Chemical and Materials Engineering Department

History:

King Abdulaziz University-Rabigh founded the Department of Chemical and Materials Engineering in 2010 and became operational in 2011.

Department Requirements

In order to qualify for a B.Sc. degree in Chemical and Materials Engineering:

- A student must successfully complete 155 credit hours with an overall GPA of 2.75 out of 5 or better while satisfying the curriculum requirements of his program of specialization.
- Each student is also required to complete one summer training of 10 weeks in industry under the supervision of a faculty member.
- The typical study period is five years (10 semesters) and the credit units are distributed as follows:

University Requirements	26
Faculty Requirements	44
Program Compulsory Requirements	68
Program Elective Requirements	11
Free Courses (from outside Faculty)	6

Compulsory courses:

Course code and number	Course title	credit hours	Communication hours	Distribution of communication hours (lecture, Lab, Exercises)	prerequisites
CHEN 201	Intro to Chemical Engineering	3	4	(3 ، -- ،1)	CHEM 281
CHEN 201 Intro to Chemical Engineering Broad definitions of Chemical Engineering, introduction to chemical engineering calculations, material balances in processes with and without chemical reactions, recycle by-pass and purge calculations, critical properties and compressibility charts, vapor-liquid equilibrium, partial saturation and humidity, computer applications.					
CHEN 202	Chemical Eng Thermodynamics	3	4	(3 ، -- ،1)	CHEM 240
CHEN 202 Chemical Eng Thermodynamics Introduction to thermodynamics concepts, first law of thermodynamics, Mass and energy balances in closed and open systems, volumetric properties of pure fluids, heat effects, humidity charts, second law of thermodynamics, entropy, Computer applications to thermodynamics problems, power cycles					
CHEN 210	Materials Science and Eng	3	5	(2 ، 2 ،1)	CHEM 110
CHEN 210 Materials Science and Eng Classification of engineering materials. Atomic and molecular bonding. Properties and microstructure. Elastic and plastic behavior. Order in solids, phases and solid- solutions, crystal geometry, disorder in solids, atomic movement and rearrangement, phase diagrams, solid-state transformations. Applications of metals, ceramics, polymers and composites. Service stability, corrosion and failure. Involves laboratory experiments and practices					
CHEN 211	Polymer Science and Eng	2	4	(1 ، 2 ،1)	CHEM 231
CHEN 211 Polymer Science and Eng Classification of polymeric materials, calculation of molar mass and molar mass distribution, poly-merization reactions, kinetics of polymerization reactions, composites materials, polymer processing, mechanical and physical properties, commercial polymer, laboratory experiments					
CHEN 231	Fluid and Particle Mechanics	3	4	(1 ، 2 ،1)	MATH 204, CHEN 201
CHEN 231 Fluid and Particle Mechanics Fluid static, mass balance, momentum balance, energy balance on finite and differential systems, laminar and turbulent flow in pipes, fluid flow in porous media, boundary layer theory, fluid flow, flow behavior, flow applications					
CHEN 301	Thermodynamics of Materials	3	4	(1 ، 2 ،1)	CHEN 210
CHEN 301 Thermodynamics of Materials Helmholtz free energy and Gibbs free energy, energy-property relationships, Thermal equilibria, Ellingham diagrams, 1st and 2nd order transformations, equilibrium constant, Fugacity and Chemical activity, Equilibrium constant and its variation with temperature, Vant Hoff equation, Gibbs-Duhem relationship, Thermodynamics of solutions, Typical Equilibrium Phase Diagrams.					
CHEN 311	Electrochem and Corrosion Eng	2	4	(1 ، 2 ،1)	CHEM 240
CHEN 311 Electrochem and Corrosion Eng					

