

COMSATS University Islamabad

Registrar Secretariat, Academic Unit (PS)

No. CUI-Reg/Notif- /1/82 /26/EFS: 64381

August 31, 2026

NOTIFICATION

The Academic Council, in its 44th meeting held on August 04, 2026, on the recommendations of the Board of Advanced Studies and Research (BASAR) in its 39th meeting held on June 30, 2026, approved the revised Scheme of Studies of **Doctor of Philosophy in Chemical Engineering**, effective from Fall 2026:

1. Duration of the Program:

i.	Minimum Duration	03 Years
ii.	Minimum No. of Semesters	06 Semesters
iii.	Maximum Duration	08 Years
iv.	Maximum No. of Semesters	16 Semesters

2. No. of Courses and Credit Hours in PhD:

S. No.	Category	SAME/RELEVANT* DISCIPLINE		INTRA-DISCIPLINARY	
		No. of Courses	No. of Credit Hours	No. of Courses	No. of Credit Hours
v.	Minimum Deficiency Courses of level 7	-	-	02-03	06-09
vi.	Core Courses	01	03	01	03
vii.	Mandatory Courses	03	05	03	05
viii.	Elective Courses	04	12	04	12
ix.	Research Dissertation	01	09	01	09
x.	Total (Minimum)	09	29	11-12	35-38

† Non-Muslim students shall study HUM853 Advanced Topics in Ethics as alternative to the two core courses: Advanced Understanding of Holy Quran-I & II. For these students, the number of Mandatory courses is 02 resulting in total 08 courses for same/ relevant discipline and total 10-11 courses for intradisciplinary category.

For INTRADISCIPLINARY:

- For prospective graduate students coming from an Intra-disciplinary field two tests must be taken, i.e., the GRE Subject and GRE/NTS/HAT General / Equivalent as per CUI rules and regulations/Graduate Handbook.
- Subject to fulfilment of other prescribed requirements, the department may award provisional admission and allow the prospective student to take deficiency courses as per CUI rules and regulations/Graduate Handbook. Admission may be confirmed after successful completion of

deficiency courses. The zero semester of an intradisciplinary PhD candidate shall not count towards the comprehensive examination and maximum study duration.

5. The credit hours earned through deficiency courses shall be mentioned in the student's transcript, however, shall not be counted towards calculating CGPA of the degree.

General:

6. PhD students may enroll in courses only numbered 700-899, except for the PhD Dissertation (900).
7. Courses completed during the MS program (including the mandatory courses of Quran and Artificial Intelligence) will not count towards the PhD program's requirements, ensuring no duplication or repetition of coursework.
8. **Deficiency Courses:** The requirement for deficiency courses shall be determined as per policy in the CUI Graduate Handbook, as amended from time to time.
9. **General Eligibility Criteria:** The general eligibility criteria for admission into PhD Program remain as prescribed in the CUI Graduate Handbook.

To assess the relevance of applicants' academic background for admission into the same/relevant disciplines category, the Departmental Admission Committee shall:

- Review the applicant's academic credentials, including transcripts and degree(s).
- Conduct an interview to evaluate suitability for the respective program.

Based on this evaluation, the Departmental Admission Committee shall forward its recommendations to the Dean's Office through the proper channel for endorsement of the final decision.

10. All other requirements, terms, and conditions stipulated in the CUI Graduate Rules/ Regulations/ Policy and Graduate Handbook, as amended from time to time, shall also be applicable.
11. The respective Campus Director must ensure that the program secures the necessary accreditation and/or NOC from the relevant Accreditation Council(s) or HEC, where applicable. Maintaining continuous accreditation is essential to safeguard student credentials and prevent future qualification or recognition issues for graduates.

This partially modifies notification numbers CUI-Reg/Notif-810/24/EFS: 23678 dated May 11, 2026.

Encl: (Total 74 Pages)


Dr. Muhammad Hanif
Additional Registrar

Distribution:

1. All Campus Directors / In-Charge, CUI Campuses
2. All Principal Officers / All Deans of Faculties
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8. Registrar Office / Academic Unit, CUI Principal Seat

CC:

1. SO to the Rector
2. PS to the Registrar

1. Core Course:

S. No.	Code	Course Title	Credit Hours
1.	CHE815	Advanced Topics in Chemical Engineering	3(3, 0)

2. Mandatory Courses:

S. No.	Code	Course Title	Credit Hours
1.	HUM851	Advanced Understanding of Holy Quran-I	1(0, 1)
2.	HUM852	Advanced Understanding of Holy Quran-II	1(0, 1)
3.	CSC803	Artificial Intelligence: Principles and Applications	3(3, 0)

3. Mandatory Alternative Course for Non-Muslim Students in Lieu of Quran Courses*:

S. No.	Code	Course Title	Credit Hours
1.	HUM853	Advanced Topics in Ethics	2(0, 2)

*Shall be effective from Fall 2025 intakes

LIST OF ELECTIVE COURSES:

- a) PhD students shall enroll in any four (04) courses numbered 700–899 from the following list.

Sr. No.	Course Code	Course Title	Credit Hours
1.	CHE700	Advanced Treatment of Simultaneous Heat and Mass Transfer	3(3, 0)
2.	CHE701	Computational Fluid Dynamics	3(3, 0)
3.	CHE702	Advanced Catalytic Processes	3(3, 0)
4.	CHE703	Fluidization Engineering	3(3, 0)
5.	CHE704	Novel Separations	3(3, 0)
6.	CHE710	Oil and Gas Economics	3(3, 0)
7.	CHE711	Surface Petroleum Operations	3(3, 0)
8.	CHE712	Petroleum Transmission	3(3, 0)
9.	CHE713	Natural Gas Transmission	3(3, 0)
10.	CHE720	Chemicals Emission and Control	3(3, 0)
11.	CHE721	Fate and Transport of Chemical in Environment	3(3, 0)
12.	CHE722	Industrial Environmental Microbiology	3(3, 0)
13.	CHE723	Industrial Environmental Chemistry	3(3, 0)
14.	CHE724	Hazardous and Toxic Chemical Waste Treatment	3(3, 0)
15.	CHE725	Bioremediation of Toxic Chemicals	3(3, 0)
16.	CHE726	Solid Waste Engineering	3(3, 0)
17.	CHE730	Bio-Reaction Engineering	3(3, 0)
18.	CHE731	Bio-Process Design	3(3, 0)
19.	CHE732	Production of Biofuels	3(3, 0)

20.	CHE733	Metabolic and Cell Engineering	3(3, 0)
21.	CHE734	Manufacturing Practices for Bioprocesses	3(3, 0)
22.	CHE740	Polymer Rheology	3(3, 0)
23.	CHE741	Principles of Polymer Conversion Operations	3(3, 0)
24.	CHE742	Polymer Membranes	3(3, 0)
25.	CHE743	Sol-Gel Processing	3(3, 0)
26.	CHE744	Membrane Science & Technology	3(3, 0)
27.	CHE750	Textile Quality Assurance	3(3, 0)
28.	CHE751	Mechanics of Textiles	3(3, 0)
29.	CHE752	Advanced Yarn Engineering	3(3, 0)
30.	CHE753	Fiber Forming Polymers	3(3, 0)
31.	CHE754	Fiber Engineering Science	3(3, 0)
32.	CHE760	Scientific Communication for Engineering Research	3(3, 0)
33.	CHE805	Advanced Research Methods	3(3, 0)
34.	CHE806	Advanced Instruments and Analytical Techniques	3(3, 0)
35.	CHE810	Natural Gas Processing	3(3, 0)
36.	CHE811	Petroleum Processing	3(3, 0)
37.	CHE830	Separation Processes for Bio-Chemical Products	3(3, 0)
38.	CHE831	Bio-Molecular Kinetics and Cellular Dynamics	3(3, 0)
39.	CHE832	Bio-Nanotechnology	3(3, 0)
40.	CHE833	Bio-Mimetic Engineering	3(3, 0)
41.	CHE840	Polymer Processing	3(3, 0)
42.	CHE841	Conductive Polymers	3(3, 0)
43.	CHE842	Rheology of Complex Fluids	3(3, 0)
44.	CHE843	Polymer Nanocomposites	3(3, 0)
45.	CHE850	Characterization of Fibrous Materials	3(3, 0)
46.	CHE851	Advanced Textile Composites	3(3, 0)
47.	CHE852	Colour Physics and Measurement	3(3, 0)
48.	CHE853	Advanced Finishing Processes	3(3, 0)
49.	CSC762	Advanced Topics in Neural Networks	3(3, 0)
50.	ENE714	Advanced Energy Engineering	3(3, 0)
51.	ENE715	Waste to Energy	3(3, 0)
52.	ENE731	Energy and Environmental Policies	3(3, 0)
53.	ENE732	Special Topics in Energy and Environment	3(3, 0)
54.	ENV751	International Environmental Governance	3(3, 0)
55.	ENV753	Climate Change and Global Politics	3(3, 0)
56.	PSE702	Process Integration	3(3, 0)
57.	PSE720	Process Design and Optimization	3(3, 0)
58.	PSE731	Process Modeling and Simulation	3(3, 0)
59.	PSE732	Artificial Neural Network	3(3, 0)

60.	PSE740	Sustainable Energy Systems	3(3, 0)
61.	PSE741	PINCH Technology	3(3, 0)
62.	PSE742	Energy Audit and Management	3(3, 0)
63.	PST724	Polymer Process Machinery Technology	3(3, 0)
64.	PST725	Advanced Polymer Processing	3(3, 0)
65.	PST726	Plastic Products Manufacturing	3(3, 0)
66.	PST732	Advanced Polymer Synthesis and Processes	3(3, 0)
67.	PST733	Polymer Reaction Technology	3(3, 0)
68.	PST752	Advanced Polymer Characterization	3(3, 0)
69.	PST754	Polymers Surfaces and Interfaces	3(3, 0)
70.	PST762	Emulsion Polymers	3(3, 0)

PhD Dissertation

S. No.	Course Code	Course Title	Credit Hours
1.	CHE900	PhD Dissertation	9(0, 9)



Course Title: Advanced Topics in Chemical Engineering

Course Code: CHE815

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

This course provides an in-depth understanding of the latest research and developments in various areas of chemical engineering.

Course Contents:

Biomass conversion and processes. Production of biofuels and biochemical. Advancements in biomass conversion technology. Biorefinery; fundamentals and applications in chemical engineering. Principles of microfluidics. Applications of microfluidics in wastewater treatment. Biofuel production and chemical synthesis.

Nano-functional materials and green synthesis. Applications of advanced materials in energy and environment. Catalyst synthesis, characterization and various applications. Mechanism and kinetics of catalytic reactions.

Polymer synthesis, characterization and processing of polymers and rubbers. Applications in various industries. Advancements in polymer and rubber technology. Membrane fabrication, characterization and applications in separation processes. Advancements in membrane technology.

Advanced techniques in process modeling and simulation, model development and validation, applications in process design and optimization.

