

Refrences:

1-

First Year

Second Semester

Subject : Mathematics II	**Theoretical: 3 hr/wk**
Code: E122 /2nd Semester	**Practical: ---**
Class: 1st Year	**Tutorial: 1 hr/wk**
Pre-requisite: Mathematics I	**Units: 3**

Course Syllabus :	
1	Trigonometric functions (derivative, graph, limits, graph of inverse functions).
2	Hyperbolic functions (Derivatives, graphs, inverse functions).
3	Integration (definite, indefinite. Area under the curve)
4	Methods of integration (substitution by trigonometric function, partial fractions, integration by fraction).
5	Application of integration (volumes, length of curve, surface of revolution). Applications of Integrals : Areas between curves, Methods of finding volume : Slicing, Solids of revolution, Cylindrical shell, Lengths of plane curves, Areas of surface of revolution, Moments and Center of mass, Improper integrals
6	Transcendental function (natural logarithm, exponential function, graphs).
7	Improper integrates.
8	Differential equations
9	Determinates and matrices.
	References: 1-Erwin Kreysig, *Advanced Engineering Mathematics, 8e,* John Wiley and Sons,

First Year

Second Semester

Subject : Physics		**Theoretical: 2 hr/wk**
Code: E123 /2nd Semester		**Practical: ---**
Class: 1st Year		**Tutorial: 0**
Pre-requisite: None		**Units: 2**
Course Syllabus :		
1	Motion of charge in electric and magnetic field, Magnetostatics: current density, magnetic fields,Ampére's law, Faraday's law, magnetic potential, magnetic polarization, bound current, magnetic properties of materials (para, dia and ferro), boundary condition of B and H, basic idea of superconductor	
2	Displacement current, Maxwell's equations for free space and matter (dielectric and conductor),Electromagnetic waves, Poynting vector.	
3	Origin the refractive index, Interference: division of wave-front and division of amplitude; diffraction: Fraunhoffer, Grating, Resolving power (grating, prism, telescope and microscope); polarization: Phenomena of double refraction, Nicol prism, optical activity Production and analysis of plane, circular and elliptical polarized light, Frenels theory of optical activities and Polarimeters.	
4	Fiber optics and photonics: Fundamental ideas about optical fiber, types of fibers, Total Internal Reflection (TIR), critical angle, acceptance angle and application, basic principal of Laser and Holography and fundamental ideas about photonics	
5	Electrostatics: electric fields, potentials, Gauss's law, electric dipoles and multipoles,polarization, bound charges, linear dielectrics and force on dielectrics, electric displacement, boundary condition of E and D, work and energy of electrostatics, Laplace's equation and uniqueness theorem, image theory	
Refrences: 1-Modern Physics: Author Beiser		

First Year

Second Semester

Subject : Organic Chemistry	**Theoretical: 2 hr/wk**
Code: E122 /2nd Semester	**Practical: 2 hr/wk**
Class: 1st Year	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus :

1	Hydrocarbons aliphatics, ring, olifenes, acytelines, aromatic, Orbitals, bonding of the hydrocarbon compounds ,Thermal cracking process, hydrogenation, reduction , Special reactions: oxidation and combustion, addition, substitutions, nitation, sulphonation, halogenations, polymerization .	
2	Halides, fluorides, chlorides, bromides, iodides, process of halogenations of hydrocarbons by ionic method of free radicals, addition, substitutions.	
3	Alcohols and phenols	
4	Ethers	
5	Aldehydes and ketones	
6	Carboxylic acids, esters, amino-acids, amides .	
7	Amines and some important derivatives.Practical organic chemistry physical properties of liquid and solid organic compounds, boiling point by normal distillation and partial distillation, reactions of substitution and oxidation, preparation of aspirin, acetinelides.	

Refrenceses:

1- Morrison & Boyd, Organic Chemistry, Prentice-Hall

2- Bahl & Bahl, Advanced Organic Chemistry,

First Year

Second Semester

Subject : Process Flow Sheeting	**Theoretical: -**
Code: CHE125 /2nd Semester	**Practical: 2 hr/wk**
Class: 1st Year	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 1**

Course Syllabus :

1	Essential flow diagrams	
2	block flow diagrams (BFD)	
3	process flow diagrams (PFD),	
4	piping & instrumentation diagrams (P&ID),	
5	Equipment descriptions and standard notations,	
6	General Design Factors and Specifications	
7	Rules of thumb in design;	
8	Definition of project Establishment of design basis; ASTM and IS specifications for: Seamless / ERW pipes, pipe fittings, flanges, and fasteners ,materials for valves. Gaskets: Functions and properties, types of gaskets	
9	Piping System Design Types of Valves, Control Valves, Safety Valves, Constructional features, Criteria for selection. Piping components. Safety valves and other pressure relieving devices, constructional features, selection criteria.	

References:

1. J.M.Coulson & J.F.Richardson, Chemical Engineering, Vol.6, 3rd Edn,

2. E. Ludwig, Applied Process Design for Chemical & Petrochemical Plants, Vol I, II, II,

First Year

Second Semester

Subject : Chemical Engineering Principles II	**Theoretical: 3 hr/wk**
Code: CHE126 /2nd Semester	**Practical: - hr/wk**
Class: 1st Year	**Tutorial: 1 hr/wk**
Pre-requisite: Chemical Engineering Principles I	**Units: 3**

Course Syllabus :

1	Ideal gas, state equation if ideal gas, mixture of ideal gases.	
2	Real gases: pure & mixed with applications to material balances focus on *z* factors, introduce equations of state and trial & error solutions.	
3	Vapor pressure: Antoine equation, Clausius-Clapeyron equation, and steam tables.	
3	Mixture of gas and saturated vapor .	
4	Gas–Vapor Mixtures: relative saturation, relative humidity, dew point temperature, dew point pressure, condensation, saturation and drying problems	
5	Vapor–Liquid Equilibrium: Raoult's Law	

References:

1-Richard M. Felder ,Elementary principle of chem. process

2- David .Humbllo ,Basic principles and calculation in chemical engineering

First Year

Second Semester

Subject : Strength of Materials	**Theoretical: 2 hr/wk**
Code: CHE127 /2nd Semester	**Practical: - hr/wk**
Class: 1st Year	**Tutorial: - hr/wk**
Pre-requisite: Engineering Mechanics	**Units: 2**

Course Syllabus:

1	Analysis of structure, structures of machines.	
2	Centroids and centers of gravity, center of gravity of lengths and reas	
3	Centroids and centers of gravity, center of gravity of volumes .	
4	Centroids and centers of gravity, composite figures.	
5	Moment of inertia.	
6	Strength of materials definitions .	
7	Simple stress	
8	Shear stress.	
9	Stress in cylinders .	
10	Simple strain	
11	Thermal stress	
12	Strength of materials, deformation in beams .	
13	Equations of stress and momentum in beams	
14	Curves of stress and momentum in beams .	
	References: **1-** Millard F. Beatty**.** Principles of Engineering Mechanics:	