Electrochemical mechanisms, corrosion kinetics, polarization and corrosion rates, passivity. Methods of testing corrosion of iron and steel and the effects of various parameters. Pourbaix diagrams. Effect of stresses on corrosion, (stress corrosion cracking, cold working, hydrogen cracking, etc.). Corrosion control technologies, corrosion of some engineering alloys. Design of simple processes.					
CHEN 321	Chemical Reaction Engineering	3	4	(3 ، -- ،1)	MATH 204, CHEN 201
CHEN 321 Chemical Reaction Engineering The course is intended to develop the student' s ability to understand mole balances, conversion and reactor sizing, rate laws and stoichiometry for single and multiple reactions and its applications to steady-state no isothermal reactor design. Collection and analysis of rate data and catalysis and catalytic reactor					
CHEN 331	Mass Transfer	3	4	(3 ، -- ،1)	CHEN 231
CHEN 331 Mass Transfer Fundamentals of mass transfer processes. 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. Analysis of chemical engineering operations involving mass transfer. Simultaneous heat and mass transfer; mass transfer accompanied by chemical reaction.					
CHEN 332	Heat Transfer	3	4	(3 ، -- ،1)	CHEN 201
CHEN 332 Heat Transfer Modes of heat transfer, steady and un-steady-state conduction in different co-ordinates, convective heat transfer with and without phase change, correlations for forced and natural convection, analogy between momentum and heat transfer, heat transfer applications.					
CHEN 333	Separation Processes	3	5	(2 ، 2 ،1)	CHEN 201
CHEN 333 Separation Processes Phase equilibrium, continuous contact and stage wise processes; fractional distillation, gas absorption and liquid-liquid extraction processes, involves laboratory experiments and practices					
CHEN 341	Process Dynamic and Control I	2	3	(1 ، 2 ،--)	CHEN 321
CHEN 341 Process Dynamic and Control I Mathematical modeling of process control, transfer functions, dynamic behavior of chemical processes, feedback control, dynamic behavior of closed-loop systems, stability analysis, frequency response analysis, controller design and tuning, introduction to computer control, laboratory and simulations applications					
CHEN 342	Numerical Methods in Chem Eng	3	4	(3 ، -- ،1)	MATH 204
CHEN 342 Numerical Methods in Chem Eng This course deals with Linear, non-linear equations, systems of equations. Jacobi, Gauss-Seidel, SOR. LU decomposition, Newton-Raphson, bisection and Wegstein's method - convergence acceleration; zeros of , polynomials; interpolating polynomial; finite difference methods; numerical differentiation, Newton-Coates and Gaussian quadrature. Solution of ODE's; the shooting method; numerical solution of reaction network equations; solution of transient heat and mass transfer models					
CHEN 390	Summer Training	2	4	(-- ، 4 ،--)	Complete 110 CU
CHEN 390 Summer Training Course 10 weeks of training in industry under the supervision of a faculty member. Students have to submit a report about their achievements during training in addition to any other requirements assigned by the department					
CHEN 431	Unit Operations Lab	2	4	(-- ، 4 ،--)	CHEN 333

CHEN 431 Unit Operations Lab Introduction, Laboratory Safety Rules, Familiarization with Experiments, Studies in Fluid Flow, The Study of Heat Exchanges, Experimental study of mass transfer, Modern separations techniques, and reaction engineering, Emphasis is on open-ended laboratory projects with electronic instrumentation; Experimental design with analytical, numerical, and statistical analysis of data.					
CHEN 441	Process Dynamic and Control II	2	3	(1 ، 2 ،--)	CHEN 341
CHEN 441 Process Dynamic and Control II Review of feedback control, cascade control, Ratio, override, selective, feed-forward, and multivariable process control, Dynamic simulation of control systems using SIMULINK and other commercial software packages, Instrumentation, design case studies, tuning case studies					
CHEN 442	Modeling and Simulation	3	4	(3 ، -- ،1)	CHEN 333
CHEN 442 Modeling and Simulation This course is designed to give a chemical engineering student the ability to solve system of algebraic- differential equations. The course will develop student ability's to drive system models and simulate digitally, simulation computer packages, aspen, Hysys, chem.-cad					
CHEN 451	Plant Design	3	4	(3 ، -- ،1)	CHEN 321, CHEN 333
CHEN 451 Plant Design Chemical and petrochemical processes plant design, locations and layout of chemical process plant, operability, controllability reliability and safety requirement of the design, cost estimation, utilization of simulation and design packages					
CHEN 499	B.Sc. Senior Project (9th and 10th Semester)	6	4	(2 ، 4 ،--)	CHEN 333
CHEN 499 Senior Project Selection of topic, literature review, project design planning, arranging for data collection and experimental work, interim report, experimental work and data collection or field study (if any), data processing analysis and results, preparation of a first draft of the final report, presentation of the project.					
Total		**52**	**78**	**(40,24,14)**	

Courses Description:

1- CHEN 201 Intro to Chemical Engineering

Broad definitions of Chemical Engineering, introduction to chemical engineering calculations, material balances in processes with and without chemical reactions, recycle by-pass and purge calculations, critical properties and compressibility charts, vapor-liquid equilibrium, partial saturation and humidity, computer applications.