Reference Books:

1. H. Scott Fogler, Elements of Chemical Reaction Engineering, Pearson, 6th Edition, 2022.
2. Kenneth Richard Hall, Gustavo Arturo Iglesias-Silva, Thermodynamics for Chemical Engineers, Wiley, 2022.
3. Anandhan Srinivasan, Sri Bandyopadhyay, Advances in Polymer Materials and Technology, Taylor & Francis, 2020.
4. Nayef Ghasem, Modeling and Simulation of Chemical Process Systems, CRC Press, 2018.
5. Eric M. V. Hoek, Introduction to Membrane Science and Technology, John Wiley & Sons, 2018.
6. Samir Kumar Khanal, Yebo Li, Bioenergy: Principles and Applications, Wiley, 2016.
7. R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, Transport Phenomena: Volume 1, Wiley, 2006.

Course Title: Advanced Treatment of Simultaneous Heat and Mass Transfer

Course Code: CHE700

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

This course is to focus on the advanced studies of heat and mass transfer with emphasis on their analysis and applications to practical engineering problems. Use of computational tools for the analysis of industrial problems involving heat and mass transfer will be employed in this course.

Course Contents:

Identify and analysis thermal processes involving heat conduction, convection and radiation and Mass transfer by molecular diffusion, Integrate fundamental principles of heat and mass transfer with quantitative analysis to solve engineering problems, problems related to various types of distillation including Multi component, Batch, Steam, Azeotropic, extractive distillation, Crystallization, Membrane separation, Transport properties, conservation equations, conduction heat transfer, convective heat and mass transport in laminar and turbulent flows, phase change processes, thermal radiation.

Reference Books:

1. Kern Donald Q. Process Heat Transfer, (1997), McGraw Hill Book Company.
2. Cengel Yunus A. Heat Transfer-A Practical approach, (1988), McGraw Hill Book Company.
3. Incropera Frank P., De Witt David P. Fundamentals of Heat and Mass Transfer (5rd ed.) (2002). John Wiley and Sons.
4. Coulson J.M., Richardson J.F. Chemical Engineering Vol-I, (1999). The English Book Society and Pergamon Press.
5. Coulson J.M., Richardson J.F. Chemical Engineering Vol-II, (5th ed.) (2002). The English Book Society and Pergamon Press.
6. J. P. Holman, Heat Transfer, (2002), McGraw Hill Book Company.
7. McCabe Warren L., Smith Julian C., Harriott peter Unit Operations of chemical Engineering (7th ed.) (2005). McGraw Hill Inc.
8. Schweitzer, Handbook of Separation Techniques for Chemical Engineers, (1979), McGraw Hill Book Co.
9. Pergamon Press Alan S.Foust, Leonard A.Wenzel Principles of Unit Operations (2nd ed.)(1980). John Wiley & Sons.

Course Title: Computational Fluid Dynamics

Course Code: CHE701

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The aim of this unit is to provide students with physical significance of each term in the governing equations for CFD, quantify & analyze the numerical error in solution of the CFD and solve practical CFD problems.

Course Contents:

Study of approaches including time accurate and steady-state methods, explicit and implicit techniques, Eulerian and Lagrangian methods, laminar and turbulent flow, compressible and incompressible approaches, projection methods, stability considerations, etc. Applications of cfd to mixing, heat transfer and reaction.

Reference Books:

1. J. H. Ferziger & M. Peric, Computational Methods for Fluid Dynamics, ((3rd ed.)), Springer, Berlin, Heidelberg, New York, (2002). ISBN 3-540-42074-6.
2. John D. Anderson, Computational Fluid Dynamics, The Basics with Applications, the Basics with Applications, (1995), McGraw Hill.
3. Pieter Wesseling, Principles of Computational Fluid Dynamics, Springer, Berlin, Heidelberg,, (1991), New York.
4. R. B. Bird, W.E. Stewart, and E.N. Lightfoot, Transport Phenomena, (1960), John Wiley and Sons.
5. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere, (1980), New York.

Course Title: Advanced Catalytic Processes

Course Code: CHE702

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To develop thorough understanding of new and developed catalytic processes practiced in petroleum refining & processing, biochemical processing and environmental processes.

Course Contents:

Role of the catalyst in terms of nature of active sites, thermodynamic consideration and adsorption-desorption aspects. Heterogeneous eliminations, additions and substitutions, General principles of catalytic hydrogenation, catalytic hydrogenation of olefins, alkynes, alkadienes and cyclic molecules, Heterogeneous oxidation of olefins and aromatics, Catalytic decomposition: catalytic cracking, hydro-cracking, hydrogen steam reforming, Catalytic unification: alkylation, polymerization, Catalytic Alteration: reforming, isomerisation, Catalytic treatment processes: hydrodesulphurization, hydro treating, sweetening, Fuel Cells, Catalytic combustion process, heterogeneous photo catalysis, enzymatic and polymerization catalytic process, mono and bimetallic catalytic processes, membrane catalysis, nanostructured metals catalytic processes.

Reference Books:

1. Robert J. Farrauto. Fundamentals of industrial catalytic processes, 2nd revised edition, (2005), John Wiley and Sons.
2. C. H. Bamford, Charles Frank Howlett, Complex catalytic processes, (2004), Elsevier Science.

Course Title: Fluidization Engineering

Course Code: CHE703

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To provide detailed knowledge of fluidization process with emphasis on properties & parameters governing the design of fluidized systems including fluidized bed reaction, gasification and combustion.

Course Contents:

Introduction to fluidization, Solid movement, Mixing, segregation, Particle to gas mass transfer, Particle to gas heat transfer, Fluidization Velocity, Elutriation and entrainment, Effect of Temperature and Pressure Fluid flow through the bed and pressure drop calculation, Fluidized Bed Scale-up, Two phase particle bed model, Fluidization systems: Dense Bed Fluidization, Bubbling Bed Fluidization, High Velocity Fluidization, Circulating Bed fluidization, Liquid Solid Fluidization, Three Phase Fluidization, Fluidization system design: Fluidized Bed Combustor/ Fluidized Bed Gasifier/ Fluidized Bed Reactor, Application of Fluidization.

Reference Books:

1. Jonghwun Jung, Design and Understanding of Fluidized Bed Reactors, (2009), VDM Verlag McGraw Hill.
2. L G Gibilaro, Fluidization Dynamics, (2001), Publisher: Butterworth-Heinemann.
3. O Molerus, Heat Transfer in Fluidized Beds Book, (1997), Wirth, K E Wirth, Chapman & Hall, McGraw Hill.
4. Simeon N Oka, E J Anthony, Fluidized Bed Combustion, (2003), CRC Press.
5. Prabir Basu, Combustion and Gasification in Fluidized Beds, (2006), CRC Press.
6. Octave Levenspiel, Fluidization Engineering, (1991), Second edition, Imprint: Butterworth Heinemann, McGraw Hill.

Course Title: Novel Separations

Course Code: CHE704

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To impart knowledge of latest separation techniques so that the students may integrate these techniques in existing and hereafter industrial ventures.

Course Contents:

Membrane separation systems: per-vaporation processes, organic solvent nano-filtration, electro-membrane processes, friction-diffusion separation process, hybrid separation systems: reactive distillation, reactive extraction, solvent stripping, reactive rectification, Melt crystallization, Ligand exchange separation technique, combined ion-exchange solvent extraction separation technique, super critical fluid extraction, chromatography, electrophoresis, superconducting magnetic separation technique, hybrid separation techniques, gas carrying evaporation.

Reference Books:

1. Suzana Pereira Nunes, Membrane technology in the chemical industry, (2007), Klaus-Viktor Peinemann.
2. C.A. Costa and Joaquim Chromatographic and Membrane Processes in Biotechnology by S. Cabral, (1991), McGraw Hill.
3. Norman Li, Separation and Purification Technology, (1992), McGraw Hill.
4. Peter R. Keller Membrane technology and industrial separation techniques, (1976), McGraw Hill.

Course Title: Oil and Gas Economics

Course Code: CHE710

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

Students will have the understanding of economic aspects in oil and gas sector; develop concept of cash flow management; risk and asset management.

Course Contents:

This unit covers the oil and gas industry from an economic perspective; international industry structure; Australian industry structure; oil and gas industry in Western Australia; the economics of investment; discounted cash flow analysis; cost–benefit analysis; internal rate of return; oil and gas markets; supply and demand determining prices and output; prices and non-renewable resources—hotelling principle; the operation of cartels; dealing with risk in oil and gas markets; open access to natural gas pipelines; natural monopoly theory; national competition policy; gas market regulation; taxation of the oil and gas industry; concept of economic rent; Commonwealth and state royalty systems; resource rent tax; oil and gas industry and the Australian economy; impact and multiplier analysis; balance of payments and exchange rate effects; government policy and the oil and gas industry; the greenhouse gas issue; and tradeable emissions permits.

Reference Books:

1. Seider, W.D., Seader, J.D. and Lewin, D.R. Process Design Principles - Synthesis, Analysis and Evaluation, (1999), John Wiley and Sons Inc.
2. Biegler, L.T., Grossmann, I.E., and Westerberg, A.W. Systematic Methods for Chemical Process Design, (1997), Prentice-Hall.
3. Smith, R. Chemical Process Design, (1995), McGraw-Hill.
4. Peters, M.S. and Timmerhaus, K.D. Plant Design and Economics for Chemical Engineers, (1980), McGraw-Hill.
5. Douglas, J.M. Conceptual Design of Chemical Processes, (1988), McGraw-Hill.

Course Title: Surface Petroleum Operations

Course Code: CHE711

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The objective of this course is to provide the understanding of the processes applied to the fluid produced at the well head in the preparation for transportation or storage. Process Engineer is faced with mixture of oil, gas and water as well as small volumes of undesirable substances which have to be separated and treated for export.

Course Contents:

Processing of crude oil and the associated natural gas of the wellhead into stabilized crude oil, pipeline quality natural gas, natural gas liquids and sulfur. Gas-oil separation, crude oil desalting, gas sweetening and dehydration, recovery and fractionation of natural gas liquids, sulfur production and crude oil stabilization. Computer simulation of major oil field processes. Thermodynamics and phase equilibria of multi-component hydrocarbon mixtures. Gas compression, refrigeration and two-phase flow.

Reference Books:

1. G.V. Chinlingarian., J.O. Robertson. JR. Sanjay Kumar, Surface operation in petroleum production, (1987), CRC Press.
2. Frank Jahn, Mark Cook, Mark Graham, Hydrocarbon exploration and production, ((2nd ed.)), (2008), MacGraw Hill.

Course Title: Petroleum Transmission

Course Code: CHE712

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

Transport of petroleum to distant delivery points: present unique challenges. This course is to equip graduate students with sufficient technical details to enable them to address the multidisciplinary issues relating to petroleum transmission.

Course Contents:

Petroleum Properties; Quality; Transportation; Energy Pricing. Raw petroleum transmission: Calculating Flow Pressure Gradients; Pipelines; Temperature Profile Pipelines Operations, Offshore, Sea, Tanker Transmission Practices and Aspects; Petroleum & Gas Flow concerns.

Reference Books:

1. E. Shashi Menon, Gas Pipeline Hydraulics, (2005), CRC Press Taylor & Francis.
2. J. M. Prausnitz., J. P. O. Connell. The Properties of Gases and Liquids, B.E. Poling, (2001), McGraw Hill, New York.
3. Pipeline Design and Construction: A Practical Approach, ASME Press, American Society of Mechanical Engineers, (2000), New York.