Second Year

First Semester

Subject : Engineering Management and Ethics		**Theoretical: 2 hr/wk**
Code: E211/1st Semester		**Practical: ---**
Class: 2nd Year		**Tutorial: -**
Pre-requisite: None		**Units: 2**
Course Syllabus :		
1	Management theory and practice: functions of management; Hawthorne Experiments, leadership styles and motivational theories	
2	Marketing management: Marketing management process, product life cycle and marketing strategies. Operations management: Productivity and work study, operations strategy, statistical process control, Taguchi's parametric design, Quality function deployment, Introduction to TQM and ISO 9000. inventory costs, ABC	
3	classification, EOQ, P and Q inventory systems. Project management: project planning and feasibility analysis, project scheduling methods	
4	Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and professional ideals	
5	Social and ethical responsibilities of Technologists. Codes of professional ethics. Whistle blowing and beyond, Case studies	
Refrenceses:		
1-		

Second Year

First Semester

Subject : Applied Mathematics I	**Theoretical: 3 hr/wk**
Code: E212/1st Semester	**Practical: ---**
Class: 2nd Year	**Tutorial: 1 hr/wk**
Pre-requisite: Mathematics II	**Units: 3**

Course Syllabus:

1	Conic sections(review, transform of axes, rotation of axes)	
2	Polar coordinates	
3	Hyperbolic functions (differentiation and integration).	
4	Vectors (vectors in space, line equation in space, equation of plane).	
5	**Series:** Infinite series, Oscillating and Geometric series, their Convergence, Divergence. Tests of Convergence: nth Term test of divergence, Integral test, Comparison Test, Limit Comparison test, Ratio test, nth root test (Cauchy root test), Alternating series, Absolute and Conditional convergence. **Power Series:** Power series and its convergence, Radius and interval of convergence, Term by term differentiation, Term by term integration, Product of power series, Taylor and Maclaurin series,Convergence of Taylor series, Error estimates, Taylor's Theorem with remainder	

References:

1- Calculas by Mint.

2- Calculas by Edward.

Second Year

First Semester

Subject : Fluid Mechanics I	**Theoretical: 3 hr/wk**
Code: CHE213/1st Semester	**Practical: ---**
Class: 2nd Year	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	Concept of fluids and fluid properties; Stress in a fluid; Newtons Law of viscosity Fluid statics Basic physical Laws in Fluid Mechanics; Conservation of Mass, Linear Momentum, Angular Momentum and Energy; The Bernouli's Equation and its application. Dimensional analysis Dimensional analysis by Rayleigh's method and Buckingham's method, Dimensionless numbers .	
2	**Internal incompressible viscous flow:** Introduction; flow of incompressible fluid in circular pipe; laminar flow for Newtonian fluid; Hagen-Poiseullie equation; introduction to turbulent flow in a pipe-Prandtl mixing length; energy consideration in pipe flow, relation between average and maximum velocity, Bernoulli's equation–kinetic energy correction factor; head loss; friction factor-Fanning and Darcy, Moody diagram; major and minor losses; Pipe fittings and valves, schedule no, equivalent diameter.	
3	**Flow measurement:** Introduction; general equation for internal flow meters; Orifice meter; Venturimeter; Weirs, concept of area meters: rotameter; Local velocity measurement: Pitot tube. Hot wire anemometer, mass flowmeter. **Resistance of immersed bodies:** Introduction; concept of drag and lift;; variation of drag coefficient with Reynolds number; stream-lined body and bluff body; packed bed; concept of sphericity; Ergun equation, modified friction factor.	

References: 1- Fluid Mechanics. by victor.

2- Fluid Mechanics and hydraulics, by Jack.

Second Year

First Semester

Subject : Physical Chemistry I	**Theoretical: 2 hr/wk**
Code: CHE214/1st Semester	**Practical: 2 hr/wk**
Class: 2nd Year	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	Maxwell's distribution of molecular velocities. Collision properties – mean free path. Deviation from ideal behaviour – van der Waals equation of state.Liquid state – Equation of state of liquids, structure of liquids – vacancy model, vapour pressure, heat of vapourisation, Trouton's rule.	
2	PHASE RULE AND SOLUTIONS: Definition of terms, derivation of phase rule, application of phase rule to three component systems: acetic acid - chloroform- water system, system consisting of two salts and water. Raoult's law, ideal and non-ideal solutions, vapour pressure and boiling point diagrams of completely miscible binary solutions, completely immiscible liquids: steam distillation and its application, solubility of partially miscible liquids, solubility of gases in liquids: factors affecting solubility, Henry's law. Vapour pressure lowering, Osmosis and Osmotic pressure, boiling point elevation, freezing point depression, determination of molecular weight from colligative properties	
3	Thermo-chemistry. Second law of thermodynamics and its applications. Chemical equilibrium of homogeneous and heterogeneous reactions. Thermodynamic treatment of equilibrium constant. Ionization of water and pH scale	

References:

1- Physical Chemistry, by Barow.

Second Year

First Semester

Subject : Electric Technology	**Theoretical: 2 hr/wk**
Code: CHE215/1st Semester	**Practical: 2 hr/wk**
Class: 2nd Year	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	Theory of electricity, idea of electric potential, resistance Ohm's law , resistances In series and parallel, equivalent resistance, open and short circuits. Kirchoff's law, voltage and current divider circuits.	
2	Work, power and energy, heating effect of electric current, Joule's law of electric heating, thermal efficiency.	
3	Electrical instruments and measurements, DC potentiometer, whetstone bridge , Universal bridge, moving-Oil instrument, extension of range	
4	AC fundameneatals , generation of alternating voltage and current, equations of the alternating voltages and currents)simple and complex waveforms)> RMS value of a complex wave, average value, from factor and peak factor, vector representation of alternating quantities, series and parallel AC circuits .	
5	Semiconductors, PN.junction diode, the ideal, real diode, diode circuits with DC and AC voltage sources, logic gates.	
6	Electromagnetic circuits, absolute and relative permeability of a medium, law of magnetic circuits, B-H curve	

References:

1- Vincent Del Toro, "Electrical Engineering Fundamentals", Prentice Hall, Inc.
2. Cotton, H., "Advanced Electrical Technology"

Second Year

First Semester

Subject : Virtual Basic	**Theoretical: 2 hr/wk**
Code: CHE218/1st Semester	**Practical: 2 hr/wk**
Class: 2nd Year	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	INTRODUCTION TO VB 6.0: VB Environment, Menu Bar, Toolbars, Tool Box,Project explorer,Properties window,Form designer,Form layout	
2	VB The language:Variable , Constants,Arrays,Procedures, Functions,Control Flow Statements,Looping , nesting	
3	Managing Form:Form Basics,Form Events,Form Properties,Form Methods	
4	Managing Menus: Creating and modifying menu atDesign time,Programming menu commands,Shortcut Keys,Menus at runtime	
5	Drag & Drop operations: Drag mode property,Drag Drop & Drag Over Method Mouse Conflicts	
6	Design a Project using MDI form, common dialog control and rich text box.	
7	Creating the simple programs based on Chemical Engineering using VB.	

References:

1- Jesse Liberty, Learning Visual Basic .

