بسم الله الرحمن الرحيم

Proposed Study Plan

For

The Chemical Engineering Department

College of Engineering

King Khalid University

2022/2023

Chemical Engineering Department
First Year – Common Engineering Year

Level 1						
Course Code	**Course Title**	**Credit Hour**				**prerequest**
		Lectures	**Lab/ Tutorial**	**Total**	**Contact**	
-ENG011-6	Intensive English Program - 1	-	6	6	12	
-CHEM107-6	General Chemistry	5	1	6	7	
-ARAB201-2	Skills of Arabic Language	2		2	2	
Total Credit Hours		7	7	14	22	

Level 2						
Course Code	**Course Title**	**Credit Hour**				**prerequest**
		Lectures	**Lab/ Tutorial**	**Total**	**Contact**	
-ICI111-2	Islamic Culture -1	2	-	2	2	
-MATH119-5	Differentiation and Integration -1	5		5	5	-
-ENG012-6	Intensive English Program 2	-	6	6	12	-ENG011-6
Total Credit Hours		8	6	13	19	

Level 3						
Course Code	**Course Title**	**Credit Hour**				**prerequest**
		Lectures	**Lab/ Tutorial**	**Total**	**Contact**	
-102CS-3	Computer Science	2	1	3	4	
-MATH219-5	Differentiation and Integration -2	5		5	5	
-PHYS129-6	Physics	5	1	6	7	-MATH119-5
-ICI112-2	Islamic Culture - 2	2		2	2	
Total Credit Hours		14	2	16	18	

Level 4

Course Code	Course Title	Credit Hour				prerequest
		Lectures	Lab/ Tutorial	Total	Contact	
-GE111-4	Engineering Drawing		8	4	8	
-CHEM211-5	Organic Chemistry -1	4	1	5	6	-CHEM107-6
-GE211-3	Learning Skills	3		3	3	
-MATH329-4	Linear Algebra	4		4	4	
Total Credit Hours		11	9	16	21	

Level 5

Course Code	Course Title	Credit Hour				prerequest
		Lectures	Lab/ Tutorial	Total	Contact	
-ARAB202-2	Arabic Writing	2		2	2	
-CHME 211-5	Chemical Engineering Principles -1	4	1	5	6	-CHEM107-6
-ME218-4	Static & Dynamic	3	1	4	5	-MATH329-5
Total Credit Hours		9	2	11	13	

Level 6

Course Code	Course Title	Credit Hour				prerequest
		Lectures	Lab/ Tutorial	Total	Contact	
-CHME221-5	Chemical Engineering Principles -2	4	1	5	6	-CHME211-5
-ICI113-2	Islamic Culture - 3	2		2	2	
-GE221-3	Creative and Innovation	3		3	3	
-CHEM231-5	Physical Chemistry	4	1	5	6	-CHEM107-6
Total Credit Hours		14	2	16	18	

Level 7						
Course Code	**Course Title**	**Credit Hour**				**prerequest**
		Lectures	**Lab/ Tutorial**	**Total**	**Contact**	
-MATH319-5	Differential Equations	5		5	5	-MATH219-5
-CHME311-5	Chemical Engineering Thermodynamic - 1	4	1	5	6	-CHEM231-5, -CHME221-5
-IC114-2	Islamic Culture 4	2		2	2	
-CHME313-4	Mass Transfer -1	3	1	4	5	-CHME 211-5
Total Credit Hours		14	2	16	18	

Level 8						
Course Code	**Course Title**	**Credit Hour**				**prerequest**
		Lectures	**Lab/ Tutorial**	**Total**	**Contact**	
-CHME312-4	Fluid Mechanics	3	1	4	5	-CHME211-5
-CHME314-4	Chemical Process Technology	4		4	4	
-CHME321-4	Chemical Engineering Thermodynamic - 2	3	1	4	5	-CHME311-5
-CHME322-4	Mass Transfer -2	3	1	4	5	-CHME313-4
Total Credit Hours		13	3	16	19	

Level 9						
Course Code	**Course Title**	**Credit Hour**				**prerequest**
		Lectures	**Lab/ Tutorial**	**Total**	**Contact**	
-ENG301-3	Technical Report Writing	3		3	3	-ENG012-6
-CHME323-4	Particle Technology	3	1	4	5	-CHME312-4
-CHME324-5	Chemical Reactions Engineering	4	1	5	6	-CHME311-5
-CHME325-5	Heat Transfer	4	1	5	6	-CHME221-5
Total Credit Hours		14	3	17	20	
-CHME400-0	Specialized Training					Successfully pass 139 credit hours

Level 10						
Course Code	**Course Title**	**Credit Hour**				**prerequest**
		Lectures	**Lab/ Tutorial**	**Total**	**Contact**	
-CHEM242-5	Quantitative Analytical Chemistry	4	1	5	6	
-MATH419-5	Numerical Methods	5		5	5	-MATH319-5
-GE411-3	Professional Ethics and Practice	3		3	3	
-STAT329-3	Principles of Statistic and Probailities	3		3	5	
Total Credit Hours		15	1	16	19	

Level 11						
Course Code	**Course Title**	**Credit Hour**				**prerequest**
		Lectures	**Lab/ Tutorial**	**Total**	**Contact**	
-CHME411-4	Materials Science and Engineering	3	1	4	5	
-CHME421-4	Separation Processes	3	1	4	5	-CHME313-4
-CHME424-4	Industrial Pollution Control	3	1	4	5	
-CHME425-4	Industrial Safety and Occupational Health	3	1	4	5	
Total Credit Hours		12	4	16	20	

Level 12						
Course Code	**Course Title**	**Credit Hour**				**prerequest**
		Lectures	**Lab/ Tutorial**	**Total**	**Contact**	
-CHME421-5	Plant Design and Economics	4	1	5	6	-CHME322-4, -CHME325-5
-CHME422-5	Reactor Design	4	1	5	6	-CHME324-5 -CHME311-5
-CHME423-5	Modelling & Simulation	4	1	5	6	-CHME322-5, -MATH419-5
Total Credit Hours		12	3	15	18	