Course Title: Natural Gas Transmission

Course Code: CHE713

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

Transport of natural gas by pipelines to distant delivery points: presents unique challenges of flow through long conduits. Furthermore, the processing of the gas to meet delivery specifications requires process systems design. This course is to equip graduates students with sufficient technical details to enable them to address above mention issues relating to the natural gas processing and transmission.

Course Contents:

Natural Gas Origin and Composition; Sources; Phase Behavior; Properties; Quality; Transportation; Natural Gas Energy Pricing. Raw Gas Transmission: Multiphase Flow Terminology; Multiphase Regimes; Calculating Multiphase Flow Pressure Gradients; Multiphase Flow in Gas/Condensate Pipelines; Temperature Profile of Multiphase Pipelines; Velocity Criteria for Sizing Multiphase Pipelines; Multiphase Flow Assurance Monitoring; Multiphase Pipelines; Multiphase Flow Assurance Monitoring; Multiphase Pipelines Operations. Sales Gas Transmission: Gas Flow Fundamentals; Predicting Gas Temperature Profile; Compressor Stations and Associated Pipeline; Design Consideration of Sales Gas Pipelines; Pipeline Operations.

Reference Books:

1. E. Shashi Menon, Gas Pipeline Hydraulics, (2005), CRC Press Taylor & Francis.
2. J. M. Prausnitz., J.P.O. Connell. The Properties of Gases and Liquids, B.E. Poling, (2001), McGraw Hill, New York.
3. J. J. Carroll. Natural Gas Hydrates, A Guide for Engineers, (2002), Gulf Professional Publishing, Amsterdam, The Netherlands.
4. Pipeline Design and Construction: A Practical Approach, ASME Press, American Society of Mechanical Engineers, New York, (2000).
5. A. L. Kohl., F.C. Risenfeld. Gas Purification, (1985), Gulf Professional Publishing, Houston, TX.

Course Title: Chemicals Emission and Control

Course Code: CHE720

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To provide comprehensive understanding of all air pollution aspects, management and the engineering controls used to reduce emissions from industry and transport.

Course Contents:

Atmospheric Physics, Chemistry and Thermodynamics, formation and removal of atmospheric pollutants, Air pollution phenomena, fates of air pollutants, and impact on human health, methods and procedures for air pollutant measurement, management and control. Air pollution modeling techniques for institutional air quality management framework in compliance to ever increasing legislative and pollution mitigation needs.

Reference Books:

1. William Licht, Air Pollution Control Engineering: Basic Calculations for Particulate Collection, (1988), Camber Southeast, Inc.
2. Wayne T. Davis, Electrostatic Precipitator Handbook, (2000), Camber Southeast, Inc.
3. Nicholas J. Bahr, Air Quality Control Handbook, (1997), Camber Southeast, Inc.

Course Title: Fate and Transport of Chemical in Environment

Course Code: CHE721

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To provide an integrated coverage of major environmental media, quantitative treatment of fate and transport processes.

Course Contents:

Fundamental principles of mass transport, chemical partitioning, and chemical/biological transformations in surface waters, soil, groundwater, air, controlling physical, chemical, and biological processes, mathematical models for chemical transport and transformations in the environment

Reference Books:

1. Dunnivant, Frank M. Anders, Elliot, A Basic Introduction to Pollutant Fate and Transport, John Wiley & Sons, (2006).
2. John H. Montgomery, Groundwater Chemicals Desk Reference, ((3rd ed.)), (2000), CRC.
3. Harold F. Hemond, Chemical Fate and Transport in Environment, (2000), Academic Press.

Course Title: Industrial Environmental Microbiology

Course Code: CHE722

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The course introduces students to complex concepts in water microbiology, food microbiology, sterility and disinfection, the use of microorganisms in manufacturing processes and in the degradation of contaminants in the environment.

Course Contents:

The vital role of microbes in marine, freshwater and terrestrial ecosystems by exploring the dynamic interactions that take place between microbial communities, the surroundings and higher organisms, microbial diversity and function, sensing and adaptive responses of bacteria, biogeochemical cycling and microbial communities and interactions, , role of microbes in the ecological, biogeochemical and bioremedial processes in different environments, Applications to a range of environmental problems , sustainable resources and commercial applications of environmental biotechnology

Reference Books:

1. Raina M. Maier, Ian L. Pepper, Charles P. Gerba, (2000), Environmental Microbiology, ((1st ed.)), Academic Press.
2. Ralph Mitchell, Ji-Dong Gu, Wiley-Blackwell, (2009), Environmental Microbiology, ((2nd ed.)).
3. Patrick K. Jjemba, (2004), Environmental Microbiology: Principles and Applications, Science Pub Inc.

Course Title: Industrial Environmental Chemistry

Course Code: CHE723

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The main objective of this course is to gain an understanding of the chemical processes that are central to a range of important environmental problems and to utilize this knowledge in making critical evaluations of industrial problems.

Course Contents:

Principles of chemistry, pollutants source, fate, and reactivity of compounds in natural and polluted environments, phase interactions, and biochemistry of aquatic microbial, environmental implications of energy utilization, chemistry of the atmosphere, hydrosphere, and lithosphere. Industrial chemicals and issues related to air pollution, stratospheric ozone depletion, pollution and treatment of water sources, insecticides and herbicides, etc.

Reference Books:

1. Stanley E. Manahan, (2004), Environmental Chemistry, CRC Press.
2. Mohan Singh, (2007), Environmental Chemistry: Fundamentals, Jorge G. Ibanez, Margarita Hernandez-Esparza, Carmen Doria-Serrano, Arturo Fregoso-Infante, Springer.

Course Title: Hazardous and Toxic Chemical Waste Treatment

Course Code: CHE724

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To provide an introduction to the important topics of environmental ethics. To assess remediation technologies for contaminated soil/groundwater under saturated and unsaturated conditions .To offer necessary equations and design examples to evaluate the effectiveness of different treatment and containment technologies in addressing today's hazardous waste situations. To provide experiences in realistic civil and environmental engineering design and construction practice. To develop teamwork and communication skills required for multi-disciplinary civil and environmental engineering objectives.

Course Contents:

Regulations, Introduction to Contaminant Nature and Remediation Technologies. Site and Subsurface Characterization - Methodology, Planning, Site Characterization, Geographic Information System, Case History Pollution Prevention - Management Strategies, Life Cycle Analysis, Volume Reduction, Toxicity Reduction, Recycling Extraction Technologies (Soil): Supercritical Fluid Extraction, Chemical Dehalogenation Treatment (Liquid and Solids) Toxicology - Pharmacokinetics, Toxic Effects, Dose-Response relationships Process Fundamentals and Contaminant Pathways - Physical-Chemical Properties, Process Selection Procedure, Contaminant Release, Contaminant Transport Extraction Technologies (Liquid): Oil and Grease Extraction Technologies (Liquid): Air Stripping Extraction Technologies (Soil): Soil Vapor Extraction - Principle and Design Extraction Technologies (Soil): Soil Vapor Extraction - Design and Field Application Thermal Methods - Regulations, Combustion, Gases and Vapors, Incinerators, Air Pollution Control, Instrumentation Granular Activated Carbon (Liquid & Off-Gas) Solvent Extraction (Liquid and Solids) Air Sparging System (Groundwater) In Situ Bioremediation (Liquid) and Bioventing (Soil) Composting and Heap Pile Bioremediation Advanced Oxidation Processes (Liquid, Gas & Solids) Photochemical Processes (Liquid and Gas) Quantitative Risk Assessment -Hazard Identification, Exposure Assessment, Risk Assessment, Case Study.

Reference Books:

1. Michael LaGrega, Phillip Buckingham, Jeffrey Evans, Basic Hazardous Waste Management (2001), ((2nd ed.)) by William C. Blackman.
2. Mickel L., et.al, Hazardous Waste Management, (2000), MacGraw Hill.

Course Title: Bioremediation of Toxic Chemicals

Course Code: CHE725

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The use of genetic engineering to create organisms specifically designed for bioremediation has great potential. The main objective of this course is to give an in-depth knowledge to the student about the use of microorganism metabolism to remove wide range of pollutants.

Course Contents:

Introduction, Genetic systems in soil bacteria for the degradation of polychlorinated biphenyls. Selection of enhanced polychlorinated biphenyl-degrading bacterial strains for bioremediation: consideration of branching pathways, Chlorophenol degradation. Microbial metabolism of polycyclic aromatic hydrocarbons, Microbial ecology of polycyclic aromatic hydrocarbon (PAH) degradation in coastal sediments. Biodegradation of chlorinated homocyclic and heterocyclic compounds in anaerobic environments. Biodegradation of sulfonated aromatics. The biodegradation of morpholine. Microbial metabolism of carbamate and organophosphate pesticides, Biodegradation of low-molecular-weight halogenated organic compounds by aerobic bacteria, Anaerobic utilization of aromatic carboxylates by bacteria, Biodegradation of trichloroethylene in methanotrophic systems and implications for process applications, Properties of lignin-degrading peroxidases and their use in bioremediation, Biological disposal of lignocellulosic wastes and alleviation of their toxic effluents, Biodegradation of toxic chemicals by white rot fungi, Recent advances in bio processing of coal, microbial desulfurization of coal with emphasis on inorganic sulfur.

Reference Books:

1. Anna-Irini Koukkou, Microbial Bioremediation of Non-metals Current Research, (2011), Caister Academic Press.
2. G.R. Chaudhry, L. Ljungdahl, Biological Degradation and Bioremediation of Toxic Chemicals, (1995), Kluwer Academic Publishers.
3. Ronald L. Crawford, Don L. Crawford, Bioremediation: Principles and Applications, (1997), Cambridge University Press.

Course Title: Solid Waste Engineering

Course Code: CHE726

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To understand the engineering and scientific principles of municipal solid waste (MSW) management. Gain insight into the collection, transfer, and transport of municipal solid waste. Understand the design and operation of a municipal solid waste landfill. Understand the design and operation of a resource recovery facility. Understand the design and operation of a waste-to-energy facility.

Course Contents:

This course covers advanced engineering and scientific concepts and principles applied to the management of municipal solid waste (MSW) to protect human health and the environment and the conservation of limited resources through resource recovery and recycling of waste material. Topics include regulatory aspects and hierarchy of integrated solid waste management; characterization and properties of MSW; municipal wastewater sludge utilization; hazardous waste found in MSW; collection, transfer, and transport of solid waste; separation, processing, combustion, composting, and recycling of waste material; and the landfill method of solid waste disposal, which encompasses guidelines for design, construction, operation, siting, monitoring, remedial actions, and closure of landfills. Permitting and public participation processes, current issues, and innovative approaches are also addressed

Reference Books:

1. W. A. Worrell., P. A. Vesilind., Solid Waste Engineering, ((2nd ed.)), (2011), Cengage Learning.
2. W. B. Robison, the solid waste handbook, a practical guide, (1986), John Wiley and Son.
3. Jagbir Singh, Solid Waste Management, (2010) International Publishing House Pvt. Ltd.