Second Year

First Semester

Subject : Chemical Eng. Energy Balance		**Theoretical: 2 hr/wk**
Code: CHE216/1st Semester		**Practical: - hr/wk**
Class: 2nd Year		**Tutorial: 1 hr/wk**
Pre-requisite: None		**Units: 2**
Course Syllabus:		
1	Energy and Energy balance: energy balance for closed and open system. Mechanical energy balance	
2	Energy balance, general review on types of energy and 1st law of thermodynamics, total energy balance, heat capacity, latent heat of vaporization, Enthalpy calculation. Psychrometric chats	
3	Energy balance with reaction: heat of reaction and heat of combustion. Heat of reaction method, heat of formation method	
References:		
1-Richard M. Felder , Elementary principle of chemical processes		
2-David. , Basic principles and calculation in chemical engineering		

Second Year

First Semester

Subject : Engineering Statistics	**Theoretical: 2 hr/wk**
Code: CHE217/1st Semester	**Practical: - hr/wk**
Class: 2nd Year	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 2**

Course Syllabus:

1	Measure of Central Tendency and Dispersion Statistics Averages, Median Mode, Quartiles, Range, Moments, Skewness & Kurtosis, Quartile Deviation, Mean Deviation, Standard Deviation, Variance & its coefficient, Practical Significance in related problems.	
2	Statistical Inference and Testing of Hypothesis Introduction, Estimation, Types of Estimates, Confidence interval, Tests of Hypothesis, Chi-Square distribution/test, one tails & two tails tests. Application in related problems	
3	Curve Fitting :Introduction, fitting of a first and second degree curve, fitting of exponential and logarithmic curves related problems, Principle of least squares, Second order Statistics & Time series not in bit detail.	
4	Simple Regression & Correlation: Introduction, Scatter diagrams, Correlation & its Coefficient, Regression lines, Rank Correlation & its Coefficient, Probable Error (P.E), Related problems.	
5	Statistical Inference and Testing of Hypothesis Introduction, Estimation, Types of Estimates, Confidence interval, Tests of Hypothesis, Chi-Square distribution/test, one tails & two tails tests. Application in related problems.	
6	Probability Distributions Introduction, Discrete probability distributions, Binomial, Poisson, Hyper geometric & Negative binomial distributions. Continuous probability distribution, Uniform, Exponential & Normal distributions & their practical significance.	

References:

1- Z.R.Lazic, Design of experiments in chemical engineering

Second Year

Second Semester

Subject : Applied Mathematics II	**Theoretical: 2 hr/wk**
Code: E221/2nd Semester	**Practical: - hr/wk**
Class: 2nd Year	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	Partial differentiation (partial derivatives, approximation, maxima and minims of functions with more than one variable).	
2	Multiple integrals (for rectangular areas and nonrectangular areas, inverse integral, change of multiple integral to polar coordinates).	
3	Differential equations and their classification, formation of differential equations. Differential equations of first order. Methods of solution of differential equations of first order and first-degree: Separable equations, homogenous equations, equations reducible to homogenous, exact differential equations, integrating factor, linear equations, Bernoulli equations, orthogonal trajectories in Cartesian and polar coordinates, application of first order differential equations. Non-linear first order differential equations	
4	Higher order linear differential equations: Homogeneous linear equations of order n with constant coefficients, auxiliary/characteristics equations. Solution of higher order differential equation according to the roots of auxiliary equation. Non-homogenous linear equations. Working rules for finding particular integral. Cauchy Euler Equation. Introduction to partial differential equations.	

References:

1- Calculas by Mint.

Second Year

Second Semester

Subject : Fluid Mechanics II		**Theoretical: 3 hr/wk**
Code: CHE222/2nd Semester		**Practical: 2hr/wk**
Class: 2nd Year		**Tutorial: 1 hr/wk**
Pre-requisite: None		**Units: 4**
Course Syllabus:		
1	Pumps, pumps relations with centrifugal force, pumps in parallel and series, positive displacement pumps, pump efficiency, factors affecting the selection of pumps	
2	Flow and pressure measurements . **Flow measurement:** Introduction; general equation for internal flow meters; Orifice meter; Venturimeter; Weirs, concept of area meters: rotameter; Local velocity measurement: Pitot tube. Hot wire anemometer, mass flowmeter. Introduction; concept of drag and lift;; variation of drag coefficient with Reynolds number; stream-lined body and bluff body; packed bed; concept of sphericity; Ergun equation, modified friction factor.	
3	Fluid flow in the Presence of solid particles Practical fluid flow measurement of air water flow, measurement of pressure drop in the packed pipes, measurement of the free falling velocity. Measurement of the viscosity , Measurement of the pressure drop in the pipes and fittings because of friction, moment of impact .	
References:		
1- Fluid Mechanics, by Victor		
2- Fluid Mechanics and hydraulics, by Jack.		

Second Year

Second Semester

Subject : Chemical Eng. Thermodynamics I	**Theoretical: 3 hr/wk**
Code: CHE223/2nd Semester	**Practical: - hr/wk**
Class: 2nd	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	Fundamental concepts and definitions - closed, open and isolated system - intensive and extensive properties - path and state functions - reversible and irreversible process.	
2	internal energy- enthalpy - heat capacity - first law for cyclic, non-flow and flow processes - applications -P-V-T behavior of pure fluids - ideal gases and ideal gas processes - equations of state - vander Waals equation, Redlich-Kwong equation, Virial equation - principle of corresponding states - critical and pseudo critical properties - Compressibility charts	
3	Thermodynamic properties of pure fluids - Gibbs free energy, work function - Maxwell's equations - Clapeyron equation - entropy-heat capacity relationships - equations for entropy, internal energy and enthalpy in terms of measurable quantities - effect of temperature and pressure on U, H and S - relationship between CP and CV - effect of pressure and volume on heat capacities - Joule-Thomson coefficient - Gibbs - Helmholtz equation - method of Jacobians - thermodynamic diagrams -	
4	Fugacity and activity of pure fluids - selection of standard state - determination of fugacity of pure gases and liquids - effect of temperature and pressure on fugacity and activity.	

References:

1- Smith J. M. & Van Ness H.V., Introduction to Chemical Engineering Thermodynamics, McGraw Hill
2. Narayanan K. V., A Textbook of Chemical Engineering Thermodynamics, Prentice-Hall

Subject : Physical Chemistry I	**Theoretical: 2 hr/wk**
Code: CHE224/2nd Semester	**Practical: - hr/wk**
Class: 2nd Year	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 2**

Course Syllabus:

1	**Phase equilibria:** phase rule and its application. Electrolytic conduction. Electrical properties of solution. Interionic attraction theory. Electrochemical cells. Thermodynamics of electrochemical cells. Application of emf measurements. Ionic equilibria. Buffer solution. Henderson equation and its application	
2	**Adsorption, chemisorption**, applications of adsorption, adsorption of gases by solids, Freundlich adsorption isotherm, Longmuir's theory of adsorption. B.E.T. theory of multilayer adsorption (quantitative treatment only).	

References:

1- Physical Chemistry, by Barow.

Second Year

Second Semester

Subject : Fuels and Sustainable Energy	**Theoretical: 2 hr/wk**
Code: CHE225/2nd Semester	**Practical: - hr/wk**
Class: 2nd	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 2**

Course Syllabus:

1	Introduction to fuels, properties of fuel oil, coal and gas, storage, handling and preparation of fuels, principles of combustion, combustion of oil, coal and gas. Fluidized Bed Combustion Boilers.	
2	Furnaces and Waste Heat Recovery: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery.	
3	Energy conversion technologies in industrial energy systems: overview of technologies and engineering thermodynamics for process utility boilers, heat pumps, steam turbine combined heat and power (CHP) and gas turbine CHP	
4	Energy conversion performance of such systems for given energy conversion process parameters and given process head load.	
5	Greenhouse gas emissions consequences of energy efficiency measures in industry. Greenhouse gas emissions from industrial energy systems. Optimisation of industrial energy systems considering future costs associated with greenhouse gas emissions.	
6	Potential for greenhouse gas emissions reduction in industry. Overview of energy policy instruments and their impact on industrial energy system decision-making	

References:

1-Goldmberg J., Johansson, Reddy A.K.N., Energy for a Sustainable World, John Wiley
2. Bansal N.K., Kleeman M. & Meliss M., Renewable Energy Sources & Conversion Tech.,Tata McGraw Hill.