2- CHEN 202 Chemical Eng Thermodynamics

Introduction to thermodynamics concepts, first law of thermodynamics, Mass and energy balances in closed and open systems, volumetric properties of pure fluids, heat effects, humidity charts, second law of thermodynamics, entropy, Computer applications to thermodynamics problems, power cycles

3- CHEN 210 Materials Science and Eng

Classification of engineering materials. Atomic and molecular bonding. Properties and microstructure. Elastic and plastic behavior. Order in solids, phases and solid-

solutions, crystal geometry, disorder in solids, atomic movement and rearrangement, phase diagrams, solid-state transformations. Applications of metals, ceramics, polymers and composites. Service stability, corrosion and failure. Involves laboratory experiments and practices

4- CHEN 211 Polymer Science and Eng

Classification of polymeric materials, calculation of molar mass and molar mass distribution, poly-merization reactions, kinetics of polymerization reactions, composites materials, polymer processing, mechanical and physical properties, commercial polymer, laboratory experiments

5- CHEN 231 Fluid and Particle Mechanics

Fluid static, mass balance, momentum balance, energy balance on finite and differential systems, laminar and turbulent flow in pipes, fluid flow in porous media, boundary layer theory, fluid flow, flow behavior, flow applications

6- CHEN 301 Thermodynamics of Materials

Helmholtz free energy and Gibbs free energy, energy-property relationships, Thermal equilibria, Ellingham diagrams, 1st and 2nd order transformations, equilibrium constant, Fugacity and Chemical activity, Equilibrium constant and its variation with temperature, Vant Hoff equation, Gibbs-Duhem relationship, Thermodynamics of solutions, Typical Equilibrium Phase Diagrams.

7- CHEN 311 Electrochem and Corrosion Eng

Electrochemical mechanisms, corrosion kinetics, polarization and corrosion rates, passivity. Methods of testing corrosion of iron and steel and the effects of various parameters. Pourbaix diagrams. Effect of stresses on corrosion, (stress corrosion cracking, cold working, hydrogen cracking, etc.). Corrosion control technologies, corrosion of some engineering alloys. Design of simple processes.

8- CHEN 321 Chemical Reaction Engineering

The course is intended to develop the student' s ability to understand mole balances, conversion and reactor sizing, rate laws and stoichiometry for single and multiple reactions and its applications to steady-state no isothermal reactor design. Collection and analysis of rate data and catalysis and catalytic reactor

9- CHEN 331 Mass Transfer

Fundamentals of mass transfer processes. 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. Analysis of chemical engineering operations involving mass transfer. Simultaneous heat and mass transfer; mass transfer accompanied by chemical reaction.

10- CHEN 332 Heat Transfer

Modes of heat transfer, steady and un-steady-state conduction in different co-ordinates, convective heat transfer with and without phase change, correlations for forced and natural convection, analogy between momentum and heat transfer, heat transfer applications. .

11- CHEN 333 Separation Processes

Phase equilibrium, continuous contact and stage wise processes; fractional distillation, gas absorption and liquid-liquid extraction processes, involves laboratory experiments and practices

12- CHEN 341 Process Dynamic and Control I

Mathematical modeling of process control, transfer functions, dynamic behavior of chemical processes, feedback control, dynamic behavior of closed-loop systems, stability analysis, frequency response analysis, controller design and tuning, introduction to computer control, laboratory and simulations applications

13- CHEN 342 Numerical Methods in Chem Eng

This course deals with Linear, non-linear equations, systems of equations. Jacobi, Gauss-Seidel, SOR. LU decomposition, Newton-Raphson, bisection and Wegstein's method - convergence acceleration; zeros of , polynomials; interpolating polynomial; finite difference methods; numerical differentiation, Newton-Coates and Gaussian quadrature. Solution of ODE's; the shooting method; numerical solution of reaction network equations; solution of transient heat and mass transfer models

14- CHEN 390 Summer Training Course

10 weeks of training in industry under the supervision of a faculty member. Students have to submit a report about their achievements during training in addition to any other requirements assigned by the department

15- CHEN 431 Unit Operations Lab

Introduction, Laboratory Safety Rules, Familiarization with Experiments, Studies in Fluid Flow, The Study of Heat Exchanges, Experimental study of mass transfer, Modern separations techniques, and reaction engineering, Emphasis is on open-ended laboratory projects with electronic instrumentation; Experimental design with analytical, numerical, and statistical analysis of data.