Course Title: Bio-Reaction Engineering

Course Code: CHE730

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The purpose of this course is to specialize chemical engineers for the designing of reactors with some quite specific characteristics of bio-reactions, which require specialist treatment, e.g. the complex stoichiometric networks of metabolism. Biochemistry, microbiology and chemical engineering are all used to obtain a deeper insight into the complex world of bioreactions.

Course Contents:

The purpose of this course is to calculation, mathematical modelling and designing of enzyme catalyzed reactions, optimal batch and chemostat fermentations based on simple reaction kinetics, metabolic control analysis in a simple reaction network. Heat of production in fermentation process. This subject also covers the principles for the design and scale-up of a bioreactor.

Reference Books:

1. Jens Nielsen., John Villadsen and Gunnar Liden. Bioreaction Engineering Principles, ((2nd ed.)), (2003), MacGraw Hill.
2. K. Schügerl., K.-H. Bellgardt. Bioreaction Engineering: Modeling and Control (2000), ((1st ed.)), CRC Press.

Course Title: Bio-Process Design

Course Code: CHE731

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To develop the students' knowledge and appreciation of the conceptual and factual bases for bioprocess design and operation and to develop the understanding of biochemistry, in particular the structures, roles and experimental methods associated with biopharmaceuticals and their analysis. It also provides the students with an awareness of the regulatory affairs environment in the Biopharmaceutical industry.

Course Contents:

To carry out a bioprocess on a large scale, it is necessary to investigate and develop three principle areas: to obtain the best biocatalyst (microorganisms, animal cell, plant cell, or enzyme) and medium optimization for a desired process, to create the best possible environment for the catalyst to perform by designing the bioreactor and operating it in the most efficient way and to separate the desired products from the reaction mixture in the most economical way. This course endeavors to answer these questions in a systematic and conceptual way

Reference Books:

1. Michael L. Shuler., Fikret Kargi. Bioprocess Engineering: Basic Concepts, (2nd ed.), (2001).
2. Ghasem D. Najafpour. Biochemical engineering and biotechnology (1st ed.) (2007), Elsevier.
3. Joaquim M. S. Cabral., Manuel Mota., J. Tramper, Multiphase bioreactor design (2001), Taylor & Francis.
4. Elmar Heinzle., Arno P. Biwer., Charles L. Cooney. Development of sustainable bioprocesses: modeling and assessment (2006), Wiley.
5. Donald Lee Wise., Marcel Dekker. Bioprocessing and biotreatment of coal (1990), INC.

Course Title: Production of Biofuels

Course Code: CHE732

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The main objective of the course is to apply the knowledge in microbiology and process engineering to the biological conversion processes of biomass into biofuels (bioethanol, biogas, biohydrogen and biodiesel). The main focus will be on the potential and possible solutions for the technical implementation of biofuels production from different biomass resources.

Course Contents:

This course covers the conversion of organic matters into biogas, biohydrogen, bioethanol, and biodiesel. The selection of economically feasible process for the production of biofuels. The suitable biomass resources for the production of the different biofuels by regarding the biomass composition characteristics. Calculation of theoretical potential for the different biofuels from the different biomass resources. Estimation of practical biofuels yield from different biomass resources and explain the difference to the theoretical yield and the necessary mechanisms for increasing the yields.

Reference Books:

1. Caye Drapcho., John Nghiem., Terry Walker. Biofuels Engineering Process Technology, (2008), ((1st ed.)).
2. Alain Verts, Nasib Qureshi, Hideaki Yukawa, Hans P. Blaschek. Biomass to Biofuels: Strategies for Global Industries, (2010), ((1st ed.)).

Course Title: Metabolic and Cell Engineering

Course Code: CHE733

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

Metabolic and Cell engineering addresses issues related to understanding and manipulating cell structure-function relationships. This course is intended to be a bridge between cell biologists and engineers, to understand quantitatively cell biological aspects. Metabolic and Cell engineering is intrinsically connected to the new field of tissue engineering. Starting with an introduction to engineering principles and modeling at the cellular level of particular interest are cytomechanics, receptor/ligand binding, genetic engineering, enzyme kinetics, and metabolic pathway engineering.

Course Contents:

Basic cell biology and processes, Mechanics of cells and sub cellular elements (flow, hydrostatic pressure, tension, torsion, flexure, and combined loads), Receptors, ligands, and interactions, Gene transfer techniques and genetic engineering, Enzyme kinetics, Metabolic pathway engineering.

Reference Books:

1. Mohamed Al-Rubeaj. Cell Engineering, (1st ed.), (1999), Springer.
2. Mohamed Al-Rubeai. Cell Line Development (Cell Engineering), vol 6, (2009), Springer.
3. Michael R. King. Principles of Cellular Engineering: Understanding the Biomolecular Interface, (2005), Academic press.
4. Walter X. Balcavage., Michael B. Worrell., Thomas D. Hurley., James P. Hughes., Taihung Duong., Michael W. King., David A. Prentice., Gabi Nindl Waite., Lee R. Waite. Applied Cell and Molecular Biology for Engineers (2007), McGraw-Hill Professional.

Course Title: Manufacturing Practices for Bioprocesses

Course Code: CHE734

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

This course covers in-depth coverage of the development and implementation of manufacturing practices (GMPs) in the biotech industry. Topics include building and facilities, equipment design, utilities, in-process controls, records and adequate process validation.

Course Contents:

The purpose of this course is to train Chemical engineers for the quality assurance in bioprocess industries. It includes equipment, production and process control, microbiological, chemical and physical Safeties involved in bioprocess. The subject covers all the considerations to ensure the quality of the product.

Reference Books:

1. Michael L., Kargi., Fikret Shuler. Bioprocess Engineering: Basic Concepts ((2nd ed.)), (2001).

Course Title: Polymer Rheology

Course Code: CHE740

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

This course provides an overview of polymer rheology with emphasis on application to polymer processing. This course will cover the general methods for rheological characterization of liquid and solid polymers. The knowledge gained about rheological principles is then applied, together with standard conservation laws, to the analysis and derivation of basic models for several key polymer fabrication processes.

Course Contents:

Linear Elastic Solids, Basic forces: expansion/contraction, extension and shear, Stress tensors and deformations, Interrelationships between elastic moduli, Poisson's ratio, Thermodynamics of elasticity, Linear Viscous Fluids, Newtonian flow and simple shear, Measurement of viscosity: Capillary, Couette, cone/plate flow, Viscosity of suspensions and dilute polymer solutions, Viscosity of concentrated and undiluted polymers, Linear Viscoelasticity, Nature of the viscoelastic response, Creep, creep/recovery, and stress relaxation, Sinusoidal deformations and isochronal experiments, Tg and time-temperature superposition, Non-linear Effects

Reference Books:

1. Goodwin, James William, and Roy W. Hughes. Royal Society of Chemistry, (2008).
2. Hiemenz, Paul C., and Timothy P. Lodge. Polymer Chemistry. CRC press, (2007).
3. Young, Robert J., and Peter A. Lovell. Introduction to Polymers. CRC press, (2011).
4. Larson, Ronald G. The Structure and Rheology of Complex Fluids. Vol. 150. New York: Oxford university press, (1999).
5. Rudolph, Natalie, and Tim A. Osswald. Polymer Rheology: Fundamentals and Applications. Carl Hanser Verlag GmbH Co KG, (2014).

Course Title: Principles of Polymer Conversion Operations

Course Code: CHE741

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The objective of this course is to develop a better understanding in graduate students regarding all aspects of the current polymer compounding processes, plastics injection molding and product engineering. Additionally, this course would include deeper knowledge of polymers and polymer related processes. On successful completion of the course, students will be able to understand Principles of polymer compounding & processing, its effects on morphological structure and properties of manufactured plastic products. Material and process selection, product design for manufacturing, plastics conversion techniques, especially injection molding and in-mold plastics bonding

Course Contents:

Fundamentals of polymer processing, Introduction to polymer engineering, Compounding and processing of polymers, Structure and characterization of polymers, Processing of thermosets, Plastics and ecology, Business and management aspects of polymer processing, Essentials management and quality control (QC) techniques that are useful in polymer processing unit. Practical training on Injection Molding Machine will also be the part of course.

Reference Books:

1. D.W. Van Krevelan, Properties of Polymers, Correlation with Chemical Structure, Elsevier Amsterdam, (1990).
2. W.B. Billmeyer, Textbook of Polymer Science, (3rd ed.), (1984), Wiley.
3. S.L. Rosen, Fundamental Principles of Polymeric Materials, (1982), Wiley.
4. D.J. Williams, Polymer Science and Engineering, (1971), Prentice-Hall.
5. E.C. Bernhardt, Processing of Thermoplastic Materials, (1959), Reinhold.
6. Cheremisinoff, Nicholas P. Advanced Polymer Processing Operations. William Andrew, (1998).
7. Asua, José M., ed. Polymeric Dispersions: Principles and Applications. Vol. 335. Springer Science & Business Media, (2012).

Course Title: Polymer Membranes

Course Code: CHE742

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

This course will provides a comprehensive overview on the development of polymeric membranes having advanced functions in the various membrane separation processes for liquid and gaseous mixtures (gas separation, reverse osmosis, pervaporation, nanofiltration, ultrafiltration, microfiltration) and in other important applications of membranes such as biomaterials, catalysis (including fuel cell systems).

Course Contents:

The course will describe in detail membrane separation technology and wide range of applications e.g classification of membranes & process, Fabrication techniques, Transport Processes in membranes & their performance characterization, Thermodynamic considerations, Phase equilibria in polymer ternary systems, Morphology of membranes., Fouling of membrane, Gas separation process through membrane technology, Characteristic properties of membranes, Ion-Exchange Membranes, Heterogenous and homogenous membranes, Fluorocarbon membranes, Methods of testing

Reference Books:

1. S. Ramakrishna, Z. Ma., T. Matsuura, Polymer Membranes in Biotechnology: Preparation, Functionalization and Application, (2010), World Scientific Publishing co.
2. Xu, Zhi-Kang, Huang, Xiao-Jun, Wan, Ling-Shu, Surface Engineering of Polymer Membranes, (2009), Zhejiang University Press.
3. S. M. Javaid Zaidi, Takeshi Matsuura, Polymer Membranes for Fuel Cells, Springer Verlag, (2008).
4. B. D. Freeman, I. Pinnau, Polymer Membranes for Gas and Vapor Separation: Chemistry and Materials Science, (1999), ACS, Symposium Series.

Course Title: Sol-Gel Processing

Course Code: CHE743

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

Sol-Gel Processing is designed to Provide in-depth Knowledge of technique widely used in the fields of materials science and engineering and the methods used primarily for the fabrication of materials (typically a metal oxide) starting from a chemical solution (or sol) that acts as the precursor for an integrated network (or gel) of either discrete particles or network polymers.

Course Contents:

Introduction to Sol-Gel Processing, Chemistry of precursor's solutions, Sol-Gel process of silica Sol-gel process of complex oxides, Sol-gel process of hybrid materials, Sol-gel Process of Mesoporous Materials, Preparation of Stable Solutions, Organic-Inorganic Hybrid Systems, Applications as a Protective coatings, food industry, Thin films and fibres.