Second Year

Second Semester

Subject : Materials and Energy Balance	**Theoretical: 2 hr/wk**
Code: CHE226/2nd Semester	**Practical: - hr/wk**
Class: 2nd	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 2**

Course Syllabus:

1	Multiple unit system involving reaction, recycle, and purge	
2	Material balances with chemical reactions and multiple components including use of algebraic techniques. Simultaneous material and energy balance.	
3	Flow sheets, material and energy balance for complete projects.	
4	Unsteady state Material and energy balance .	

References:

1- Elementary principle of chemical process, by Richard M. Felder,

2- Basic principles and calculation in chemical engineering,by David .himmelblau .

Second Year

Second Semester

Subject MATLAB Engineering	**Theoretical: 2 hr/wk**
Code: CHE227/2nd Semester	**Practical: 2 hr/wk**
Class: 2nd	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	Introduction to Matlab: Arithmatic Expressions , Mathematical functions , Logical Operators, Relational Operators , Matrices , Working with polynomials (manipulating polynomials, derivatives roots, eigen values), Linear Equations , Graphics - 2-D and 3-D plots, Log-log and semi-log plots - Histograms , Writing in an m-file, function calling in matlab , Functions in Matlab (with examples) - if, else, elseif, while, for, switch, break	
2	Numerical Analysis using Matlab :- Bisection method ,- Regula-falsi method - Newton Raphson method	
3	Numerical Solutions of ODEs using Matlab - Euler Method - Modified Euler Method - Runge Kutta Method	
4	System of Linear Equations - Gauss Elimination Method - Gauss Jordan Elimination Method	
5	Numerical Integration using Matlab - Simpson's Rule - Weddle's Rule - Trapezoidal Rule	
6	Statistical Techniques - Basic statistical data analysis technique - Linear Regression - Curve fitting techniques - Statistical distributions	

References:

1- Palm, Introduction to MATLAB (R) for Engineers, Third Ed., 2011

2- Alkis Constantindes, Numerical Methods for Chemical Engineers with MATLAB Applications / Edition 1

Second Year

Second Semester

Subject : Environmental Pollution	**Theoretical: 2 hr/wk**
Code: CHE228/2nd Semester	**Practical: 2 hr/wk**
Class: 2nd	**Tutorial: - hr/wk**
Pre-requisite:	**Units: 2**

Course Syllabus:

1	Basics of environment Biosphere, Atmosphere, Lithosphere, Hydrosphere and Pedosphere Population growth, Mathematical Models, Resources - non-renewable and renewable, concepts of Sustainable Development.Environmental degradation:	
1	Water pollution (sources, decomposition of organic compounds, effect of pollution on lakes) . Water Pollution and Control Pollutants of water, their origin and effects: Physico Chemical, Bactriological and Biological parameters, standard limits, ideas of determination of water pollutants.	
2	Water pollution (specific measurement of water, COD, BOD) Water Pollution – classification and characterization of water pollutants, sources, causes, effects of water pollution; control processes : physical- design of equalization tanks, sedimentation tanks clarifiers etc.,	
3	Water pollution (supply and treatment of water, purification of water, ion exchange, salt removal, treatment of heavy water of city, treatment of industrial water) .	
4	Air pollution and control:Primary and Secondary Pollutants, Health effects associated with air pollutants, threshold limits, Green house effect and its impacts ,atmospheric stability, temperature inversion Sources and effect of different air pollutants- Suspended particulate matter, oxides of carbon, oxides of nitrogen,oxides of sulphur, PAN. Smog, Depletion Ozone layer:Preliminary ideas of Air Pollution Control Equipments, (ESP. cyclone separator, bag house, catalytic converter,scrubber	
5	Air pollution (specific air measurements, suspended particles, gases).	
6	Air pollution (control, effect of air pollutants on human health)	

References:

1. K.B.Schnelle & C.A.Brown, Air Pollution Control Technology Handbook,

Third Year

First Semester

Subject : Chemical Eng. Analysis I	**Theoretical: 2 hr/wk**
Code: CHE311/1st Semester	**Practical: 2 hr/wk**
Class: 3rd	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	1st order differential equations (homogeneous, linear, Bernolli's) Solutions of first order differential equations by various method. Solutions of general linear equations of second and higher orders with constant Coefficients. Solution of homogeneous linear equations. Applications	
2	2nd order differential equations (non-linear, linear and its solution using D-operator).	
3	Solution of differential equations in series by the method of Frobenious.	
4	Laplace Transform: Definition. Laplace transforms of some elementary functions. Sufficient conditions for existence of Laplace transforms. Inverse Laplace transforms. Laplace transforms of Derivatives. The unit step function. Periodic function. Some specialtheorems on Laplace transforms	

References:

1-Jenson and Jeffery, Mathematical Methods in Chemical Engineering,
2. Mickley, Reid and Sherwood, Applied Mathematics in Chemical Engineering, Tata-McGraw-Hill

Third Year

First Semester

Subject : Heat Transfer I	**Theoretical: 3 hr/wk**
Code: CHE312/1st Semester	**Practical: 2 hr/wk**
Class: 3rd	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	Basic modes of heat transfer; Heat transfer by conduction: One dimensional steady state heat conduction, Fourier's Law. Radial systems (cylinder and sphere)	
2	Thermal conductivity, Compound resistance in series; Steady state heat transfer analysis through extended surface;	
3	Unsteady state heat conduction with and without heat generation	
4	Concept of thermal diffusivity; Concept of heat transfer coefficient in convective-conductive system, Critical thickness of insulation	
5	One dimensional unsteady state heat conduction- semi infinite solid: Lumped system analysis; Use of transient – temperature charts	
6	Heat transfer by convection: Convection heat transfer mechanism; Forced convection in systems of simple geometrics (plate, cylinder	
7	Thermal boundary layer; Co-relation for heat transfer coefficient: internal flow & external flow, Momentum & heat transfer analogies	
8	Free convection: concept; Analysis of free convection in hot vertical plate, Corrections of free convection over simple cylinder, sphere etc.	

References:

1- Hollman J.P., Heat Transfer, McGraw Hill

2-. Kern D.Q., Process Heat Transfer, McGraw Hill.

Third Year

First Semester

Subject : Mass Transfer I	**Theoretical: 3 hr/wk**
Code: CHE313/1st Semester	**Practical: - hr/wk**
Class: 3rd	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	Basic mass transfer theories: diffusion of gases and liquids; diffusion through stagnant layer and equimolar counter diffusion	
2	Mass transfer between gas and liquid phases; two film and other theories, mass transfer coefficients.	
3	HTU and NTU concepts, Mass transfer coefficients. Continuous contact mass transfer; packed and spray column; gas absorption in packed column; types of absorption towers, height and diameter of towers, efficiency of absorption towers .	
4	Extraction (liquid-liquid),extraction calculations of partial solubility, extraction calculations of non-soluble liquids .	

References:

1-C.J.Geankoplis, Transport Processes and Unit Operations, Prentice-Hall
2. T.K.Sherwood, R.L.Pigford and C.R.Wilke, Mass Transfer, McGraw-Hill,
3. R.E.Treybal, Mass-Transfer Operations, McGraw-Hill.