Level 13						
Course Code	**Course Title**	**Credit Hour**				**prerequest**
		Lectures	**Lab/ Tutorial**	**Total**	**Contact**	
-GE511-3	Engineering Entrepreneurship	3		3	3	
-CHME511-4	Chemical Process Control	3	1	4	5	-CHME423-5
-CHME512-5	Computer Applications in Chemical Engineering	3	2	5	7	-CHME423-5
-CHME513-3	Graduation Project -1	3		3	3	Pass 169 credit hours
Total Credit Hours		12	2	15	18	

Level 14						
Course Code	**Course Title**	**Credit Hour**				**prerequest**
		Lectures	**Lab/ Tutorial**	**Total**	**Contact**	
-IE411-3	Engineering Management	3		3	3	
-CHME514-4	Elective Subjects in Energy and Environment	4		4	4	
-CHME521-3	Graduation Project -2	3		3	3	-CHME513-3
Total Credit Hours		10	0	10	10	

Level 15						
Course Code	**Course Title**	**Credit Hour**				**prerequest**
		Lectures	**Lab/ Tutorial**	**Total**	**Contact**	
-CHME523-4	Elective Subjects in Bio Engineering	4		4	4	
-CHME522-5	Elective Subjects in Chemical and Petrochemical Industries	4	1	5	6	
Total Credit Hours		8	1	9	10	

COURSE CONTENTS

This section provides the course contents for subjects taught within the Department ONLY

The format used is this adopted by King Khalid University

Chemical Engineering Principles-1

Course Title	**Chemical Engineering Principles 1**
Course Code	**-CHME211-5**
No. of units(Theoretical + Tutorials)	**5 (4+1)**
Level-Year	**5-2**
Prerequisite (if any)	**-CHEM107-6**

1) Brief Course Description

This course provides an introduction to basic concepts in chemical engineering. Origin and role of Chemical Engineering, Engineering Calculations, Processes and process variables. It prepares students to formulate and solve material balances on chemical process systems in single unit & multiple units for non-reactive and reactive processes. It introduces the engineering approach to problem solving.

2) Course Objectives

At the end of this course the student should be able to:

1. Describe the role of chemical engineering and its relation with other disciplines.
2. Estimate quantities from one set of units to another quickly and accurately.
3. Define, calculate, and estimate properties of process materials including fluid density, flow rate, chemical composition variables (mass and mole fractions, concentrations), fluid pressure, and temperature.
4. Draw and label process flowcharts from verbal process descriptions.
5. Derive and solve material balance equations for single-unit and multiple-unit processes, processes with recycle and bypass, and reactive processes.
6. Perform pressure-volume-temperature calculations for ideal and non-ideal gases.

3) Course Contents

What is chemical engineering? Historical background of chemical engineering. Introduction to chemical engineering calculations: Units and dimensions; conversion

of units, systems of units; Force and weight; Numerical calculations and estimation; Dimensional homogeneity and dimensionless quantities; Process data representation and analysis. Processes and process Variables: Mass and volume; Flow rate; Chemical composition; Pressure; Temperature. Fundamental of material balances; Process classification; Mole and mass balances; Material balance calculations; Balances on multiple-unit processes; Recycle and Bypass; Chemical reaction stoichiometry; Balance on reactive processes; Combustion reactions. Single-phase systems: Liquid and solids densities; Ideal gases; Equation of state for non-ideal gases; Compressibility factor equation of state.

4) Course Assessment

- Mid-Term Tests ……..(30 %)
- Tutorials…….. (20%)
- Final Exam……..(50%)

5) Teaching Methods

- Lectures
- Training exercises (Tutorials)

6) Reference Books:

1. FELDER, R.M. & ROUSSEAU, R.W. 2004. *Elementary Principles of Chemical Processes*, Wiley.
2. HIMMELBLAU, D. M. & RIGGS, J. B. 2005. *Basic principles and calculations in chemical engineering*, Prentice Hall.

Chemical Engineering Principles-2

Course Title	**Chemical Engineering Principles 2**
Course Code	**-CHME221-5**
No. of units(Theoretical + Tutorials)	**5 (4+1)**
Level-Year	**6-2**
Prerequisite (if any)	**-CHME211-5**

1) Brief Course Description

This course introduces the basic concepts of multiphase systems. Energy forms, energy balances, and thermodynamic principles. Energy balance calculations on reactive and non-reactive processes. Solution of simultaneous material and energy balance equations for process flow sheets using software.

2) Course Objectives

At the end of this course, the student should be able to:

1. Draw and label process flowcharts from verbal process descriptions.
2. Write and solve material and energy balance equations for multiple unit process.
3. Perform various vapor– liquid equilibrium calculations.
4. Calculate internal energy and enthalpy changes for process fluids undergoing specified changes in temperature, pressure phase and chemical composition.
5. Incorporate the results of these calculations into process material and energy calculations.

3) Course Contents

Multiphase systems: Single-component phase equilibrium; The Gibbs phase rule; Gas-Liquid systems of one condensable components; Multicomponent gas-liquid systems; Solutions of solids in liquids; Equilibrium between two liquid phases. Energy and energy balances: Forms of energy; First law of thermodynamics; Energy balances on closed systems; Energy balances on open systems at steady

state; Tables of thermodynamic data; Mechanical Energy Balances. Simultaneous material and energy balances on nonreactive processes: Elements of energy balance calculations; changes in temperature and pressure; phase change operations; heat of mixing and solutions. Simultaneous material and energy balances on reactive processes: Heat of reaction; measurement and calculation of heat of reaction; Formation reaction and heat of formation; Heat of combustion; Energy balances of reactive processes.

2. Course Assessment

- Mid-Term Tests ..... (30 %)
- Tutorial..... (20%)
- Final Exam..... (50%)

3. Teaching Methods

- Lectures
- Training exercises (Tutorials)

4. References

1. FELDER, R.M. & ROUSSEAU, R.W. 2004. *Elementary Principles of Chemical Processes*, Wiley.
2. HIMMELBLAU, D. M. & RIGGS, J. B. 2005. *Basic principles and calculations in chemical engineering*, Prentice Hall.