Reference Books:

1. Sumio Sakka. HandBook of Sol-gel Science and Technology: Processing Characterization and Applications Volume 1, (2004), Kluwer Academic Publishers.
2. A. C. Pierre. Intrduction to Sol-Gel Processing, (1998), Kluwer Academic Publisher.
3. C. J. Brinker., G. W. Scherer, Sol Gel Science, (1990), Academic Press.

Course Title: Membrane Science & Technology

Course Code: CHE744

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To provide a comprehensive overview on the development of membranes and membrane based separation technology for liquid and gaseous mixtures

Course Contents:

Introduction and history of Membranes and Membrane Separation Processes; Membrane Materials and their properties (organic and inorganics); Phase inversion in polymers; Phase inversion membranes (NIPS, TIPS, VIPS, etc.); Techniques for the fabrication of membranes; Characterization of Membranes; Transport Processes through membranes; Application of polymer membranes in different processes: gas separation, reverse osmosis, pervaporation, nanofiltration, ultrafiltration, microfiltration, pervaporation, fuel cell technologies, membrane bioreactors, membrane distillation, membrane dialysis; Challenges with application of membrane technology; Membrane Modules & Process Design.

Reference Books:

1. R. W. Baker, Membrane Technology and Applications, (2012), Third Edition, John Wiley and Sons Ltd.
2. Marcel Mulder, Basic Principles of Membrane Technology, (2nd ed.) Kluwer Academic Publications, (1996).
3. S. Ramakrishna, Z. Ma., T. Matsuura, Polymer Membranes in Biotechnology: Preparation, Functionalization and Application, (2010), World Scientific Publishing co.
4. Xu, Zhi-Kang, Huang, Xiao-Jun, Wan, Ling-Shu, Surface Engineering of Polymer Membranes, (2009), Zhejiang University Press.
5. B. D. Freeman, I. Pinnau, Polymer Membranes for Gas and Vapor Separation: Chemistry and Materials Science, (1999), ACS, Symposium Series.

Course Title: Textile Quality Assurance

Course Code: CHE750

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

Principles of quality control and assurance are inculcated using case studies. Emphasis is on global quality standards being implemented in the textiles & apparel industry. Analysis of products, comparison with standards and reporting of results are the key areas to improve a product or the process of manufacturing the product. Students will be able to understand the basics of producing a high quality product.

Course Contents:

Quality Assurance: Concepts (various definitions and approaches) used for quality, significance and applications of quality control. Difference in quality control and quality assurance, and their uses. Statistical techniques SPC, FMEA, and their influence on improving the quality of textile processes and products. Sampling and measuring methods used for determining fabric and yarn properties. Spinning Process Control: Raw material control, and its effects on process, on- line and off- line process controls, yarn clearing control. Weaving Process Control: Raw material control, on- line and off- line weaving process control, fault control. Making- up Process and Its Relation with Fabric Properties: Characteristics and faults of fabrics, AEIH Recommendations, Care labeling: types and use.

Reference Books:

1. Sara J. Kadolph, Quality Assurance for Textiles and Apparel, ((2nd ed.)), (2007) Textile Testing Solutions, SDL Atlas, (2005).

Course Title: Mechanics of Textiles

Course Code: CHE751

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

In this course, the students will study about the mechanics of engineering materials, including textile yarns and fabrics, plasticity of textile fibres, compression of textile materials, drape and hand of woven and knitted fabrics.

Course Contents:

Hierarchical mechanical dependency relationships in textiles are discussed. Included are the role of fiber and yarn twist, yarn crimp, finishes, and coatings to mechanical response of textiles. Dynamic and static response to various types of loading are investigated. Tearing, abrasion, and wear properties as a function of textile form are presented.

Reference Books:

1. Ferdinand Pierre Beer, Mechanics of Materials, (2008).
2. Jinlian Hu, Structure and mechanics of woven fabrics, (2004), Woodhead Publishing in Textiles.
3. A. Bogdanovich., C. Pastore. Mechanics of Textile and Laminated Composites, (1996).

Course Title: Advanced Yarn Engineering

Course Code: CHE752

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

In this course the students will study carding, drawing, combing, roving, ring spinning, woolen/worsted spinning systems, auto winding and yarn packing. In-depth study of ring spinning frame will be discussed in this course. Modern concepts related to drafting, twisting, and package formation on roving frame and ring spinning frame will be focused. Different effects of conditioning and environmental conditions will also be discussed in this course.

Course Contents:

Yarn Manufacturing: Production processes for continuous filament, staple, novelty, bulk and stretched yarns. Explanations and discussions of stress-strain properties of nylon, polyester, viscose, aramid, spandex, rayon, glass and metallic fibers. Fibre Blending: Blends, blending system, processing of blend and synthetic staple fibers into yarn. Blending of cotton with man-made fibers. PET Production Equipment: Equipment used for the production of polyester fibers, starting from the PET chips- study of equipment and material, and their effects on process. Manufactured Fibers (Synthetic Fibers): Manufacturing process (brief), properties and application (uses) of Viscose Rayon, Lyocell, Polyamide, Acrylic.

Reference Books:

1. Brearley., Iredale. The Woolen & Worsted Industry, (2003).
2. Gilbert R. Merrill, Manual of Cotton Spinning, (1999).
3. Eric Oxtoby, Spun Yarn Technology, (1987).

Course Title: Fiber Forming Polymers

Course Code: CHE753

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

Upon successful completion of the course students are expected to comprehend the theory of synthetic macromolecule along with their synthesis and characterization. Apply the procedures and control of fiber production, analyze structures, processes and techniques of polymer optimization and quality assurance.

Course Contents:

Introduction and basic concepts, polymer processing methods, synthetic textile fibers, Classification of polymers, Basic polymerization reactions, Natural polymers (cellulose and keratin), Synthetic polymers (polyamides, polyacrylonitriles, polyesters), fiber production, Synthesis, structure, morphology, stereochemistry, properties, spinning and dyeing of textile polymers, Textile polymer materials, modern polymer fibers, production methods, general characteristics, dyeing applications of textile polymers, properties, uses. Multiblock copolymers, synthesis, yarn production, molecular characterization, morphology, properties. Molecular weights determination by size exclusion chromatography (SEC), traditional natural polymer fibers and modern textile synthetic polymers, viscosity measurements in solution, membrane osmometry (MO), light scattering. UV–Visible and Infrared spectroscopies for textile fiber recognition, Colorimetric determination of polymer concentration, influence of concentration on the quality of textile fibers, X-ray diffraction (XRD), polymer crystallization, Differential Scanning Calorimetry (DSC), Electron microscopy (SEM, TEM) for studying of textile fibers morphology, Melting, glass transition temperature, crystallinity and mechanical properties of fibers, designing of the products with improved features, develop techniques of filling, plasticizing and coating, Fillers, plasticizers. Polymeric coatings, identification of textile fibers by ASTM

Reference Books:

1. J. M. G. Cowie, Polymers: Chemistry and Physics of Modern Materials, ((2nd ed.)), Blackie Academic and Professional, (1994).
2. John W. S. Hearle., W. E. Morton. Physical Properties of Textile Fibres, (2008).
3. R. A. Charvat, Coloring of Plastics: Fundamentals, John Wiley and Sons, (2003).

Course Title: Scientific Communication for Engineering Research

Course Code: CHE760

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The primary objective of this course is to equip students with essential skills for scientific research writing and effective presentation. By the end of the course, students will develop a structured approach to writing synopses, theses, and research articles. Learn to communicate complex ideas clearly and concisely through written and verbal means. Gain proficiency in preparing and delivering impactful scientific presentations. Understand the conventions of scholarly writing and publishing in engineering disciplines. Understand and apply academic writing conventions, including proper citation and referencing. Master referencing techniques and ethical practices, including avoiding plagiarism in engineering research.

Course Contents:

Introduction to Engineering Research Writing: Importance of precision, clarity, and objectivity in technical writing. Common challenges in engineering research documentation. Role of communication in the research process. Fundamentals of Academic Writing for Engineers: Developing clear and concise technical sentences. Incorporating domain-specific terminology and addressing common errors in engineering writing. Communicating technical concepts effectively to diverse audiences. Drafting a Synopsis for Engineering Projects: The purpose and structure of a technical synopsis are as follows: outlining objectives, problem statements, methodology, and anticipated results. Crafting a synopsis for written and oral presentations. Writing Engineering Theses: Key sections: abstract, introduction, literature review, experimental setup, results, discussions, and conclusions. Presentation of technical diagrams, data, and references following engineering standards. Strategies for presenting thesis findings during oral defenses and reviews. Composing Research Articles in Engineering: Guidelines for drafting abstracts, problem definitions, and results discussions. Preparing technical figures, tables, and charts for journal publications. Aligning with editorial requirements of high-impact engineering journals. Preparing research highlights and graphical abstracts for effective communication. Citations and Referencing in Engineering Research: Overview of referencing styles (IEEE, APA, etc.) used in engineering research. Tools for managing citations and ensuring accuracy. Ethical communication of references and ideas. Peer Review and Manuscript Improvement: Insights into the peer review process in engineering journals. Techniques for self-editing and enhancing technical drafts for publication. Communicating with reviewers and responding to feedback constructively. Technical Communication and Presentation Skills: Preparing and delivering effective technical presentations. Designing impactful slides with a focus on clarity and visual appeal. Communicating complex technical ideas to technical and non-technical audiences. Enhancing verbal and non-verbal communication for research presentations.

Reference Books:

1. Finkelstein, L., Aune, J. E., & Potter, L. A. (2022). **Technical writing for engineers & scientists** (4th ed.). McGraw-Hill.

2. Martin, T. P. (2022). **Technical writing for engineers who don't like to write: A straightforward guide written by an engineer for engineers**. Kitz Press.
3. Glasman-Deal, H. (2020). **Science research writing for non-native speakers of English** (2nd ed.). World Scientific.
4. Belcher, W. L. (2019). **Writing your journal article in twelve weeks: A guide to academic publishing success** (2nd ed.). University of Chicago Press.
5. Alley, M. (2018). **The craft of scientific writing** (4th ed.). Springer.
6. Day, R. A., & Gastel, B. (2016). **How to write and publish a scientific paper** (8th ed.). Cambridge University Press.
7. Swales, J. M., & Feak, C. B. (2012). **Academic writing for graduate students: Essential tasks and skills** (3rd ed.). University of Michigan Press.

Course Title: Advanced Research Methods

Course Code: CHE805

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The course aims to foster critical thinking and analytical skills for the evaluation of existing research methodologies while encouraging students to propose improvements. Additionally, students will develop expertise in experimental design and optimization, exploring connections between chemical engineering and other disciplines through an interdisciplinary lens. Ethical conduct in research will be emphasized throughout the course, promoting responsible and transparent practices.

Course Contents:

Advanced Research Methods: overview of the research process, literature review and critical analysis, formulating research questions and hypotheses. Research Design and Planning: experimental design principles, statistical methods for data analysis, simulation techniques in chemical engineering research. Interdisciplinary Perspectives: integration of knowledge from other scientific disciplines, collaborative research approaches. Advanced Measurement Techniques: instrumentation and measurement methods, analytical techniques in chemical engineering. Ethical Considerations in Research: responsible conduct of research, publication ethics and plagiarism prevention. Data Analysis and Interpretation: advanced statistical tools, computational methods for data interpretation. Communication of Research Findings: effective scientific writing, presentation skills and conference participation.