Third Year

First Semester

Subject : Chemical Eng. Thermodynamics II	**Theoretical: 3 hr/wk**
Code: CHE314/1st Semester	**Practical: - hr/wk**
Class: 3rd	**Tutorial: 1 hr/wk**
Pre-requisite: Chemical Eng. Thermodynamics I	**Units: 3**

Course Syllabus:

1	Solution thermodynamics: relationships among the thermodynamic properties for systems of variable composition; partial molar properties; fugacity and fugacity coefficients; fugacities in ideal solutions; property changes of mixing; activity and activity coefficients;	
2	Phase equilibria: nature and criteria of equilibrium; phase rule and Duhems theorem; vapour-liquid equilibrium calculations for miscible systems; Gibbs-Duhem equation. Chemical reaction equilibria: the reaction coordinate; criteria of equilibrium for chemical reactions; equilibrium constant; effect of temperature on equilibrium constants; phase rule and Duhems theorem for reacting systems.	
3	Thermodynamics of flow processes; conservation of mass and energy; mechanical energy balances; maximum velocity in pipe flow; metering and throttling processes; nozzles; compressors; ejectors.	
4	arnot refrigeration cycle; air-refrigeration cycle; vapour-compression cycles; comparison of refrigeration cycles absorption refrigeration, heat pump; liquefaction processes.	

References:

1- Smith J. M. & Van Ness H.V., Introduction to Chemical Engineering Thermodynamics.

2. Narayanan K. V., A Textbook of Chemical Engineering Thermodynamics,

Third Year

First Semester

Subject : Engineering Materials Properties	**Theoretical: 3 hr/wk**
Code: CHE315/1st Semester	**Practical: 2 hr/wk**
Class: 3rd	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	Crystalline structure	
2	Phase diagram	
3	Alloys of copper, aluminum and iron	
4	Plastics (polymers)	
5	Properties and uses of polyethylene	
6	Ceramies	
7	Electrochemical cell (electrochemical theory)	
8	Crystalline deformations	
9	Corrosion and its control Practical tests of the resistance of materials to friction, crystalline structure of metals .	

References:

1-Van Vlack, Elements of Material Science
2. Khanna O.P., A Text Book of Material Science & Metallurgy

Third Year

First Semester

Subject : Water Technologies	**Theoretical: 2 hr/wk**
Code: CHE317/1st Semester	**Practical: - hr/wk**
Class: 3rd	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 2**

Course Syllabus:

1	Water quality standards for drinking water, mineral water, boiler feed water and swimming pools. Water recycling and reuse, rain water harvesting. Water pollution control and water management.	
2	Water resources- Rainfall and runoff, ground water and surface waters. Quantity of water-Domestic water needs, Industrial demand, Institutional demand and Fire fighting demand .Quality of water- Impurities in water and their importance, water borne diseases. Water Analysis-Physical, Chemical and Biological analysis.	
3	Treatment technologies-Coagulation, flocculation and sedimentation. Usual coagulants, the jar test, flash mixers, flocculators, clarifiers and clariflocculators. Filtration- classification of filters, slow sand filters, rapid sand filters and pressure sand filters. Disinfection of water chlorination,ozonation and ultra-violet rays.	
4	Carbon adsorption, Desalination, Ion exchange and membrane processes. Turbidity removal, taste and dour control, iron and manganese removal and fluoride removal. Removal of hardness, removal of dissolved salts and nutrients. Dewatering and disposal of waste from water treatment plants.	
5	Description of methods of water purification and treatment. Fundamentals involved in Multi Stage Flash Distillation, reverse osmosis, electro dialysis etc	
6	Study of properties of water and aqueous solutions. Detailed discussion and analysis of design maintenance, energy requirements and economics of the major process of purification	

References:

1- Mark.J.Hammer & Mark.J.Hammer Jr., Water and Wastewater Technology,
2. W.Wesley Eckenfelder,Jr, Principles of water quality management,

Third Year

First Semester

Subject : Petrochemical Engineering	**Theoretical: 2 hr/wk**
Code: CHE316/1st Semester	**Practical: - hr/wk**
Class: 3rd	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 2**

Course Syllabus:

1	Production of the basic materials for the petrochemical industry (olefins and aromatics	
2	Petrochemicals from methane	
3	Ethylene derivatives	
4	Propylene derivatives	
5	High molecular weight olefins derivatives	
6	Petrochemicals in benzol and zylenes	
7	Polymers production techniques	
8	Thermoplastic	
9	Thermosit	
10	Industrial fibers	
11	**Industrial rubber**	

References:

كيمياء وتكنولوجيا البوليمر للمؤلف د. كوركيس عبد ادم

مقدمة في البتروكيمياويات للمؤلف د.عماد عبد القادر الدبوني

Third Year

Second Semester

Subject : Chemical Eng. Analysis II		**Theoretical: 2 hr/wk**
Code: CHE321/2nd Semester		**Practical: - hr/wk**
Class: 3rd		**Tutorial: 1 hr/wk**
Pre-requisite: None		**Units: 3**
Course Syllabus:		
1	Mathematical modeling (application on chemical engineering steady state and unsteady state systems).	
2	Error, Gamma, beta, and Bell functions	
3	Fourier Transform: Definition and properties. Fourier Integral, the limit of Fourier series, Inverse Fourier Transform.	
4	Finite differences (application on chemical engineering systems with multiple steps).	

References:

1-Jenson and Jeffery, Mathematical Methods in Chemical Engineering,
2. Mickley, Reid and Sherwood, Applied Mathematics in Chemical Engineering, Tata-McGraw-Hill.

Third Year

Second Semester

Subject : Process Heat Transfer	**Theoretical: 3 hr/wk**
Code: CHE322/2nd Semester	**Practical: - hr/wk**
Class: 3rd	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	Heat transfer of fluids with phase change: Introduction; Dropwise and film-type ondensation; Film condensation on vertical surface, Nusselt equation;	
2	Condensation outside horizontal and vertical tube bank; Heat transfer to boiling liquid, Analysis of boiling curve, Nucleate boiling mechanism	
3	Experimental relations of heat transfer by forced convection inside pipes	
4	Flow through cylindrical and spherical bodies, Flow through bundle of tubes	
5	Radiation heat transfer: Introduction; Black body radiation, Plank's distribution law, Monochromatic emissive power; Wein's displacement law; Kirchoff's Law; Emissivity of Solids, Concept of gray body; Radiation between surfaces, Concept of View Factor, Radiation shield; Absorption and emission in a gaseous medium.	
6	Heat Exchanger: Classification; Construction of shell and tube heat exchanger; LMTD, LMTD, NTU method	
7	correction factor, Dirt factor, Individual and overall heat transfer coefficient; Design procedure of shell and tube heat exchanger.	
8	Evaporation: Classification; Capacity, Steam economy; Boiling point elevation (Duhring rule);	
9	Material and energy balance of single effect evaporator; Design procedure of single effect evaporator; Introduction to multiple effect evaporator: Forward feed, Backward feed,	

References:

1- Hollman J.P., Heat Transfer, McGraw Hill

2. Kern D.Q., Process Heat Transfer, McGraw Hill

Third Year

Second Semester

Subject : Mass Transfer II	**Theoretical: 3 hr/wk**
Code: CHE323/2nd Semester	**Practical: - hr/wk**
Class: 3rd	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	Distilliation, McCade-Thiclc method, Lewis-Sorel method, batch distillation, multi-component distillation.	
2	Multicomponent distillation: bubble and dewpoint calculations for multicomponent systems; simplified methods for calculation of stages , flash distillation, continuous rectification, key components, minimum number of plates, minimum reflux ratio	
3	Humidification and cooling and drying towers, steps of drying	
4	Azeotropic and Extractive distillation,	
5	Evaporation, types of evaporators, single and multiple effect evaporators, material and energy balances in the evaporators.	