16- CHEN 441 Process Dynamic and Control II

Review of feedback control, cascade control, Ratio, override, selective, feed-forward, and multivariable process control, Dynamic simulation of control systems using SIMULINK and other commercial software packages, Instrumentation, design case studies, tuning case studies

17- CHEN 442 Modeling and Simulation

This course is designed to give a chemical engineering student the ability to solve system of algebraic- differential equations. The course will develop student ability's to drive system models and simulate digitally, simulation computer packages, aspen, Hysys, chem.-cad.

18- CHEN 451 Plant Design

Chemical and petrochemical processes plant design, locations and layout of chemical process plant, operability, controllability reliability and safety requirement of the design, cost estimation, utilization of simulation and design packages

19- CHEN 499 Senior Project

Selection of topic, literature review, project design planning, arranging for data collection and experimental work, interim report, experimental work and data collection or field study (if any), data processing analysis and results, preparation of a first draft of the final report, presentation of the project.

Compulsory Courses outside the department:

Course code and number	Course title	credit hours	Communication hours	Distribution of communication hours (lecture, Lab, Exercises)	prerequisites
EEN 100	Electrical Circuits I	3	6	(2، 2، 2)	PHYS 202
EEN 100: Electrical Circuits Electric quantities and circuit elements; Kirchhoff's laws; Mesh and node analyses; Sinusoidal steady-state analysis using phasors; Network theorem and transformations. Three-phase circuits.					
MEN 130	Basic Workshop	1	4	(--، 2،2)	---
MEN 130 Basic Workshop I Introduction to principles of production, Engineering materials, Measurements, Standards Specifications, Foundry, Metal forming (forging, extrusion, drawing, press work, rolling, wire drawing), Sheet metal work, Welding, metal cutting and machine tools (sawing, drilling, turning, milling, shaping, slotting, grinding), Fitting, Industrial safety, Production management and production planning.					
MEN 225	Engineering Mechanics	3	4	(3، --، 13)	PHYS 281
MEN 225 Engineering Mechanics General Principles of Statics; Force Vectors (2D & 3D); Equilibrium of a Particle (2D & 3D); Force System Resultants (2D & 3D); Equilibrium of a Rigid Body (2D); Center of Gravity and centroid of a Body, Mass moment of inertia, Rotation and translation of a rigid body in the plane, General plane motion, Displacement, velocity, and acceleration of rigid bodies, Equations of motion for a rigid body,					
CHEM 231	Principles of Organic Chem I	4	6	(3، 3، --)	CHEM 110
CHEM 240	Phys Chem for Non Chem Majors	4	4	(3، 3، --)	CHEM 281
CHEN 240 Phys Chem for Non Chem Majors Explores experimental and theoretical principles of chemistry including gases, liquids, solids, Zeroth law of thermodynamics, First law of thermos-dynamics, second law of thermodynamics, chemical equilibrium, phase equilibrium, Electrochemical equilibrium, quantum theory, atomic structure and spectroscopy basics, Chemical kinetics in liquid and gas phases, Chemical potential, chemical potential, Macromolecules, introduction to solid state chemistry, Surface dynamics					
IEN 481	Intro to Entrepreneurship	1	3	(1، --، 2)	IEN 202
IEN 481 Introduction to Entrepreneurship Overview of the entrepreneurial process from an engineering perspective. Idea generation, planning, financing, marketing, protecting, staffing, leading, growing, and harvesting. Basic framework for understanding the process of entrepreneurship, principles of management and related techniques in decision making, planning, marketing, and financial control. Exercises in practical ideas about launching own enterprises. Classroom lectures are combined					
Total		**16**	**29**	**(12,10,7)**	