Reference Books:

1. Bordens, K.S., and Abbott, B.B., Research Design and Methods: A Process Approach, McGraw Hill, 2022.
2. Creswell, J.W., and Creswell, J.D., Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE Publications, 2018.
3. Durivage, M.A., Practical Design of Experiments (DOE): A Guide for Optimizing Designs and Processes, ASQ Quality Press, 2016.

Course Title: Advanced Instruments and Analytical Techniques

Course Code: CHE806

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

By the end of this course, students should possess a profound mastery of advanced instruments and analytical techniques, positioning them as adept researchers capable of advancing the frontiers of chemical engineering through sophisticated experimentation and analysis.

Course Contents:

Advanced analytical techniques: overview of modern analytical instruments; importance of analytical techniques in chemical engineering research, historical development, and recent trends in instrumentation. Spectroscopic techniques: UV-visible spectroscopy; principles and applications, instrumentation and experimental techniques, data interpretation and analysis, Infrared (IR) spectroscopy; molecular vibrations and absorption bands, FT-IR spectroscopy, applications in chemical engineering, nuclear magnetic resonance (NMR) spectroscopy; basic principles, types of NMR instruments, applications in chemical structure determination. Chromatographic techniques: gas chromatography (GC); principles and instrumentation, column selection and optimization, applications in chemical analysis, liquid chromatography (LC); types of liquid chromatography, high-performance liquid chromatography (HPLC), applications and method development. Mass spectrometry: fundamentals; ionization techniques, mass analyzers, detection and data interpretation, applications in Chemical Engineering. Atomic spectroscopy: inductively coupled plasma (ICP) spectroscopy, atomic absorption spectroscopy (AAS), x-ray fluorescence (XRF). Electrochemical techniques: potentiometry, cyclic voltammetry, applications in chemical sensing. Data analysis and interpretation: statistical methods in analytical chemistry, chemometrics and data processing, software tools for data analysis. Integration of techniques in research: case studies and practical applications.

Reference Books:

1. Robinson, J.W., Frame, E.M.S., and Frame, G.M., Instrumental Analytical Chemistry: An Introduction, CRC Press, 2021.
2. Pandian, P.S., Analytical Chemistry: An Introduction, New India Publishing Agency, 2021.
3. Skoog, D.A., Holler, F.J., and Crouch, S.R., Principles of Instrumental Analysis, Cengage Learning, 2018.

Course Title: Natural Gas Processing

Course Code: CHE810

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

Transport of natural gas by pipelines to distant delivery points presents unique challenges of flow through long conduits. Furthermore, the processing of the gas to meet delivery specifications requires process systems design. This course is to equip graduates students with sufficient technical details to enable them to address above mention issues relating to the natural gas processing and transmission.

Course Contents:

Acid Gas Treating: Acid Gas Removal Processes; Sulphur Recovery Processes. Natural Gas Compression: Compressor Selection; Thermodynamics of Gas Compression; Compression Ratio; Compression Design; Compressor Control. Natural Gas Dehydration: Water Content Determination; Glycol Dehydration; Solid Desiccant Dehydration. Natural Gas Liquid Recovery: Recovery Processes; Fractionation; Gasoline and LPG Treating. Sales Gas Transmission: Gas Flow Fundamentals; Predicting Gas Temperature Profile; Compressor Stations and Associated Pipeline; Design Consideration of Sales Gas Pipelines; Pipeline Operations.

Reference Books:

1. Shashi Menon, Gas Pipeline Hydraulics, (2005), Taylor & Francis.
2. B.E. Poling, J.M. Prausnitz The Properties of Gases and Liquids, (2001), McGraw Hill, New York.
3. R.V. Smith Practical Natural Gas Engineering, (2nd ed.), (1990), Pennwell.
4. A.L. Kohl and F.C. Risenfeld Gas Purification, (1985), Gulf Professional Publishing.
5. R.N. Maddox, J.H. Erbar, Gas Conditioning and Processing Advanced Techniques and Applications, (1982) Campbell Petroleum, Series.

Course Title: Petroleum Processing

Course Code: CHE811

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

Petroleum processing to meet customer specifications requires process systems' design. This course is to equip graduate students with in depth technical details that would enable them to address above mentioned issues relating to state of the art petroleum processing.

Course Contents:

Petroleum Origin and Composition; Sources; Basic Concepts of Petroleum Processing, Separations, Refining, Multi-Stage Separation with a review of modern day environmental impact; Design, operation, catalytic and reaction routes, Off site utilities, refinery planning, process revamping, Crude oil assays and optimizing process configuration.

Reference Books:

1. D.S.Jones, Peter R. Pujado Handbook of petroleum processing, (2006) Springer.
2. James H. Gary Petroleum refining: Technology and Economics, By Glenn E., Third Edition, (2001), CRC Press.
3. J.G Speight, Baki Ozum Petroleum Refining Processes, (2002), CRC Press.
4. Sergiu D, Raseev Thermal and Catalytic Processes in Petroleum Refining, (2003) CRC Press.

Course Title: Separation Processes for Bio-Chemical Products

Course Code: CHE830

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

This course serves as an introduction to the fundamental principles of separation operations for the recovery of products from biological processes, membrane filtration, chromatography, centrifugation, cell disruption, extraction, and process design. Characterization of biological fluids.

Course Contents:

This course involves the application of Chemical Engineering principles and approaches to biologically-based systems and processes. It is central to the area of biotechnology processes that produce pharmaceuticals, fine chemicals and genetically engineered products. It will be expected that students develop an understanding of the science and engineering principles underlying modern industrial practices in downstream processing for biochemical product recovery.

Reference Books:

1. Phillip C. Wankat, Separation Process Engineering (2009), ((2nd ed.)), CRC Press.
2. Shuler, ML and F Kargi, Engineering: Basic Concepts-.Bioprocess (1992), MacGraw Hill.
3. Shutte, H., and M. R. Kula, Cell Disruption and Isolation of Non-Secreted Products, (1996), Springer.

Course Title: Bio-Molecular Kinetics and Cellular Dynamics

Course Code: CHE831

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

Application of bimolecular interactions on various biological problems focused on their complicated kinetics and their dynamics.

Course Contents:

This subject addresses in depth knowledge with kinetic and equilibrium mathematical models of bio-molecular interactions, as well as the application of these quantitative analyses to biological problems across a wide range of levels of organization, from individual molecular interactions to populations of cells.

Reference Books:

1. Shargel, Leon, et al., Applied Biopharmaceutics and Pharmacokinetics, (2004), New York, NY: McGraw-Hill Professional Publishing.
2. Hammes, Gordon G., Thermodynamics and Kinetics for the Biological Sciences. Hoboken, (2000), NJ: John Wiley and Sons.
3. Strogatz, Steven H., Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering (2000), Cambridge, MA: Perseus Publishing.

Course Title: Bio-Nanotechnology

Course Code: CHE832

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The objective of this course is to teach the basic principles behind the fabrication, characterization, and utilization of biologically-derived materials ordered at the nanoscale.

Course Contents:

This course is design to give an Introduction to biofabrication and bioengineering as applied to nanoscience and nanoengineering. Biological nanostructures, bioelectronics, and biophysics. Basic biochemistry. Bioconjugation and characterization of biological systems on surfaces and nanoscale materials. Biological synthesis of inorganic nanocrystals

Reference Books:

1. Christof M. Niemeyer Editor, Chad A. Mirkin, Nanobiotechnology: Concepts, Applications and Perspectives, ((1st ed.)), (2004), Princeton Home.
2. Chad A. Mirkin, Christof M. Niemeyer, Nanobiotechnology II: More Concepts and Applications, ((1st ed.)), (2007), McGraw Hill.

Course Title: Bio-Mimetic Engineering

Course Code: CHE833

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The course is design to focus on methods and materials that exist in nature and those that were inspired by natural processes or organisms. It is designed to provide students with an introduction to biological materials, methods, mechanisms, and organizational principles, as they exist in nature. It will also cover the man-made technologies and engineering advancements that have been inspired by or created to mimic biology

Course Contents:

The purpose of this course is to study of nature's solutions to specific problems with the aim of determining appropriate engineering analogs. Morphology, scaling, and design in organisms applied to engineering structures. Mechanical principles in nature and their application to engineering devices. Mechanical behavior of biological materials as governed by underlying microstructure, with the potential for synthesis into engineered materials.

Reference Books:

1. Stephen Mann, J. Webb, Robert J.P. Williams, Biomineralization: Chemical and Biochemical Perspectives, (1989), McGraw Hill.
2. Yoseph Bar-Cohen Biomimetics: Nature Based Innovation Biomimetics Series, ((1st ed.)), (2011), CRC Publisher.

Course Title: Polymer Processing

Course Code: CHE840

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The objective of the course is to provide knowledge about the polymer processing operations. The principles will be illustrated by focusing on some of the important thermoplastic polymer processing operations, with realistic examples.

Course Contents:

Introduction of polymer processing, Principles of mixing and its limitations, properties of polymer melt, Processing Techniques Extrusion, Classification of extruders, Machine parts for single screw extrusion, Specialities of double screw extrusion, Technological principles in extruders, Melting process, Metering and pressure built-up, Extrusion technologies coextrusion of multilayered films, Injection Molding Machine, Machine parts for injection molding, Molds, Technology of injection molding, Rapid Prototyping technologies, Rubber processing, Calendaring, Blow molding

Reference Books:

1. Tim A. Osswald, Understanding Polymer Processing: Processes and Governing Equations Carl Hanser Verlag GmbH & Company KG, (2018).
2. By Z.Tadmor, C. G. Gogos, Principles of Polymer Processing Wiley Interscience (2013).
3. Walter Michaeli, Plastics Processing: An Introduction, (1995), Hanser Publishers.
4. Manas Chanda, Plastics Technology Handbook, (2006), (4th ed.), CRC Press.

Course Title: Conductive Polymers

Course Code: CHE841

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The main focus of this course is to enable the students to understand the basic concepts of conducting polymers and their conduction mechanism, methods of synthesis and characterization of conducting polymers along with their applications.

Course Contents:

Introduction to conducting polymers, discovery of polyacetylene , concept of doping and n-type polarons and bipolarons, conduction mechanism, redox type polymers (electroactive polymers), Synthesis of conducting polymers, Chemical synthesis, electrochemical synthesis, template synthesis, precursor synthesis, soluble polymers (colloids and dispersions), advantages and disadvantages of various synthesis methods, Characterization methods: elemental analysis for dopant, Infra-Red, UV (electro chemical) scanning electro microscopy (SEM), electro chemical characterization, cyclic voltometry electro chemical quartz crystal microbalance (EQCM), probe beam deflection (PBD) and conductive fillers.

Reference Books:

1. Peter R. Teasdale, Leon A. P. Kane-Maguire, Gordon G. Wallace, and Geoffrey M. Spinks, Conductive Electroactive Polymers.
2. T.Asaka, S. Komabe and T. Momma, Conductive Polymers.
3. Conducting Polymers, Fundamentals and Applications, by Prasanna. Chandrasekhar - (1999), ISBN: 9780792385646.
4. Handbook of conducting polymers (1st, 2nd and (3rd ed.)itions) ISBN: 9781574446654.