References:

1-C.J.Geankoplis, Transport Processes and Unit Operations, Prentice-Hall
2. T.K.Sherwood, R.L.Pigford and C.R.Wilke, Mass Transfer, McGraw-Hill,
3. R.E.Treybal, Mass-Transfer Operations, McGraw-Hill.

Third Year

Second Semester

Subject : Corrosion Engineering	**Theoretical: 2 hr/wk**
Code: CHE324/2nd Semester	**Practical: - hr/wk**
Class: 3rd	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 2**

Course Syllabus:

1	Introduction and Scope: Corrosion: Definition, wet and dry corrosion,mechanism, electro-chemical principles and aspects of corrosion, Faradays laws, specificconduction, specific resistance, transport no. mobility etc. Various forms of corrosion, a brief review of corrosion. Rate expressions. Thermodynamic aspects of corrosion, equlibrium potential, Narnst equation for electrode potential. EMF series, overvoltage,application of Nernst equation to corrosion reactions, calculation of corrosion rates.	
2	Polarisation and corrosion potentials: Reference electrodes for corrosion measurements, types of polarisation, concentration, activation and resistance polarisations, Tafel equation, Tafel constant, Evans Diagrams. Anodic control, cathodic control, mixed control. Pourbaix-diagram for Fe -H2O system.	
3	Galvanic corrosion, uniform attack, pitting corrosion, dezincification,cavitation, erosion, fretting corrosion, intergranular and stress corrosion cracking.Remedial measures for the above.	
4	High temperature oxidation, Pilling Bedworth ratio, mechanisms of Oxidation, corrosion, testing procedures and evaluation: Corrosion of iron and steel in Aqueous media, Effect of velocity, temperature and composition of media	
5	Prevention techniques, modification of the material by alloying, appropriate heat treatment. Chemical and Mechanical methods of surface treatment coatings - metallic,non-metallic linings, cathodic protection, passivity and anodic protection	

References:

1. Fontana, M.G., “Corrosion Engineering”, McGraw-Hill.
2. Jones, D.A., “Principal and Protection of Corrosion”, Prentice-Hall

Third Year

Second Semester

Subject : Engineering Economics	**Theoretical: 2 hr/wk**
Code: CHE325/2nd Semester	**Practical: - hr/wk**
Class: 3rd	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 2**

Course Syllabus:

1	Estimation of cost of the industrial projects	
2	Factors affecting the production cost and investment	
3	Capital investment	
4	Cost index	
5	Calculation of capital investment	
6	Profit and cost on investment	
7	Types of profits-payment	
8	Depreciation (types, methods of calculation)	
9	Optimum design	
10	Rate of optimum production for evert production unit, optimum rate production that gives highest profit per unit of time	
11	Packed and plate towers and the cost of the mass heat transfer equipments	

References:

1-Jelen F.C., Cost and Optimization Engineering, McGraw Hill
2. Davies G.S., Process Engineering Economics, Chem. Eng. Ed. Dev.
3. Peters & Timmerhaus, Plant Design & Economics for Chemical Engineering,

Third Year

Second Semester

Subject : Chemical Industries	**Theoretical: 2 hr/wk**
Code: CHE326/2nd Semester	**Practical: - hr/wk**
Class: 3rd	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 2**

Course Syllabus:

1	Treatment of industrial water (general properties of water for the domestic use, temporary and permenant hardness, calculations used in the determination of the positive and negative ions, preciptaion, test of water, water extraction from rivers and seas, water properties in the industrial uses, treatments in boilers heat exchangers and condensers,	
2	Industrial carbon (types, properties, chemical absorption processes).	
3	**Ammonia-** Source of hydrogen; methods of obtaining hydrogen from different sources, source of nitrogen - liquefaction of air and distillation of liquid air. Synthesis of ammonia- physico chemical principles, catalyst for synthesis of ammonia, process flow sheet and sequence of operation, details of major equipments.	
4	**Urea** - Raw materials, manufacturing process with flow sheet, sequence of operation, major equipments details.	
5	***Hydrochloric Acid:*** Raw materials, principles of manufacture, flow-sheet and sequence of operation, major engineering problems,uses	
6	**sulfuric acid**: sulfuric acid production process, Contact process, Physico-chemical principles and general theory of contact reaction with thermodynamic and reaction engineering aspects, different types of catalyst – preparation methodology and relative merits, flow-sheet and sequence of operation, details of major equipments, advancement of process technology and major engineering problems, DCDA process, uses	
7	**Nitric Acid:** Raw materials,Ostwald Process –physico-chemical principles, catalyst, process flowsheet and sequence of operation, details of major equipments, uses.	
8	**Cement:** Chemical composition of Portland cement, raw materials, dry and wet process for manufacturing cement clinker, setting and hardening of cement.	

References:

1- Chemical process industries, by R. Norris Shreve .

Third Year

Second Semester

Subject : Reactor Design I	**Theoretical: 3 hr/wk**
Code: CHE327/2nd Semester	**Practical: - hr/wk**
Class: 3rd	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	Thermodynamic of chemical reactions	
2	Reaction kinetics (homogeneous reactions, equation, dependence of rate of reaction on concentration and temperature, analysis of information from constant volume batch reactor, varying volume, batch reactor, how to reach to the rate equation) 3 Ideal reactors (single ideal reactor.	
3	Ideal batch reactor, steady state continuous stirred reactor, plug flow reactor).	
4	Operation of reactors at different temperatures (adiabatic of batch reactor, exothermic reactions in continuous stirred reactor, adiabatic and non-adiabatic operation of plug flow reactor).	

References:

1-Levenspiel O., Chemical Reaction Engineering, John Wiley
2. Fogler H.S., Elements of Chemical Reaction Engineering, Prentice Hall
3. Smith J.M., Chemical Engineering Kinetics, McGraw Hill

Fourth Year

First Semester

Subject : Engineering Project I	**Theoretical: - hr/wk**
Code: E411/1st Semester	**Practical: 2 hr/wk**
Class: 4th	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 2**

Course Syllabus:

This is an independent study under the supervision of department members. Each student is expected to do research trying to explore and define a potential study area suitable for a senior design project. A specific engineering problem must then be identified from within the selected study area. Results from this study must be documented and submitted in the form of a design project proposal

Fourth Year

First Semester

Subject : Unit Operation	**Theoretical: 3 hr/wk**
Code: CH E412/1st Semester	**Practical: 2 hr/wk**
Class: 4th	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 4**

Course Syllabus:

1	Transfer of heat, mass and momentum	
2	Reynolds analogy	
3	Non Newtonian fluids	
4	Mixing	
5	Fluid flow through packed columns	
6	Fluidization	
7	Filtration	
8	Flow of particles through fluids	
9	Sedimentation	

References:

1- Coulsun, Chemical Eng. Vol. 2

2- Smith, unit operations for chemical engineering.