List of selective courses for Chemical and Materials Engineering Department:

Course code and number	Course title	credit hours	Communication hours	Distribution of communication hours (lecture, Lab, Exercises)	prerequisites
CHEN 411	Materials Selection	4	7	(2 ، 4 ، 1)	CHEN 210
CHEN 411 Materials Selection Selection criteria for metals, alloys, ceramics and plastics, mechanical behavior, corrosion and oxidation resistance at ambient and elevated temperatures, materials for marine environments, oil production and transport, refineries, petrochemical and desalination industries, refractory materials. Computer applications, and economic considerations, laboratory experiments					
CHEN 412	Composite Materials	3	5	(2 ، 2 ، 1)	CHEN 210
CHEN 412 Composite Materials Role of interfaces, processes and production of polymer matrix composites, metal matrix composites, ceramic matrix composites, design aspects of composites bases structures, application and properties of composite materials, production of glass fiber and carbon fiber composites, Titanium bases composite materials.					
CHEN 413	Mat Structure and Failure Anal	3	5	(2 ، 2 ، 1)	CHEN 210
CHEN 413 Materials Structure and Failure Analysis Structural characterization, quantitative and qualitative analysis, thermal analysis, differential calorimetry, molecular spectroscopy, engineering aspects of failure and failure analysis, failure modes, characterization of fractured surface, chemical analysis, failure prevention and histories, mechanical and metallurgical causes of failures, creep failures, corrosion induced failure, pitting as stress concentration.					
CHEN 414	Mat and Nanomat Character	4	5	(2 ، 4 ، 1)	CHEN 211
CHEN 414 Mat and Nanomat Character Nano fabricated computed devices, bio molecular devices and molecular electronics, integrated micro systems and MEMS, molecular manufacturing and nano robots, material engineering processes applied to electro-active polymers, micro-nano scale instrumentation measuring					
CHEN 415	Biomaterials	3	7	(2 ، 2 ، 1)	CHEN 210 CHEN 211
CHEN 415 Biomaterials Classification of biomaterials, classes of materials used in medicine, biomaterials surfaces, practical aspects of biomaterials, surface characterization of biomaterials, applications of materials used in medicine.					
CHEN 416	Extractive Metallurgy	3	5	(2 ، 2 ، 1)	CHEN 210
CHEN 416 Extractive Metallurgy Major operations in the iron and steel-making industry; direct reduction processes, blast furnaces, converter and electric-arc steel-making and steel refining methods; electro slag (ESR) and vacuum induction refining (VIR). Bauxite production. Electro-thermal reduction of cryolite to produce commercial aluminum. Production of TiO2. Extractive metallurgy of titanium. Gold extraction. Continuous casting.					
CHEN 452	Water and Wastewater Treatment	4	5	(2 ، 4 ، 1)	CHEN 333
CHEN 452 Water and Wastewater Treatment Wastewater introduction, Wastewater charac-teristics, Technologies in wastewater treatment, wastewater constituents, wastewater sampling and analytical procedures, physical characteristics of water, metallic and nonmetallic constituents,					