Course Title: Rheology of Complex Fluids

Course Code: CHE842

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The basic concept of this course is to enable the students to address industrial need for rheological measurement and understanding, this course is relevant to the students who not only use rheometers but more importantly have to understand and interpret data for quality assurance, improvement of processes and development of new product formulations.

Course Contents:

Introduction , Non-Newtonian Fluids, Fundamentals of Rheology, Mechanics of Liquid Mixtures, Rheology, Oscillatory Shear Rheology for Probing Nonlinear Viscoelasticity of Complex Fluids: Large Amplitude Oscillatory Shear, An Introduction to Hydrodynamic Stability, Applications, Statics and Dynamics of Dilute Polymer Solutions, Polymer Rheology.

Reference Books:

1. J. Murali Krishnan; Abhijit Deshpande, Rheology of Complex Fluids, (2010), Springer Verlag, McGraw Hill.
2. Ronald G. Larson, The Structure and Rheology of Complex Fluids Topics in Chemical Engineering, (1998), Oxford University Press.
3. John M. Dealy, Ronald G. Larson, Structure and rheology of molten polymers from structure to flow behavior and back again, (2006), Hanser Gardner Publications.

Course Title: Polymer Nanocomposites

Course Code: CHE843

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The synthesis of polymer nanocomposites is an integral aspect of polymer nanotechnology. The basic objective of this course is to give an in-depth Knowledge to the student about the synthesis of different polymer nanocomposites with organic and inorganic materials and the characterization of these nanocomposites to investigate the improvement in their properties.

Course Contents:

Introduction to polymeric materials and their classification. Need of Blends, Composites and Nanocomposites. Applications and production methods for nanocomposites., Polymer Nanocomposites Based on Layered Silicates, Polymer Nanocomposites Based on Carbon Nanotubes and Nano fibers, Polymer Nanocomposites Based on Inorganic Nanoparticles, Applications of Polymer Nanocomposites, Manufacturing/Synthesis of different Nano fillers. Testing and Characterization of nanocomposites.

Reference Books:

1. Jawaid, M., Qaiss, A., and Bouhfid, R., Nanoclay reinforced polymer composites, (2016), Spriner.
2. Ajayan, P. M., Schadler, L. S., and Braun, P. V., Nanocomposite science and technology, (2006), John Wiley & Sons.
3. Gao, F., Advances in polymer nanocomposites: types and applications, (2012), Elsevier.

Course Title: Characterization of Fibrous Materials

Course Code: CHE850

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

In this course, the students will study in detail the microscopic and sub-microscopic structure, mechanical, chemical, electrical, thermal and optical properties of textile fibres.

Course Contents:

Chemical nature, structure; mechanical, electrical, and thermal properties; viscoelastic properties, use of instrumentation with computer-controlled data acquisition; IR, RAMAN, and molecular spectroscopies; SEM; and creep/stress relaxation. The physical and mechanical testing of fibers, yarns and fabrics are studied, along with the static and dynamic load response of textiles

Reference Books:

1. John W. S. Hearle and W. E. Morton, Physical Properties of Textile Fibres CRC Press.
2. Steven B. Warner, Fibre Science, (1994), Springer.

Course Title: Advanced Textile Composites

Course Code: CHE851

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

Develop knowledge of textile Composite materials - what are they and how do they differ from other classes of materials

Course Contents:

The objectives of this course will be to expose the student to the textile materials and processes used in composite applications and to introduce methods of analyzing and predicting the behavior of the resultant products. Fiber architecture of textiles used for composites is reviewed along with manufacturing processes. Tools for predicting elastic properties will be introduced along with the relationship of elastic properties and geometric considerations.

Reference Books:

1. William D. Callister, Material Science & Engineering, (2009), McGraw Hill.
2. Schwartz, Composite Hand Book, (1992), McGraw Hill.

Course Title: Colour Physics and Measurement

Course Code: CHE852

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

In this course the students study fundamentals of color perception, description, notation, communication and measurement. The course covers topics such as elements of color perception, standard illuminants, specification of color, Munsell system, CIELAB system, color difference, pass/fail system, shade sorting, strength analysis of dyes from solution, relative dye strength and tone analysis, assessment of whiteness and degree of yellowness, anatomy of color measuring instruments, and principles of computer color matching.

Course Contents:

Light sources and light interactions, photo physics, photo chemistry and light fastness, colour-order system, colour spaces and differences, textile recipe prediction. Colour Measuring Instruments and measurement of textile substrates: Spectrophotometer and colorimetry. Kubelka and Monk expression for colour strength (K/S) assessment. Colour Assessment Systems: CIE standard illuminants and system, CIE Lab, CMC Formula, Colour Order System, Colour Scales, Colour Spaces

Reference Books:

1. A.D. Sule, Computer Colour Analysis, (2002), McGraw Hill.
2. James Park Instrumental Color Formulation, (1993), Book Intl Publishers.
3. F.W. Culolow, Colour and its Application, (1972), McGraw Hill.
4. H.D. Murray Colour in Theory and Practice, (1952), Oxford Press Publishers.

Course Title: Advanced Finishing Processes

Course Code: CHE853

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

In this course, the students will study the classification, rationale, principles, mechanisms, and methods of different mechanical and chemical finishing processes. The students will cover finishes like chemical softening, hand-building finishes, drying and setting, easy-care finishes, water- and oil- repellent finishes, flame retardant finishes, soil release finishes, anti-static finishes, UV protection finishes, antimicrobial finishes, finishes for color fastness improvement, calendaring, emerizing, raising, compressive shrinkage, bio-polishing and other novel finishes.

Course Contents:

Spectrum of Finishing Processes and Requirements for water in the processes. Principal chemicals, auxiliaries and their effects on the finishing processes. Formulation composition, physical conditions and their effects on the process-end-results. Details (formulation and processing method) for the following processes: Water- proofing, flame- proofing, antiseptics, oil- repellancy, soil- release finishing, softening of textiles, bluing (OBA treatments). Quality Control: Quality control tests for finishing processes and the chemical used. Quality control tests for the finished textile products.

Reference Books:

1. Derek Heywood, Textile Finishing, Society of Dyers and Colorists, (2003), McGraw Hill.
2. W. D. Schindler, P. J. Hauser, Chemical Finishing of Textiles, (2004), Wood head.Publishing.

Course Title: Advanced Energy Engineering

Course Code: ENE714

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

This course aims to provide an understanding of energy engineering including its principles, associated environmental, health and safety issues and the structure and management of energy sectors in Pakistan.

Course Contents:

Introduction to energy engineering; energy production, processing, utilization, conservation and the associated environmental, health and safety issues. Energy resources in Pakistan. Energy available from renewable sources. Structure and management of energy sectors in Pakistan; electricity sector and natural gas sector. Principles of energy engineering. Thermodynamics; first law & its application, second law & its application, Irreversibility & energy and basic power generation cycles. Fluid Mechanics; stress-strain relations & viscosity, mass & momentum balance and flow through pipe. Heat Transfer; conduction, radiation and convective heat transfer. Energy supply systems. Energy storage. Trends and impacts of energy use in transport, buildings, appliances and manufacturing systems. Smarter heating and efficient electricity usage in Pakistan. Future energy plans for Pakistan.

Reference Books:

1. Kopanos, G. M., Pei, L. and Georgiadis, M. C. Advances in Energy Systems Engineering. Springer International Publishing, (2017).
2. Sørensen, B.E. Renewable energy: physics, engineering, environmental impacts, economy & planning. (4th ed.) Elsevier Academic Press, (2011).
3. Kalogirou, S.A. Solar Energy Engineering: Processes and Systems. (1st ed.) British Library, (2009).
4. Viswanathan, B. and Scibioh, M.A. Fuel Cells: Principles and Applications. Taylor & Francis Group, (2007).
5. Boyle, G., Everett, B. and Ramage, J. Energy Systems and Sustainability. OUP and Open University, (2004).
6. Scheer, H. A Solar Manifesto. James & James, (2004).

Course Title: Waste to Energy

Course Code: ENE715

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

This course intends to develop the understanding of waste to energy processes and the skills required for the indigenous design of processes. It also explores the environmental and social benefits of waste to energy processes.

Course Contents:

Introduction to “Waste to Energy”. Types of wastes, properties & analysis; agro residues, industrial waste and municipal waste. Waste to energy processes; biochemical processes, thermal processes, chemical processes, thermochemical processes, their design and exergy analysis. Biochemical processes; aerobic digestion and anaerobic digestion. Thermochemical processes; gasification, pyrolysis and liquefaction. Waste incubators. Briquetting; utilization and advantages of briquetting. Waste to energy systems for district heating. Environmental & social benefits of waste to energy conversion.

Reference Books:

1. Reddy, P.J. Energy Recovery from Municipal Solid Waste by Thermal Conversion Technologies. CRC Press, (2016).
2. Castaldi, M and Klinghoffer, N. Waste to Energy Conversion Technology. Woodhead Publishing, (2013).
3. Rogoff, M.J. and Screve, F. Waste-to-Energy: Technologies and Project Implementation. (2nd ed.) William Andrew, (2011).
4. Hall, D.O. and Overeed, R.P. Biomass – Regenerable Energy. New York: John Willy and Sons Ltd., (1987).
5. EL-Halwagi, M.M. Biogas Technology- Transfer and Diffusion. New York: Elsevier Applied science Publisher, (1984).

Course Title: Energy and Environmental Policies

Course Code: ENE731

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

This course aims to provide an understanding of the mounting concerns regarding energy use and its impact upon the environment. The course also emphasizes the life cycle assessment, environmental impact assessment and energy markets.

Course Contents:

Environmental laws and regulations. Life cycle assessment. Environmental impact assessment. Introduction to environmental economics. Economic policies for environmental regulation. Introduction to energy codes and policies; energy conservation act, solar policy, hydro policy, biomass policy. Global and local energy demand/supply; the oil market, the gas market, the coal market. Climate change and economic growth. The Kyoto protocol. The Paris agreement. Energy policies and market structures: how energy markets are affected from policies and government regulation. Relations between key environmental and energy policy related factors.

Reference Books:

1. Rosenbaum, W.A. Environmental Politics and Policy.(8th ed.) Washington D.C: CQ Press, (2015).
2. Percival, R.V., Schroeder, C.H., Miller, A.S. and Leape, J.P. Environmental regulation: Law, science and policy. Wolters Kluwer Law & Business, (2013).
3. Victor, D.G. Global warming gridlock. (3rd ed.) Cambridge: Cambridge university press, (2011).
4. Burke, G., Singh, B.R. and Theodore, L. Handbook of environmental management and technology. (2nd ed.) John Wiley & Sons Inc., (2005).
5. Lenschow, A. Environmental policy integration: Greening sectoral policies in Europe. Routledge, (2002).