Fourth Year

First Semester

Subject : Process Dynamics	**Theoretical: 3 hr/wk**
Code: CHE413/1st Semester	**Practical: - hr/wk**
Class: 4th	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	Laplace transform, transforming of nonlinear equations to linear, effective functions, 1st order response	
2	Calculation of time elapsed, steady state coefficient, final value theorem	
3	Total time delay	
4	Response of 1st order systems (reacted and un-reacted), 2nd order system (characteristics and response) .	
5	Closed loop systems, transfer function and flow diagram .	
6	Transfer of signals between the elements of system, symbols of control and measuring devices .	
7	Air control valve	

References:

1. Coughanowr and Koppel, Process Systems Analysis and Control,
2. Stephnopolous, Chemical Process Control
3. W.L.Luyben, Process Modeling, Simulation and Control for Chemical Engineers, McGraw-Hill .

Fourth Year

First Semester

Subject : Equipments Design I		**Theoretical: 2 hr/wk**
Code: CHE414/1st Semester		**Practical: - hr/wk**
Class: 4th		**Tutorial: 1 hr/wk**
Pre-requisite: None		**Units: 2**
Course Syllabus:		
1	Introduction to Mechanical Aspects of Chemical equipment Design-Design Preliminaries-Design of thick walled high pressure vessels-Design of Cylindrical and spherical vessels under internal pressure-Design ofheads and closures-Design of tall vessels-Preparation of detailed drawing for some chemical process equipment-Process .	
2	Pumps and piping systems, pipe fittings, valves, steam traps, selection of metal type of pipes, pumps characteristics and data basis, optimum diameter, types of pumps, operating characteristics of centrifugal pumps .	
3	Vessels and tanks types, flash, tanks for liquefied gasoil, principles of designing vessels, stress considerations, design of vertical columns, design of pressure vessel, foundation .	
4	Mechanical design of process equipment: tall columns, column supports & accessories, etc.Mechanical design of non standard flange. Design of storage tanks for Volatile and Nonvolatile liquids.	
References:		

1- E. Ludwig, Applied Process Design for Chemical & Petrochemical Plants, Vol I, II, II, Gulf Publication,
2- J.M.Coulson & J.F.Richardson, Chemical Engineering, Vol.6,

Fourth Year

First Semester

Subject : Petroleum Refinery I	**Theoretical: 3 hr/wk**
Code: CHE416/1st Semester	**Practical: - hr/wk**
Class: 4th	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	Crude oils and their chemical composition	
2	Physical and chemical characteristics of crude oil and its products	
3	Evaluation of crude oil	
4	Preparation of crude oil for refining	
5	Crude oil refining (atmospheric and vacuum distillation, basic unit in the distillation unit).	

References:

1-Nelson, W.L., "Petroleum refining engineering", McGraw-Hill Book Co.
2. Bhaskara Rao, B.K., Modern Petroleum Refining Processes", Oxford-IBH Publishing Co.

Fourth Year

First Semester

Subject : Numerical Methods	**Theoretical: 2 hr/wk**
Code: CHE417/1st Semester	**Practical: 2 hr/wk**
Class: 4th	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	**Solution of Non-linear equations:** Bisection method, Newton-Raphson method, Secant method, Modified Newton-Raphson method for multiple roots - Application in thermodynamic property calculation, bubble point and dew point calculation. Finding of multiple roots of a polynomial. Solution of a set of non-linear equations	
2	**Solution of simultaneous linear equations:** Gauss elimination Method, Gauss-Jordon Method -Pivoting and illconditioning,Condition number of a matrix. Iterative method - Jacobi iteration, Gauss-Seidel Method. SOR method,	
3	**Numerical Solution of ODE:** Initial and boundary value problem- Explicit ADAMS-BASHFORTH Techniques like Euler's Method, ADAMS-BASHFORTH 2nd and fourth order methods. Implicit ADAMS-MOULTON techniques including Implicit Euler.	
4	**Numerical differentiation and integration** and Taylo's series Runge-Kutta Method(2nd, 3rd and 4th order), Euler's predictor-corrector method (Heun' method)-finite difference method (forward,backward and central differences), Stability analysis of ODES of Euler methods, Runge-Kutta methods, step-size control	
5	Interpolation (Lagrange method, Newton Niefel)	

References:

1- Hanna, O.T. and O.C. Sandal, , Computation Methods in Chemical Engineering,
2- Davis M. E., "Numerical Methods and Modeling for Chemical Engineers",Wiley, New York,
3- Mathew J.H., Numerical Methods for Mathematics, Science and Engineering.

Fourth Year

First Semester

Subject : Reactor Design II		**Theoretical: 3 hr/wk**
Code: CHE415/1st Semester		**Practical: - hr/wk**
Class: 4th		**Tutorial: 1 hr/wk**
Pre-requisite: None		**Units: 3**
Course Syllabus:		
1	Design of single reaction reactors (system of single reactor, connection of plug flow reactors in series or in parallel, connection of continuous stirred reactors with the same or different volumes in series, connection of different types of reactors in series	
2	Recycle reactor	
3	Self catalytic reactor	
4	Introduction to design of reactors with heterogeneous reactions, analysis of the reactor (solid-fluid), height of the reactor unit, activity of catalyst .	

References:

1-Levenspiel O., Chemical Reaction Engineering, John Wiley
2. Fogler H.S., Elements of Chemical Reaction Engineering, Prentice Hall
3. Smith J.M., Chemical Engineering Kinetics, McGraw Hill

Fourth Year

Second Semester

Subject : Engineering Project II	**Theoretical: - hr/wk**
Code: E421/2nd Semester	**Practical: 2 hr/wk**
Class: 4th	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 2**

Course Syllabus:

This is an independent study under the supervision of department members. Each student is expected to do research trying to explore and define a potential study area suitable for a senior design project. A specific engineering problem must then be identified from within the selected study area. Results from this study must be documented and submitted in the form of a design project proposal

Fourth Year

Second Semester

Subject : Transport Phenomena	**Theoretical: 3 hr/wk**
Code: CHE423/2nd Semester	**Practical: - hr/wk**
Class: 4th	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	Vapour liquid equilibrium; Raoult's law ; Relative volatility; minimum and maximum boiling mixtures; enthalpy concentration diagrams for binary systems; Flash, Differential and Steam Distillation; Azeotropicand Extractive Distillation	
2	Multistage tray towers; Graphical methods using Mc Cabe-Thiele and Ponchon – Savarit analysis; minimum reflux, total reflux and optimum reflux ratio, open steam, multiple feed and side stream Multi component Calculations using Short-cut methods;	
3	Absorption- Equilibrium, co-current operation, counter current multistage operation, dilute gas mixtures,Multicomponent absorption, tray efficiency;	
4	Liquid-liquid Extraction-, choice of solvent, equilibria on triangular coordinates, single stage and multistagesingle cross current extraction, continuous counter current multistage extraction, insoluble liquids;	
5	Solid-liquid Extraction- Method of operation, Shank's system and other systems, equilibrium curve, single stage and multistage single cross current leaching, multistage counter current leaching using rectangular and triangular method,	
6	Adsorption- Adsorbents, adsorption equilibria, adsorption for dilute solutions, single stage and multistage single cross current operation,	

	multistage counter current operation using Freundlich equation for equilibria,	

References:

1- Henley, E.J., Equiibrium Stage Separation Operations in Chemical Engineering,
2- Smith, unit operations for chemical engineering

Fourth Year

Second Semester

Subject : Process Control and Instrumentation	**Theoretical: 3 hr/wk**
Code: CHE424/2nd Semester	**Practical: 2 hr/wk**
Class: 4th	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 4**

Course Syllabus:

1	Analysis and design of advanced control systems: control of system with large dead time or inverse response; multiple-loop control systems; feedforward and ratio control; adaptive and inferential control.	
2	Optimum control by Zegler-Nickes method	
3	Concept of stability; stability testing. Frequency response analysts: Bode diagrams; Nyquist plots; Bode and Nyquist stability criteria; control system design by frequency response analysis	
4	Control of some chemical processes Design of control systems for multivariable processes: synthesis of alternative control configurations for multiple-input and multiple-output processes; interaction and decoupling of control loops	
5	Introduction to the control by computer	
6	Measuring devices of temperature, pressure, concentration and fluid flow Practical dynamic response, pressure measurement, air control value, analysis of frequency response, three phase control system,	

	control of acidity and temperature .	