analysis and selection of wastewater flow rates, Physical unit operations, chemical unit processes, biological treatment, advanced wastewater treatment, water reuse					
CHEN 454	Water Desalination	3	5	(2 ، 2 ، 1)	CHEN 332
CHEN 454 Water Desalination Resources for water, composition of sea water, introduction to desalination, desalination processes, single effect evaporation, evaporators, single effect thermal vapor compression, single effect mechanical vapor compression, multiple effect evaporation					
CHEN 466	Safety in Chem Process Indust	3	4	(3 ، -- ، 1)	CHEN 333
CHEN 466 Safety in Chem Process Indust Safety and loss prevention. Major process hazards. Hazard identification, assessment and prevention. Personal safety in industrial environment. Fire explosion and toxic release. Safety systems.					
CHEN 471	Chem Eng Design for Environ	4	5	(2 ، 4 ، 1)	CHEN 201
CHEN 471 Chem Eng Design for Environ Meteorology, lapse rate, introduction of plume, air pollution dispersion models, devices and techniques for control of particulates, Wastewater treatment techniques, membrane separation, biological treatment, chemical treatment, design for wastewater treatment plant					
CHEN 472	Industrial Pollution Control	3	5	(2 ، 2 ، 1)	CHEN 442
CHEN 472 Industrial Pollution Control Sources of pollution from chemical industries. Standards and legislations. Health and environmental effects of pollution. Air pollutants; particulate, SOx, NOx and organic vapors. Air pollution control. Treatment of industrial wastewater. Handling of solid waste. Monitoring of pollutants. Case studies for specific industries like petrochemicals, fertilizers, desalination and petroleum refining					
CHEN 481	Biochemical Engineering	3	5	(2 ، 2 ، 1)	CHEN 321
CHEN 481 Biochemical Engineering Introduction to biofuel, sources of biofuel, biofuel properties, manufacturing processes for biofuel, biodiesel, bioethanol, biogas					
CHEN 421	Fundamentals of Biofuel	3	5	(2 ، 2 ، 1)	CHEN 321
CHEN 421 Fundamentals of Biofuel Biofuel introduction, chemistry of biofuels, bioenery production technologies, first and second generation technologies for biofuel production, sources of fuel and fuel properties, environmental impacts, biorefinery, biofuel process design, recent developments in biotechnology.					
CHEN 432	Energy Conservation	3	5	(2 ، 2 ، 1)	CHEN332
CHEN 432 Energy Conservation World and local energy situation, energy policies and strategies, the environment and the economy, renewable sources and social energy requirements, conservation, substitution and technology options, integrated energy management systems, energy conservation technologies.					
CHEN 455	Design of Altern Energy Sys	4	7	(2 ، 4 ،1)	CHEN 202
CHEN 455 Design of Altern Energy Sys Introduction and overview of the energy system, modeling skills in energy systems, design of energy systems, issues associated with alternative energy					
CHEN 461	Petroleum Refinery Engineering	4	7	(2 ، 4 ، 1)	CHEN 321 & CHEN 333
CHEN 461 Petroleum Refinery Engineering					

Oil production. Surface operations. Characterization and classification of crude oils. Physical properties of oils. Refinery operations; atmospheric and vacuum distillation, treatment processes, catalytic cracking, reforming, alkylation, coking, asphalt production and lubricating oil production. Blending of refinery products. Waste treatment.					
CHEN 462	Natural Gas Engineering	3	4	(3 ، -- ،1)	CHEN 321 & CHEN 333
CHEN 462 Natural Gas Engineering Characterization and properties of natural gas. Gas gathering systems. Gas-oil multistage separation. Gas treatment and liquefaction. Gas transportation through pipelines, signal-telemetering Industrial usages.					
CHEN 463	Petrochemical Technology	3	4	(3 ، -- ، 1)	CHEN 333
CHEN 463 Petrochemical Technology Production technologies of synthesis gas, olefins and aromatic. Manufacture of important petrochemicals derived from base chemicals and synthesis gas. Production technologies of important polymers and plastics.					
CHEN 497	Selected Topics in Chem Eng	3	5	(2 ، 2 ، 1)	-
CHEN 497 Selected Topics in Chem Eng In-depth study of relevant Chemical and Materials engineering topics not covered in other courses of the program in order to enhance students' knowledge in the field of chemical engineering.					
Total		**63**	**100**	**(41,44,19)**	

Courses Desc.:

1- CHEN 411 Materials Selection

Selection criteria for metals, alloys, ceramics and plastics, mechanical behavior, corrosion and oxidation resistance at ambient and elevated temperatures, materials for marine environments, oil production and transport, refineries, petrochemical and desalination industries, refractory materials. Computer applications, and economic considerations, laboratory experiments

2- CHEN 412 Composite Materials

Role of interfaces, processes and production of polymer matrix composites, metal matrix composites, ceramic matrix composites, design aspects of composites bases structures, application and properties of composite materials, production of glass fiber and carbon fiber composites, Titanium bases composite materials.

3- CHEN 413 Materials Structure and Failure Analysis

Structural characterization, quantitative and qualitative analysis, thermal analysis, differential calorimetry, molecular spectroscopy, engineering aspects of failure and failure analysis, failure modes, characterization of fractured surface, chemical analysis, failure prevention and histories, mechanical and metallurgical causes of failures, creep failures, corrosion induced failure, pitting as stress concentration.