Chemical Engineering Thermodynamics 1

Course Title	**Chemical Engineering Thermodynamics -1**
Course Code	**-CHME311-5,**
No. of units (Theoretical + Tutorial/Lab)	**5(4+1)**
Level-Year	**7-3**
Prerequisite (if any)	**-CHEM231-5, -CHME221-5**

1) Brief Course Description

This course covers the principles and concepts of thermodynamics, first and second laws of thermodynamics, properties of pure fluids, equilibrium states for ideal and real gases, mass and energy equilibrium in open and closed systems, heat effects, and production of power from heat. Computer applications in thermodynamics.

2) Course Objectives

Upon completion of this course, the student should be able to:

1. Explain the concepts and laws of thermodynamics.
2. Define the properties of pure fluids for ideal and real gases.
3. Calculate different forms of energy.
4. Analyze energy balance problems involving ideal gas for different thermodynamic processes
5. Distinguish between sensible heat effects and latent heat of pure substances.
6. Develop the skills of computer applications in thermodynamics.

3) Course Contents

Introduction to the concepts of thermodynamics, first law and other concepts of thermodynamics, Volumetric properties of pure fluids, heat effects, the second law of thermodynamics, thermodynamic properties of fluids, application of thermodynamic to flow processes.

4) Course Assessment

- Mid-Term Tests …….. (30%)
- Tutorials+Labs …… (20%)
- Final Exam. ……..(50%)

5) Teaching Methods

- Lectures
- Training exercises (Tutorials+Labs)

6) References

1. VAN NESS, H.C. & ABBOTT, M.M. 2004. *Introduction to Chemical Engineering Thermodynamics*, 7th Edition, McGraw-Hill.
2. KORETSKY, M. D. 2004. *Engineering and chemical thermodynamics*, Wiley Hoboken, NJ.
3. ELLIOTT, J.R. & LIRA, C.T. 2011. *Introductory Chemical Engineering Thermodynamics*, 2nd Edition, Prentice Hall.

Fluid Mechanics

Course Title	**Fluid Mechanics**
Course Code	**-CHME312-4**
No. of units (Theoretical + Tutorial/Lab)	**4 (3+1)**
Level-Year	**8–3**
Prerequisite (if any)	**-CHME211-5**

1)Brief Course Description

This course is devoted primarily to the basic principles and practical applications of fluid mechanics. Mathematical methods are applied to demonstrate applications to fluid systems.

2) Course Objectives

At the end of this course, the student should be able to:

1. Differentiate between various types and states of fluids and their properties.
2. Apply conservation principles of mass, energy, and momentum to fluid systems.
3. Acquire and interpret data for flow and pressure measurement using different kinds of instruments

3) Course Contents

Introduction to fluid mechanics: definition of fluid mechanics and of fluid properties and types of fluids. Fluid static: pressure and Pascal's law, pressure measurements, pressure forces on surfaces, buoyancy force; fluid flow and conservation of mass, momentum, energy and Bernoulli equations, Fluid friction calculation in different types of fittings and equipments. Fluid flow instrumentations.

4) Course Assessment

- Mid-Term Tests…….. (30 %)
- Tutorials+labs…….. (20 %)
- Final Exam…….. (50 %)

5) Teaching Methods

- Lectures.
- Training exercises (Tutorials and Labs)

6) References

1. WELTY, J. R., WICKS, C. E., RORRER, G., WILSON, R. E. and RORRER, G.L. 200. *Fundamentals of momentum, heat, and mass transfer*, John Wiley & Sons.
2. CROWE, C.T., ELGER, D.F. & ROBERSON, J.A. 2004. *Engineering Fluid Mechanics*, John Wiley and Sons.
3. NEVERS, N.D. 2005. *Fluid Mechanics for Chemical Engineering*, McGraw-Hill.
4. MOTT, R.L. 2005. *Applied Fluid Mechanics*, Prentice Hall.

Mass Transfer-1

Course Title	**Mass Transfer - 1**
Course Code	**-CHME313-4**
No. of units (Theoretical + Lab)	**4 (3+1)**
Level – Year	**7-3**
Pre-requisites (if any)	**-CHME211-5**

1) Brief Course Description

This course covers the basic principles of mass transfer operations. Students will be introduced to various skills needed to conduct mass transfer operations on different industries. Among them, but not limited to steady and unsteady-state molecular diffusion. The course also provides the necessary skills of separating mixtures by utilizing different techniques.

2) Course Objectives

Upon completion of the course, the students will be able to:

1. Define mass transfer by molecular diffusion and convection.
2. Explain Fick's Law of diffusion in mass transfer operations
3. Calculate values for binary diffusion coefficients in gas liquid and solid phases at specified conditions.
4. Apply the analogy between heat and mass transfer operations.
5. Use T-x-y and y-x diagrams of binary mixtures, with the concept of the q-line, to determine equilibrium phase compositions.
6. Apply the McCabe-Thiele method for determining minimum reflux ratio, minimum number of equilibrium stages and number of equilibrium stages.

3) Course Contents

Fundamentals of mass transfer operations, Fick’s Law, The control volume approach to the mass transfer processes, differential equations of mass transfer. Steady and unsteady –state molecular diffusion. Natural and forced convection mass transfer. Mass transfer theories. Convective mass transfer correlations. Binary distillation. Phase equilibrium data. Equilibrium curves. McCabe Thiele methods, Ponchon Savarit method.

4) Course Assessment

- Mid-Term Tests ……..(30 %)
- Tutorials+Labs……..(20%)
- Final Exam. ……..(50%)

5) Teaching Methods

- Lectures
- Training exercises (Tutorials + Labs)

6) Reference Books

1. COULSON, J.M. & RICHARSON, J.F. Chemical Engineering, 6th Edition, Volume-2, Butterworth and Heinemann.
2. MCCABE, W. L., SMITH, J. C. & HARRIOTT, P. 1993. *Unit operations of chemical engineering*, McGraw-Hill New York.
3. TREYBAL, R.E. 1980. Mass Transfer Operations, 3rd Edition, McGraw-Hill Book Company.
4. CUSSLER, E. L. 2009. *Diffusion: mass transfer in fluid systems*, Cambridge university press.
5. SEADER, J.D. & HENLEY, E.J. 2006. Separation Process Principles, 2nd Edition, John Wiley & Sons.
6. BERGMAN, T. L., LAVINE, A. S., DEWITT, D. P. & INCROPERA, F. P. 2011. Fundamentals of heat and mass transfer, Wiley Publication.