References:

1. Coughanowr and Koppel, Process Systems Analysis and Control,
2. Stephnopolous, Chemical Process Control
3. W.L.Luyben, Process Modeling, Simulation and Control for Chemical Engineers, McGraw-Hill .

Fourth Year

Second Semester

Subject : Equipments Design II	**Theoretical: 2 hr/wk**
Code: CHE425/2nd Semester	**Practical: - hr/wk**
Class: 4th	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 2**

Course Syllabus:

1	Heat transfer equipments types of heat exchangers and fields of application, capacity and design of the exchangers, characteristics of the exchangers, furnaces, convection and radiation places, types of fuel, layout of furnaces, types of steam boilers .	
2	Mass transfer equipments types of columns, plate and packed columns, types of plates and packing, design considerations, losses in pressure in columns	
3	Reactor design	

References:

1- E. Ludwig, Applied Process Design for Chemical & Petrochemical Plants, Vol I, II, II, Gulf Publication,
2- J.M.Coulson & J.F.Richardson, Chemical Engineering, Vol.6,

Fourth Year

Second Semester

Subject : Catalytic Reactor Design	**Theoretical: 2 hr/wk**
Code: CHE426/2nd Semester	**Practical: - hr/wk**
Class: 4th	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 2**

Course Syllabus:

1	Heterogeneous processes; Catalysis and adsorption; Classification and preparation of catalysts; Promoters and inhibitors	
2	Catalyst characterization: Surface area and pore size distribution; Introduction to other characterization techniques (XRD, electron microscopy, electron spectroscopy, thermal analysis, desorption spectroscopy.)	
3	Rate equations of fluid-solid catalytic reactions; Hougen-Watson and power law models; Procurement and analysis of kinetic data; Kinetics of catalyst deactivation and regeneration.	
4	Reaction and diffusion in porous catalysts; Isothermal and non-isothermal effectiveness factors; Effect of intra-phase transport on yield, selectivity and poisoning; Global reaction rate.	
5	Design of catalytic reactors: Isothermal and adiabatic fixed bed reactors; Staged adiabatic reactors; Non-isothermal non-adiabatic fixed bed reactors; Fluidized bed reactors; slurry reactors; Trickle bed reactors; Reactors with novel configurations- radial flow reactors, honey-comb reactors, membrane reactors	
6	Models for fluid-solid non-catalytic reactions; Controlling mechanisms and global reaction rates; Reactor design for fluid solid reactions including fluidized bed reactors with and without elutriation. Gas-liquid and liquid-liquid reactions; Rate equations based on film theory; Reactor design for instantaneous reactions and slow reactions.	

References:

1-Levenspiel O., Chemical Reaction Engineering, John Wiley

2. Fogler H.S., Elements of Chemical Reaction Engineering, Prentice Hall

Fourth Year

Second Semester

Subject : Petroleum Refinery II	**Theoretical: 2 hr/wk**
Code: CHE427/2nd Semester	**Practical: 2 hr/wk**
Class: 4th	**Tutorial: 1 hr/wk**
Pre-requisite: None	**Units: 4**

Course Syllabus:

1	Introduction. Origin, formation and composition of petroleum. Evaluation of crude oils. Refinery products and their uses. Analysis of petroleum products. Fractionation of petroleum. Thermal processes (cracking, coking, steam cracking) .	
2	Catalytic processes in oil refineries (catalytic cracking, hydro cracking, desulphurization by hydrogen, reforming isomerization, polymerization , steam reforming)	
3	Conventional chemical treatment of refinery products (treatment with sulfuric acid, treatment with earth) .	
4	Lubricating oils (properties and needs, production techniques, removal of asphalt by solvents, extraction by furfural, de-waxing).	
5	Production of different types of fuels and oil products (gasoil, solvents car and aeroplane gasoline, jet fuel, kerosene, diesel, asphalt, wax). Practical density, flash point, viscosity, aniline point, sulfur content, water content, carbon content, salt content .	

References:

1-Nelson, W.L., "Petroleum refining engineering", McGraw-Hill Book Co.
2. Bhaskara Rao, B.K., Modern Petroleum Refining Processes", Oxford-IBH Publishing Co.

Fourth Year

Second Semester

Subject : Optimization and Simulation	**Theoretical: 2 hr/wk**
Code: CHE428/2nd Semester	**Practical: 2 hr/wk**
Class: 4th	**Tutorial: - hr/wk**
Pre-requisite: None	**Units: 3**

Course Syllabus:

1	Nature and organisation of optimisation problems - scope and hierarchy of optimisation - typical applications of optimisation - essential features of optimisation problems - objective function - investment costs and operating costs in objective function - optimising profitability- constraints - internal and external constraints - formulation of optimisation problems -typical examples - nature of functions and their representation - continuous functions -discrete functions - unimodal functions - convex and concave functions - necessary and sufficient conditions for optimum of unconstrained functions.	
2	Analytical method necessary and sufficient conditions for optimum in single and multi-variable unconstrained and constrained problem	
3	**OPTIMIZATION TECHNIQUES** Formulation of a LPP - Graphical Method - Simplex method - duality - dual simplex method – sensitivity analysis, transportation and assignment problems, traveling salesman problem - Lagrange multipliers and Kuhn-Tucker conditions - quadratic programming problem - Dynamic Programming - Integer Linear	
4	Numerical methods for unconstrained functions - one dimensional search - gradient-free search with fixed step size - gradient search with acceleration - Newton's method - Quasi-Newton method - dichotomous search -fibonacci search - golden-section method – quadratic interpolation - numerical methods for unconstrained multivariable optimisation – univariate search - simplex method - Powell's method - method of steepest descent - Fletcher-Reeves conjugate - gradient method - Newton's method	
5	Classification of mathematical models. Fundamental features of models. General methods of solution. Application to problems in staged operations, fluid mechanics, heat transfer and reactor design. Parameter estimation.	
6	**Dynamic Simulations** Batch reactor, Gravity flow tank, Three CSTR in series, Non-isothermal CSTR .Chemical Reactor Simulation: Modeling and simulation of isothermal and non-isothermal operation of batch reactor, isothermal and non isothermal CSTR and Semi-batch reactor	

References:

1. Luyben W. L., "Process Modeling Simulation and Control for Chemical Engineers", McGraw Hill, 1988.
2. Edgar T.F. & Himmelblau D.M., Optimization of Chemical Processes,