4- CHEN 414 Mat and Nanomat Character

Nano fabricated computed devices, bio molecular devices and molecular electronics, integrated micro systems and MEMS, molecular manufacturing and nano robots, material engineering processes applied to electro-active polymers, micro-nano scale instrumentation measuring

5- CHEN 415 Biomaterials

Classification of biomaterials, classes of materials used in medicine, biomaterials surfaces, practical aspects of biomaterials, surface characterization of biomaterials, applications of materials used in medicine.

6- CHEN 416 Extractive Metallurgy

Major operations in the iron and steel-making industry; direct reduction processes, blast furnaces, converter and electric-arc steel-making and steel refining methods; electro slag (ESR) and vacuum induction refining (VIR). Bauxite production. Electro-thermal reduction of cryolite to produce commercial aluminum. Production of TiO2. Extractive metallurgy of titanium. Gold extraction. Continuous casting.

7- CHEN 452 Water and Wastewater Treatment

Wastewater introduction, Wastewater charac-teristics, Technologies in wastewater treatment, wastewater constituents, wastewater sampling and analytical procedures, physical characteristics of water, metallic and nonmetallic constituents, analysis and selection of wastewater flow rates, Physical unit operations, chemical unit processes, biological treatment, advanced wastewater treatment, water reuse

8- CHEN 454 Water Desalination

Resources for water, composition of sea water, introduction to desalination, desalination processes, single effect evaporation, evaporators, single effect thermal vapor compression, single effect mechanical vapor compression, multiple effect evaporation

9- CHEN 466 Safety in Chem Process Indust

Safety and loss prevention. Major process hazards. Hazard identification, assessment and prevention. Personal safety in industrial environment. Fire explosion and toxic release. Safety systems.

10- CHEN 471 Chem Eng Design for Environ

Meteorology, lapse rate, introduction of plume, air pollution dispersion models, devices and techniques for control of particulates, Wastewater treatment techniques, membrane separation, biological treatment, chemical treatment, design for wastewater treatment plant

11- CHEN 472 Industrial Pollution Control

Sources of pollution from chemical industries. Standards and legislations. Health and environmental effects of pollution. Air pollutants; particulate, SOx, NOx and organic vapors. Air pollution control. Treatment of industrial wastewater. Handling of solid waste. Monitoring of pollutants. Case studies for specific industries like petrochemicals, fertilizers, desalination and petroleum refining

12- CHEN 481 Biochemical Engineering

Introduction to biofuel, sources of biofuel, biofuel properties, manufacturing processes for biofuel, biodiesel, bioethanol, biogas

13- CHEN 421 Fundamentals of Biofuel

Biofuel introduction, chemistry of biofuels, bioenery production technologies, first and second generation technologies for biofuel production, sources of fuel and fuel properties, environmental impacts, biorefinery, biofuel process design, recent developments in biotechnology.

14- CHEN 432 Energy Conservation

World and local energy situation, energy policies and strategies, the environment and the economy, renewable sources and social energy requirements, conservation, substitution and technology options, integrated energy management systems, energy conservation technologies.

15- CHEN 455 Design of Altern Energy Sys

Introduction and overview of the energy system, modeling skills in energy systems, design of energy systems, issues associated with alternative energy

16- CHEN 461 Petroleum Refinery Engineering

Oil production. Surface operations. Characterization and classification of crude oils. Physical properties of oils. Refinery operations; atmospheric and vacuum distillation, treatment processes, catalytic cracking, reforming, alkylation, coking, asphalt production and lubricating oil production. Blending of refinery products. Waste treatment.

17- CHEN 462 Natural Gas Engineering

Characterization and properties of natural gas. Gas gathering systems. Gas-oil multistage separation. Gas treatment and liquefaction. Gas transportation through pipelines, signal-telemetering Industrial usages.

18- CHEN 463 Petrochemical Technology

Production technologies of synthesis gas, olefins and aromatic. Manufacture of important petrochemicals derived from base chemicals and synthesis gas. Production technologies of important polymers and plastics.

19- CHEN 497 Selected Topics in Chem Eng

In-depth study of relevant Chemical and Materials engineering topics not covered in other courses of the program in order to enhance students' knowledge in the field of chemical engineering.