Chemical Process Technology

Course Title	**Chemical Process Technology**
Course Code	**-CHME314-4**
No. of units (Theoretical + Tutorial/Lab)	**4 (4+0)**
Level-Year	**8-3**
Prerequisite (if any)	**No prerequest**

1) Brief Course Description

This course is designed to introduce the principles of chemical industries for students. Numbers of national and international industries that have global impact on world economy are investigated. Students will be taught on how these industries are formed and developed from the drawing board to production point

2) Course Objectives

Upon completion of the course, students should be able to:

1. Understand the principles of defining customers need.
2. Develop skills on specifying lucrative industries.
3. Understand how different commodities are manufactured.
4. Graphical demonstrate various production procedures.

3) Course Contents

Salient features of manufacture of commodity chemicals. Status of chemicals and chemical industry in Saudi Arabia. Engineering aspects of the manufacture of basic inorganic chemicals such as sulphuric acid, caustic soda, soda ash, ammonia, nitric acid and urea. Solid, liquid and gaseous fuels carbonization and gasification of coal. Engineering aspects of the manufacturing of cement, sugar, vegetable oil and pulp& paper. Aspects of the manufacture with consideration for routes of basic organic chemicals.

4) Course Assessment

- Mid-Term Tests ……..(30%)
- Home work+Assignment…..…… (20%)
- Final Exam. ……. (50%)

5) Teaching Methods

- Lectures
- Home work+Assignment
- Filed visits, if possible.

6) References

1. SHREVE, R. N. & BRINK, J. A. 1984. *Chemical Process Industries*, 5th McGraw-Hill Book Co.
2. DRYDEN, C., RAO, M.G. & SITTING, M. *Outlines of Chemical Technology*, East West Press.
3. SPEIGHT, J. G. 2002. *Chemical and process design handbook*, McGraw-Hill New York.
4. ULLMANN. *Encyclopedia of Industrial Chemistry*, 7th Edition, 40 Volume set, Wiley-VCH.

Chemical Engineering Thermodynamics 2

Course Title	**Chemical Engineering Thermodynamics -2**
Course Code	**-CHME321-4**
No. of units (Theoretical + Tutorial/Lab)	**4(3+1)**
Level-Year	**8-3**
Prerequisite (if any)	**-CHME311-5**

1) Brief Course Description

This course mainly concentrates on the refrigeration and liquefaction. Introduction to vapor/liquid equilibrium, theory and applications of solution thermodynamic, chemical reaction equilibria, topics in phase equilibria, thermodynamic analysis of processes, and introduction to molecular thermodynamics.

2) Course Objectives

Upon completion of the course, the students will be able to:

1. Demonstrate the concept of energy conservation.
2. Demonstrate the application of thermodynamics for chemical engineering.
3. Distinguish between the four laws of thermodynamics.
4. Apply the first law of thermodynamics on closed, isolated and open system.
5. Conduct mass and energy balance for open system.
6. Use steam and other thermodynamics properties tables
7. Apply the equations of state to calculate properties for example, enthalpy and entropy of pure fluids using departure functions.
8. Identify the chemical potential and its role in the phase equilibrium
9. Analyze the performance of power plants operation.
10. Apply the thermodynamic principles to the analysis of chemical processes and equipment such as turbines, compressors, pumps, and others.

3) Course Contents

Refrigeration and liquefaction, introduction in vapor/liquid equilibrium, solution thermodynamic theory, solution thermodynamics applications, chemical reaction

equilibria, topics in phase equilibria, thermodynamic analysis of processes, introduction to molecular thermodynamic.

4) Course Assessment

- Mid-Term Tests ……..…… (30%)
- Tutorials+labs……..…… (20%)
- Final Exam..……..……..……... (50%)

5) Teaching Methods

- Lectures
- Training exercises (Tutorials + Labs)

6) References

1. VAN NESS, H.C. & ABBOTT, M.M. 2004. *Introduction to Chemical Engineering Thermodynamics*, 7th Edition, McGraw-Hill.
2. ELLIOTT, J.R. & LIRA, C.T. 2011. *Introductory Chemical Engineering Thermodynamics*, 2nd Edition, Prentice Hall.
3. CENGEL, Y.A. & BOLES, M.A. 2008. Thermodynamics: an engineering approach, McGraw –Hill.

Mass Transfer-2

Course Title	**Mass Transfer 2**
Course Code	**-CHME322-4**
No. of units (Theoretical + Lab)	**4 (3+1)**
Level – Year	**8-3**
Pre-requisites (if any)	**-CHME313-4**

1) Brief Course Description

This course covers different in-depth calculations and designs of various operations related to mass transfer with broad industrial applications, i.e. fractional distillation, gas absorption, humidification.

2) Course Objectives

Upon completion of the course, the students will be able to:

1. Calculate various parameters in multicomponent distillation column using short-cut method.
2. Design packed bed absorber
3. Gain the skills on conducting experiments and mass transfer operations accompanied by chemical reactions.

3) Course Contents

Multicomponent distillation calculations, short cut methods, absorption process; types of absorption. Packing, calculations of absorption columns. Humidification process. Types, operation and calculations of cooling towers. Psychometric chart.

4) Course Assessment

- Mid-Term Tests…… (30%)
- Tutorials and lab…… (20 %)
- Final Exam. …… (50%)

5) Teaching Methods

- Lectures
- Training exercises (Tutorials + Labs)

6) References

1. COULSON, J.M. & RICHARSON, J.F. Chemical Engineering, 6th Edition, Volume-2, Butterworth and Heinemann.
2. MCCABE, W. L., SMITH, J. C. & HARRIOTT, P. 1993. *Unit operations of chemical engineering*, McGraw-Hill New York.
3. TREYBAL, R.E. 1980. Mass Transfer Operations, 3rd Edition, McGraw-Hill Book Company.
4. SEADER, J.D. & HENLEY, E.J. 2006. Separation Process Principles, 2nd Edition, John Wiley & Sons.
5. BERGMAN, T. L., LAVINE, A. S., DEWITT, D. P. & INCROPERA, F. P. 2011. Fundamentals of heat and mass transfer.

Particle Technology

Course Title	**Particle Technology**
Course Code	**-CHME323-4**
No. of units (Theoretical +Lab)	**4 (3+1)**
Level- Year	**9-3**
Pre-requisite (if any)	**-CHME312-4**

1) Brief course description

To familiarize the students with the concept, mechanisms and applications of particulate technology.

2) Course Objectives

Upon completion of the course, the students will be able to:

1. Define various types of size reduction technologies.
2. Describe different types of screening technologies.
3. Explain various types of conveying techniques.
4. Discuss various types of particle storage and handling equipment.

3) Course Contents

Particle size distribution, classification, screening and sieving, mechanism of size reduction, machinery for crushing, grinding and storage. Pneumatic and hydraulic conveying; Screw, vibrating, belt conveyors and elevators; Fluidization, mixing and agitation, Flow pattern and baffles, rate of mixing and power consumption; Agglomeration phenomena and its application e.g., granulation, pelletization, tabling and storage; dust explosion.

4) Course Assessment

- Mid term tests ……(30%)
- Labs.……(20%)
- Final exam:…… (50%)

5) Teaching Methods

- Lectures
- Training exercises (Labs)

6) References

1. MCCABE, W. L., SMITH, J. C. & HARRIOTT, P. 1993. *Unit operations of chemical engineering*, McGraw-Hill New York.
2. COULSON J. M. & RICHARDSON J.F. 1999. *Chemical Engineering*, volume-2, Pergamon Press.
3. NEVERS, N.D. 2005. *Fluid Mechanics for Chemical Engineering*, McGraw-Hill.

Chemical Reactions Engineering

Course Title	**Chemical Reactions Engineering**
Course Code	**-CHME324-5**
No. of units(Theoretical + Tutorial/Lab)	**5(4+1)**
Level-Year	**9-3**
Prerequisite (if any)	**-CHME311-5**

1) Brief Course Description

This course applies the concepts of reaction rate, stoichiometry and equilibrium in chemical reaction systems. Analysis and interpretation of kinetic data. To develop the students' ability to understand mole balances, conversion and reactor sizing, rate laws and stoichiometry for a single and multiple reactions and its applications to steady-state isothermal reactors.

2) Course Objectives

Upon completion of the course, the students will be able to**:**

1. Apply the mole balance equations for various reactors
2. Define conversion and study various reaction rates
3. Design and compare different types of chemical ideal reactors
4. Analyze experimental kinetic data of reactions

3) Course Contents

Overview of chemical reaction engineering, *Mole balances and Ideal reactors,* Conversion and ideal reactors sizing, Rate laws and stoichiometry, Isothermal reactor design, Collection and analysis of rate data, Multiple reactions.

4) Course Assessment

- Mid-Term Tests…….. (30%)
- Tutorials+labs …….. (20%)
- Final Exam. …….. (50%)

5) Teaching Methods

- Lectures
- Training exercises (Tutorials + Labs)

6) References

1. FOGLER, H. 2006. *Elements of Chemical Reaction Engineering*, Fourth Edition, Pearson Education International.
2. LEVENSPIEL, O. 1999. *Chemical reaction engineering*, 3rd Edition, John Wiley and Sons.
3. FOGLER, H. S. 2010. *Essentials of chemical reaction engineering*, Pearson Education.
4. DAVIS, M. E. & DAVIS, R. J. 2012. *Fundamentals of chemical reaction engineering*, Courier Corporation.

Heat Transfer

Course Title	**Heat Transfer**
Course Code	**-CHME325-5**
No. of units (Theoretical + Lab)	**5 (4+1)**
Level – Year	**9 – 3**
Pre-requisites (if any)	**-CHME311-5**

1) Brief Course Description

This course introduces students to the basic concepts of heat transfer such as conduction, convection and radiation and applies this knowledge for the design of heat transfer equipments.

2) Course Objectives

Upon completion of the course, the students will be able to:

1. Define the fundamentals of heat transfer processes (conduction, convection and radiation).
2. Analyze and calculate the natural and forced heat convection
3. Apply the skills for the design of various heat transfer equipments.

3) Course Contents

This course covers heat transfer principles and practical application in chemical engineering field. Introduction to heat transfer. Modes of conduction, convection and radiation. Steady and un-steady-state conductions. Free and forced convection in laminar and turbulent flows. Analysis and calculation of the natural and forced heat convection. Applications on heat exchangers design.

4) Course Assessment

- Mid-Term Tests ……(30 points)
- Labs+tutorials……...(20 points)
- Final Exam. ……(50 points)

5) Teaching Methods

- Lectures
- Training exercises (Tutorials + Labs)

6) References

1. WELTY, J. R., WICKS, C. E., RORRER, G. & WILSON, R. E. 2009. F*undamentals of momentum, heat, and mass transfer*, John Wiley & Sons.
2. BERGMAN, T.L., LAVINE, A.S., INCROPERA, F.P. AND DEWITT, D.P. 2011. *Introduction to Heat Transfer*, 6th Edition, John Wiley and Sons.
3. KERN, D. Q. 1950. *Process heat transfer*, Tata McGraw-Hill Education.

Materials Science and Engineering

Course Title	**Materials Science and Engineering**
Course Code	**-CHME411-4**
No. of units (Theoretical + Tutorial/Lab)	**4(3+1)**
Level-Year	**11- 4**
Prerequisite (if any)	**No prerequest**

1) Brief Course Description

The material covered in this course involves major concepts of materials science and engineering such as the atomic structure and bonding, properties, applications, processing, and heat treatment of major types of materials and alloys, diffusion, crystalline structure of materials, chemical and mechanical properties of materials (stress, strain, ductility, yield strength), alloys theory, ferrous alloys, and non – ferrous alloys (copper, aluminum, magnesium, titanium) and phase diagrams.

2) Course Objectives

Upon completion of the course, student should be able to**:**

1. Explain the essential concepts of materials science and engineering and the atomic structures of materials.
2. Know the crystalline structure of materials, phase diagram of materials, chemical and mechanical properties of engineering materials and their alloys.
3. Gain numerical problems solving skills.
4. Differentiate between the different types of materials.

3) Course Contents

This course covers: Properties and structure of engineering material, atomic structures and chemical bonding, amorphous and crystalline Structures, diffusion in solids, mechanical properties and characterization of engineering materials. Capabilities and limitations of different materials: metals, polymers, glass, ceramics and refractories materials.

4) Course Assessment

- Mid-Term …….. (30%)
- Tutorials and labs ……..…… (20%)
- Final Exam. ……..…… (50%)

5) Teaching Methods

- Lectures.
- Training exercises(Tutorials+labs)

6) References

1. CALLISTER, W. D. 2007. *Materials science and engineering: an introduction*, 3rd Edition, John Wiley and Sons.
2. OHRING, M. 1995. *Engineering materials science*, Academic press.
3. CHUNG, Y.-W. 2007. *Introduction to Materials Science and Engineering*, CRC. Taylor & Francis, Boca Raton, FL.
4. SMITH, W.F. 2006. *Foundations of Material Science and Engineering*, 4th Edition, McGraw Hill.

Separation Processes

Course Title	**Separation Processes**
Course Code	**-CHME421-4**
No. of units (Theoretical + Tutorial/Lab)	**4 (3+1)**
Level-Year	**11- 4**
Prerequisite (if any)	**-CHME313-4**

1) Brief Course Description

This course covers various techniques applied in engineering separations and addresses the methodologies applied in physical and chemical separation processes, besides monitoring the mass transfer techniques applied in each method.

2) **Course Objectives**

Upon completion of the course, students should be able to:

11. Understand the basic principles of physical and chemical separations
12. Gain skills of differentiating among various separation techniques to be applied on different types of materials.
13. Understand the mass transfer operations and their mechanisms behind each technique.
14. Gain the necessary skills for using the separation processes equipments.

3) Course Contents

This course covers introduction to separation processes, separation mechanisms, parameters affecting separation processes, mass transfer operations and the equipment used in separation processes. Solid liquid extraction, liquid-liquid extraction, drying, crystallization and adsorption.

4) Course Assessment

- Mid-Term Tests …….. (30%)
- Tutorials+ labs ……..(20%)
- Final Exam. ……..(50%)

5) Teaching Methods

- Lectures
- Training exercises (Tutorial+ Labs)

6) References

1. SEADER, J.D. & HENLEY, E.J. 2006. Separation Process Principles, 2nd Edition, John Wiley & Sons.
2. MCCABE, W. L., SMITH, J. C. & HARRIOTT, P. 1993. *Unit operations of chemical engineering*, McGraw-Hill New York.

Plant Design and Economics

Course Title	**Plant Design and Economics**
Course Code	**-CHME421-5**
No. of units (Theoretical + Tutorial/Lab)	**5(4+1)**
Level-Year	**12-4**
Prerequisite (if any)	**-CHME322-4, -CHME325-5**

1) Brief Course Description

The material covered in this course involves plant design considerations of chemical and petrochemical processes, site selection, plant locations and layout, plant safety and hazards, types of flow sheeting, selection of material handling and storage systems, and transport, Equipment design and specifications, Operability, controllability and reliability of plant design. Analysis of cost estimation and economic evaluation. Project development, computer application, case studies.

2) Course Objectives

Upon completion of this course the student should be able to:

1. Explain the stages of a plant design process, criteria of site selection, the plant location and plan layout.
2. Apply the safety requirements in plants design.
3. Statevarious types of diagrams used for material balance and energy balance.
4. Proposeequipment types, operating conditions, process technologies used.
5. Design various important equipments: reactors, heat exchangers and separation columns (distillation/sorption).
6. Estimate equipment cost using cost index, fixed and working capital investment, payback period and the profitability.
7. Develop the skills to evaluate the economic feasibility of projects.
8. Gain the skills of computer application for design.

3) Course Contents

Introduction to plants and chemical processes design, Site Selection, Site Layout and Plant Layout, Process flow sheeting, Process design description and mass balance calculations, Process selection and chemical reactions in design, Cost estimation and economic evaluation, Materials handling, equipment design and

costs, Utilization of Simulation and design of process, Safety and environment in process design.

4) Course Assessment

- Mid-Terms tests…….. (30%)
- Tutorials…….... (20%)
- Final Exam. ……..…….. (50%)

5) Teaching Methods

- Lectures
- Training exercises (Tutorials)

6) References

1. PETERS, M.S. & TIMMERHAUS, K.D. 2004. *Plant Design and Economics for Chemical Engineers*, 5th Edition, McGraw-Hill.
2. WHITE, T., FRAZELLE, B. & TREVINO, J. 1996. *Facilities Planning Problems*, John Wiley & Sons.
3. TOMPKINS, J.A., WHITE, J.A., BOZER, Y.A., FRAZELLE, E.H., TANCHOCO, J.M.A and TREVINO, J. 1996. *Facilities Planning*, 2nd Edition, John Wiley and Sons.
4. COULSON, J. M., RICHARDSON,J. F. & SINNOTT, R. K. 1983. *Chemical Engineering*, 1st Edition, Volume- 6, Pergamon Press

Reactors Design

Course Title	**Reactors Design**
Course Code	**-CHME422-5**
No. of units(Theoretical + Tutorial/Lab)	**5(4+1)**
Level-Year	**12-4**
Prerequisite	**-CHME324-5, -CHME311-5**

1) Brief Course Description

This course covers an overview of industrial reactors, non-isothermal reactor design, catalysis and kinetics of heterogeneous reactions in various reactors.

2) Course Objectives

Upon completion of the course, the students will be able to:

1. Differentiate between homogeneous and heterogeneous reactor design and analysis.
2. Analyze and design non-isothermal reactors with or without pressure drop, involving single or multiple reactions.
3. Develop rate equations for heterogeneous reactions.
4. Determine the residence time distribution of chemical reactors.

3) Course Contents

Overview of industrial reactors, *Non-isothermal reactors design* (Steady state and unsteady state), *Catalysis and catalytic reactors,* Diffusion and reaction in porous catalysts, Distributions of residence times of chemical reactors, *Models for Non-ideal reactors*

4) Course Assessment

- Mid-Term Exams…….…… (30%)
- Tutorials+labs……..…….…..... (20%)
- Final Exam. ……..……..…..(50%)

5) Teaching Methods

- Lectures
- Training exercises (Tutorials+labs)

6) References

1. FOGLER, H. 2006. *Elements of Chemical Reaction Engineering*, Fourth Edition, Pearson Education International.
2. LEVENSPIEL, O. 1999. *Chemical reaction engineering*, 3rd Edition, John Wiley and Sons.
3. FOGLER, H. S. 2010. *Essentials of chemical reaction engineering*, Pearson Education.
4. DAVIS, M. E. & DAVIS, R. J. 2012. *Fundamentals of chemical reaction engineering*, Courier Corporation.

Modeling and Simulation

Course Title	**Modeling and Simulation**
Course Code	**-CHME423-5**
No. of units (Theoretical + Tutorial/Lab)	**5(4+1)**
Level-Year	**12- 4**
Prerequisite (if any)	**-CHME322-5, -MATH419-5**

1) Brief Course Description

This course investigates the modeling, simulation, and dynamic analysis of different chemical systems. Optimizing ideal processes in chemical plants, modeling steady and unsteady processes. Solving models using analytical and numerical techniques.

2) Course Objectives

Upon completion of the course, the students will be able to:

1. Explain the principles of simulation, and dynamic analysis of different chemical systems.
2. Gain the skills of building mathematical models.
3. Develop the analytical skills and describe the properties of linear and nonlinear systems.
4. Solve the developed models using analytical and numerical techniques.

3) Course Contents

The course concentrates on the principles of simulation, and dynamic analysis of different chemical systems. Introduction to modeling, Models of systems - Lumped parameter systems - Distributed parameter systems, simulation and analysis of steady and unsteady state mass, energy and momentum balance. Examples related to chemical engineering field, Laplace transform application, transfer functions, interacting and non-interacting systems, high order systems and optimization of chemical processes.

4) Course Assessment

- Mid-term tests……..……..(30 %)
- Tutorial and assignments ……..…… (20 %)
- Final exam. ……..……..……..…….. (50 %)

5) Teaching Methods

- Lectures
- Training exercises (tutorials)

6)References

1. COUGHANOWR, D.R. & LEBLANC, S.E. 2009. *Process Systems Analysis and Control*, 3rd Edition, McGraw-Hill.
2. LUYBEN, W.L., 1989. *Process modeling, simulation and control for chemical engineers*. McGraw-Hill Higher Education.
3. OGATA, K. 1998. *System dynamics*, Prentice Hall New Jersey.
4. CACHIN, I. & PLASS, H.J. 2001. *Analysis and Design of System Dynamics*, Herper Collins Publication.

Industrial Pollution Control

Course Title	**Industrial Pollution Control**
Course Code	**-CHME424-4**
No. of units (Theoretical + Lab)	**4 (3+1)**
Level-Year	**11-4**
Prerequisite (if any)	**No prerequest**

1) Brief Course Description

The students will gain knowledge in the field of environmental engineering by understanding the types of pollution, pollution control and introduction to the environmental impact assessment (EIA), its methods and techniques.

2) Course Objectives

Upon completion of the course, the students will be able to:

1. Define types of air, water and solid waste pollution.
2. Discuss various control technologies.
3. Identify different disposal techniques.
4. Compare national and international environmental pollution control standards.
5. Perform accident investigations and recommend appropriate control measures.
6. Make comparison between various stages of any project using IEE and EIA.

3) Course Contents

Concept of Pollution, Types of Pollution: air, water and solid waste. Measurement of Pollutants; Pollution control technologies for air, water, and solid wastes. Principles and purpose of Industrial Environmental Evaluation (IEE) and Environmental Impact Assessment (EIA) and its significance for the society. Cost and benefits of EIA. Main stages in EIA process. Public consultation and participation in EIA process. EIA methods and techniques for impact prediction and evaluation. Case Studies.

4) Course Assessment

- Mid term tests…….. (30%)
- Labs …….. (20%)
- Final exam…….. (50%)

5) Teaching Methods

- Lectures
- Training exercises (Labs)

6) References

1. RAO, P. V. 2002. *Textbook of environmental engineering*, PHI Learning Pvt. Ltd.
2. WANG, L. K., HUNG, Y.-T., LO, H. H. & YAPIJAKIS, C. 2005. *Waste treatment in the process industries*, CRC Press.
3. ALLEN, D. T. & ROSSELOT, K. S. 1997. *Pollution prevention for chemical processes*, Wiley-Interscience.

Industrial Safety & Occupational Health

Course Title	**Industrial Safety & Occupational Health**
Course Code	**-CHME425-4**
No. of units (Theoretical)	**4(3+1)**
Level-Year	**11-4**
Prerequisite (if any)	**No prerequest**

1) Brief Course Description

This course will prepare students to control safety hazards in the workplace. Understand the importance of illumination and ventilation in the workplace, occupational ergonomics, noise exposure, accident investigation, recognize electrical hazards and be able to control electrical hazards in the workplace. Be able to detect health effects of ionizing radiation, Introduction to confined space entry requirement, environmental management, workers compensation, machine guarding, Personal Protective Equipment (PPE) and its proper use, Fire prevention and fire fighting, Planning for emergencies and first aid.

2) Course Objectives

Upon completion of the course, the students will be able to:

1. Recognize safety hazards and recommend strategies for remediation and compliance.
2. Recommend strategies for the control of chemical hazards in the occupational and general environment.
3. Recognize ergonomic problems and recommend appropriate control measures.
4. Perform accident investigation and recommend appropriate control measures.

3) Course Contents

History of the Labor and Safety movement, Identification, Recognition and Control of safety hazards. Illumination and ventilation requirement of workplace. Industrial noise and its control. Ergonomics, identification and control of ergonomic stresses. Personnel Protective Equipment and its proper use. Confined space and entry

procedures. Electromagnetic radiation and sources of ionizing radiation, Explosions, toxic releases and its prevention. Fire prevention and fire fighting techniques. Planning for emergencies and first aid, Importance of material specification data sheet (MSDS)

4) Course Assessment

- Mid- term tests:..... (30%)
- Tutorials+Labs:..... (20%)
- Final exam:..... (50%)

5) Teaching Methods

- Lectures
- Training exercises (Tutorial and Labs)

6) References

1. RAY, A.C. 2003. *Industrial Safety and Health Management*, Prentice-Hall.
2. MACLEOD, D. 2000. *The Rule of Work*, CRC Press.

Chemical Process Control

Course Title	**Chemical Process Control**
Course Code	**-CHME511-4**
No. of units (Theoretical + Lab)	**4(3+1)**
Level-Year	**13-5**
Prerequisite (if any)	**-CHME423-5**

1) Brief Course Description

This course investigates the fundamentals of the control for various unit operations and the application of process measurement and instrumentation, this course provides an overview of process control algorithms as well as the mathematical techniques that may be used to analyze process systems. The aim is to learn how to select appropriate control schemes and strategies for common unit operations encountered within the chemical industry. As proper application and efficient operation of the process control can improve the safety and profitability of processes

2) Course Objectives

Upon completion of the course, the students will be able to:

1. Differentiate between various types of instruments used in chemical industries
2. Explain the principles and importance of control systems in chemical industries.
3. Gain analytical skills of open loop and closed loop systems.
4. Apply computer applications in chemical process control.

3) Course Contents

The course covers instruments used for measuring pressure, temperature, level and flow control in chemical industries. Introduction of control systems and mechanisms, analysis of dynamic behavior of chemical processes, design of control systems, transfer functions and block diagram representation. Feedback/Feed forward control, Routh stability analysis, root locus method, frequency response analysis, Multivariable Process Control, PID controller design and tuning, laboratory and computer simulations applications.

4) Course Assessment

- Mid-Term Tests ……(30 %)
- Tutorial labs ……..(20 %)
- Final Exam. ……(50 %)

5)Teaching Methods

- Lectures.
- Training exercises (Tutorial + Labs)

6) References

1. COUGHANOWR, D.R. & LEBLANC, S.E. 2009. *Process Systems Analysis and Control*, 3rd Edition, McGraw-Hill.
2. DUNN, W. 2005. *Fundamentals of industrial instrumentation and process control*, McGraw Hill Professional.
3. MCMILLAN, G. K. 1993. *Process/Industrial Instruments and Controls Handbook*, McGraw-Hill.
4. SEBORG, D.E. EDGAR, T.F. & MELLICHAMP, D.A. 1999. *Process/Industrial Instruments and Controls Handbook*, Vol.7, McGraw-Hill.
5. SMITH, A. & CORRIPIO, A. 2006. *Principles and practice of automatic process control*. 3rd Edition, Jhon Wiley & Sons. *Inc.*
6. Benjemin, C.K & LUYBEN, W.L. *Modeling, Simulation and Control for Chemical Engineers*, Last Edition, McGraw-Hill.
7. MARLIN, T. 2000. *Process Control: Designing Processes and Control Systems for Dynamic Performance*, McGraw-Hill

Computer Applications in Chemical Engineering

Course Title	**Computer Applications in Chemical Engineering**
Course Code	**-CHME512-5**
No. of units(Theoretical + Lab)	**5(4+1)**
Level-Year	**13-5**
Prerequisite (if any)	**-CHME423-5**

1)Brief Course Description

This course utilizes MATLAB to solve chemical engineering problems. It starts from solving all types of algebraic and ordinary differential equations using MATLAB to mathematical fitting of experimental data. Modern software such as ASPEN HYSYS is used to simulate, plan and integrate chemical processes.

2) Course Objectives

Upon completion of the course, the students will be able to:

1. Know the necessary principles for using the software in chemical engineering applications.
2. Use MATLAB™ to write simple algorithms for selected chemical engineering problems.
3. Apply modern process simulation software (such as Aspen-HYSYS).
4. Solve linear and non-linear equations for some of the chemical engineering problems using simulation software.

3) Course Contents

The course covers applications of MATLAB for Modeling of dynamic and thermodynamics properties, fitting data in linear and nonlinear equations. Linear and non-linear programming; solving algebraic and differential equations. HYSYS for process flow diagram, process integration and simulation of different chemical processes.

4) Course Assessment

- Mid-Term Tests ……..…(30%)
- Labs ……..……..(20%)
- Final Exam. ……....(50%)

5) Teaching Methods

- Lectures.
- Training exercises (Labs)

6) References

1. CHAPRA, S. C. 2012. Applied numerical methods. *With MATLAB for Engineers and Scientists*.
2. BURDEN, R. & FAIRES, J. 2001. Numerical analysis 7th ed., Brooks/Cole, Thomson Learning Inc.
3. KWON, Y. W. & BANG, H. 2000. *The finite element method using MATLAB*, CRC press.
4. MATHEWS, J.H. & Fink, K.D. 2000. Numerical Methods using MATLAB, 3rd Edition, Jones and Barlett Publication.
5. Aspen HYSYS Manual.

Graduation project-1

Course Title	**Graduation project-1**
Course Code	**-CHME513-3**
No. of units(Theoretical + Lab)	**3(0+1)**
Level-Year	**13-5**
Prerequisite (if any)	**Pass 169 credit hours**

Graduation project-2

Course Title	**Graduation project-2**
Course Code	**-CHME521-3**
No. of units(Theoretical + Lab)	**3(0+1)**
Level-Year	**14-5**
Prerequisite (if any)	**-CHME513-3**

Elective Subject in Energy and Environment

Course Title	**Elective Subject in Energy and Environment**
Course Code	**-CHME514-4**
No. of units(Theoretical + Lab)	**4(4+0)**
Level-Year	**14-5**
Prerequisite (if any)	**No prerequest**

Elective Subject in chemical and petrochemical industries

Course Title	**Elective Subject in chemical and petrochemical industries**
Course Code	**-CHME522-5**
No. of units(Theoretical + Lab)	**5(4+1)**
Level-Year	**15-5**
Prerequisite (if any)	**No prerequest**

Selected Topics in Bioengineering

Course Title	**Elective Subject in Bioengineering**
Course Code	**-CHME523-4**
No. of units(Theoretical + Lab)	**4(4+0)**
Level-Year	**15-5**
Prerequisite (if any)	**No prerequest**

List of Elective Subjects	
-CHME514-4	**Elective Subjects in Energy and Environment**
	Renewable Energy
	Environmental Pollution Control
	Introduction to Environmental Impact Assessment
-CHME522-5	**Elective Subjects in Chemical and Petrochemical Industries**
	Petroleum Refining
	Catalyst and Catalytic Processes
	Pharmaceutical Industry
-CHME523-4	**Elective Subjects in Bio Engineering**
	Biochemical Engineering
	Bioprocess Engineering
	Bioreactor Engineering