Course Title: Special Topics in Energy and Environment

Course Code: ENE732

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To develop awareness and indulge in specific research activities To develop strong industry-academia linkage

Course Contents:

A series of lectures by renowned researchers in the field and by Industrial experts shall be conducted. It is an attend only course with either Pass or Fail grading status as per attendance rules and regulations of CIIT. There shall be field trips, research projects, presentations and report writing. List of journals, experts and speakers shall be finalized by the graduate research committee. Details of Courses

Course Title: Process Integration

Course Code: PSE702

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

This course aims to provide an understanding of process integration (PI) with regard to energy efficiency, waste minimization and an efficient use of raw materials to communicate the principles of PI, provide recommendations for process design and implementation, and to apply these principles and recommendations to PI processes/problems.

Course Contents:

Introduction: Introduction to Process Integration, Importance of Process Integration and applications in Chemical Industries, Overview of Process Integration. Heat Exchanger Networking: Hot Composite Curve, Cold Composite Curve, Problem Table Algorithm, Grand Composite Curve (GCC), Area Targeting by Uniform Bath formula and Unit Targeting by Eulers' formula, Heuristics for Pinch Design, Maximum Energy Recovery Design, Evolution of Network. Reactor Integration: Choice of Idealized reactor model and reactor performance. Reactor configurations; Temperature Control, Gas-Liquid and Liquid-Liquid Reactors, Choice of Reactors. Heat Integration characteristics of reactors, Appropriate placements of reactors. Use of GCC for Heat Integration of reactors. Distillation Integration: Distillation sequencing, Heat Integration characteristics of Distillation column, appropriate placement of distillation column, various configurations for heat integration of distillation column. Mass Exchanger Network Synthesis: Mass Exchanger Network, Minimum Mass Separating Agents (MSA), Mass exchange networks for minimum external MSA. Minimum Number of Mass Exchangers.

Reference Books:

1. Mahmoud M. El-Halwagi, Process Integration, ((1st ed.)), Academic Press, (2006).
2. Robin Smith, Chemical Process Design and Integration, John Wiley and Sons. Ltd., New Delhi, (2005).
3. Warren D. Seider, J. D. Seader and Daniel R Lewin, Product & Process Design Principles, ((2nd ed.)), John Wiley and Sons. Ltd. (2004), ISBN 0-471-21663-1.
4. Uday V. Shenoy, Heat Exchanger Network Synthesis: Process Optimization by Energy and Resource Analysis, Gulf Publication, (1995).

Course Title: Process Design and Optimization

Course Code: PSE720

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

This course aims to provide an understanding of the technology available to design and optimize process systems, business models and operations with state-of-the-art versions of modelling and optimization approaches in order to understand both the potential and the limitations of available techniques.

Course Contents:

System characterization: Identification of objectives, design variables, constraints, subsystems, System-level coupling and interactions, Examples of MSDO in practice, Visualization techniques in design optimization. Subsystem model development: Model partitioning and decomposition, interface control, Collaborative Optimization, Bi-Level Formulations, Subsystem model selection: fidelity versus expense, Model and simulation development and validation. Optimization and exploration techniques: Review of linear and nonlinear programming, Heuristic techniques: genetic algorithms simulated annealing, Tabu search, Design of Experiments (DOE): Full factorial search, parameter study, Taguchi/orthogonal arrays, latin hypercubes, Mixed integer programming (application to hub spoke / network problems). Sensitivity and post-optimality analysis: Jacobian matrix, Hessian, finite differences, Adjoint methods and Lagrange multipliers. Multiobjective optimization: Weighted sum optimization, Weak and strong dominance, Pareto front computation, Goal programming and isoperformance, Physical Programming, Multiattribute Utility Theory. System assessment and extensions: optimality, Design for value: including lifecycle costing, Optimizing product families and platforms. Implementation issues: Model reduction, Approximation techniques: response surfaces, kriging, neural networks, Concurrent design

1. Reference Books:

1. Biegler, Grossmann and Westerberg, Systematic Methods for Chemical Process Design (Part II), Prentice Hall, (1997).
2. Panos Y. Papalambros and Douglass J. Wilde, Principles of Optimal Design – Modeling and Computation, ((2nd ed.)), , Cambridge University Press, (2000), ISBN 0 521 62727 3.
3. R. E. Steuer. Multiple Criteria Optimization: Theory, Computation and Application. Wiley, New York, (1986).
4. David E. Goldberg, Genetic Algorithms – in Search, Optimization & Machine Learning, Addison –Wesley, (1989), ISBN 0 201 15767-5.
5. Bazaraa, M.S., H.D. Sherali and C.M. Shetty, Nonlinear Programming, John Wiley (1992).
6. Edgar, T.F. and D.M. Himmelblau, Optimization of Chemical Processes, McGraw Hill (2001).
7. Hillier, F.S. and G.J. Lieberman, Introduction to Operations Research, Holden Day (1986).
8. Minoux, M., Mathematical Programming: Theory and Algorithms, John Wiley (1986).
9. Reklaitis, G.V., A. Ravindran and K.M. Ragsdell, Engineering Optimization - Methods and Applications, John Wiley (1983).
10. Williams, H.P., Model Building in Mathematical Programming, Wiley-Interscience (1978).
11. Westerberg, A.W., H.P. Hutchinson, R.L. Motard, P. Winter, Process Flowsheeting,

Cambridge University Press (1985).

Course Title: Process Modeling and Simulation

Course Code: PSE731

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

This course provides an overview of modeling and simulation techniques and addresses the role of modeling and simulation in the systems engineering process and provides methods for architecting and managing the development of complex models/simulations. The course introduces students to important design considerations for the development of complex distributed software simulations and frameworks.

Course Contents:

Introduction: Definitions of Modeling and Simulation, Modeling and simulation techniques, Applications, Discrete vs. Continuous time, Process flow in simulation study. Queuing systems, Communications networks, Event-driven simulation, List processing. Simulation software: Selection process, Simulation in High Level Language (C, C++), Simulation packages (Matlab/Simulink/Hysys), Interpreted vs. compiled simulators. Statistical models: Useful Statistical Models, Distributions, Queuing models,. Characteristics, Performance Measures, Steady-State Behavior, Networks of Queues. Random Number Generation: Properties of Random Numbers, Generation of Pseudo-Random Numbers, Testing for Randomness, Pitfalls, Random Variate Generation, Inverse Transform, Direct Transform, Convolution, Accept-Reject. Input Modeling: Data Distributions, Histograms, Parameter Estimation, Goodness-of-Fit, Selecting Input Model without Data. Verification and Validation of Simulation Models: Model Building, Verification of Simulation Models, Calibration and Validation of Models. Output Analysis: Types of Simulations with Respect to Output Analysis, Stochastic Nature of Output Data, Measures of Performance, Output Analysis for Termination Simulations, Output Analysis for Steady-State Simulations.

Reference Books:

1. Law M, Kelton W, Simulation Modeling and Analysis. McGraw-Hill, New York, NY, (2000).
2. Madachy R. Software Process Dynamics, Wiley/IEEE Press, (2007).
3. B. Wayne Bequette, Process Dynamics: Modeling, Analysis and Simulation, Prentice Hall, NJ, (1998).
4. W.Fred Ramirez, Computational Methods for Process Simulation, ((2nd ed.)), Betterworthus and Heinemann, Oxford, (1997).
5. Khoshnevis B, Systems Simulation - Implementations in EZSIM. McGraw-Hill, New York, NY, (1992).
6. William L. Luyben, Process Modeling Simulation and Control for Chemical Engineers, ((2nd ed.)), , McGraw Hill, (1990).
7. Westerberg, A.W., H.P. Hutchinson, R.L. Motard, P. Winter, Process Flowsheeting, Cambridge University Press (1985).

Course Title: Artificial Neural Network

Course Code: PSE732

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

This Course aims to provide a theoretical and highly rigorous treatment of machine learning, Artificial Neural Networks (ANN) including single and multi-layer, fully-connected perceptions with simplified error analysis and backpropagation, starting at the most fundamental level. The course will also teach students about industrial and academic applications of neural networks and how to recognize tasks that ANN are suitable for.

Course Contents:

Introduction to ANN, Basics of ANN, Backpropagation networks (BPN, Activation & Synaptic Dynamics, Basic functional units of ANN for pattern recognition tasks, Feedforward neural networks, Feed back neural networks, Competitive learning neural networks, Applications of ANN in industrial processes, MATLAB programming for ANN problems.

Reference Books:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach (((3rd ed.))), Pearson Education Ltd., USA, (2014).
2. Simon S. Haykin, Neural Networks: A Comprehensive Foundation, Prentice Hall, (1999).
3. Sun Yuan Kung, Digital Neural Networks, Prentice Hall, (1993).

Course Title: Sustainable Energy Systems

Course Code: PSE740

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

This aims to assess current and potential future energy systems, covering resources, extraction, conversion, and end-use technologies, with emphasis on meeting regional and global energy needs in the 21st century in a sustainable manner including various renewable and conventional energy production technologies, energy end-use practices and alternatives, and consumption practices in the context of engineering, political, social, economic, and environmental goals.

Course Contents:

Energy sources for a more sustainable future, Overview of energy use and related issues, Major energy options; issues of supply and demand, Overview of units and dimensions for global energy flows (Quads, MMBOE, MW, EJ, etc.); energy conversions (chemical to thermal, chemical to electric, etc.); and economic considerations, Climate Change; Science, Economics, and Policy. Energy transfer and conversion methods, Energy and Sustainability (Clean Technologies), Energy sustainability issues; Energy footprints, Opportunities and barriers; timing issues, Drivers of change. Resource evaluation and depletion analyses, Energy conversion, transmission, and storage, Energy supply, demand, and storage planning, Power systems dynamics, Energy end use, option assessment, and tradeoff analysis

Reference Books:

1. McKay, David J. C. Sustainable Energy – Without the Hot Air. UIT Cambridge, Ltd., (2009). ISBN: 9780954452933.
2. Randolph, John, and Gilbert M. Masters. Energy for Sustainability: Technology, Planning, Policy. Island Press, (2008). ISBN: 9781597261036.
3. Bisio, Attilio, and Sharon Boots. Wiley Encyclopedia of Energy Technology and the Environment. Wiley-Interscience, (1996). ISBN: 9780471148272.

Course Title: PINCH Technology

Course Code: PSE741

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

This course covers the key concepts of heat and water pinch analysis and is designed to serve as an introduction to methods likely to be of use to practicing graduates in chemical engineering. Emphasis is on the development of specific quantitative skills that will be useful in a wide range of processes.

Course Contents:

Introduction, Key concepts of Pinch analysis, Data extraction and energy targeting, HEN Design Utilities, heat and power systems, Process change and evolution, Batch and time dependent processes, Applying the Technology in Practice, Case Studies.

Reference Books:

1. Ian C Kemp, Pinch Analysis and Process Integration, ((2nd ed.)), Elsevier Publication, (2007).
2. Mohmoud Bahy Nouredin, Pinch Technology and Beyond Pinch, New Vistas on Energy Efficiency Optimization, Booktopia, (2011).
3. Lorenz T Biegler, Ignacio E Grossmann and Aurthur W Westerberg, Systematic Methods of Chemical Process Design, Prentice Hall, (1997).

Course Title: Energy Audit and Management

Course Code: PSE742

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

This course aims to provide the background required for engineers to meet this role and to equip the students with the skills and techniques required to implement energy management.

Course Contents:

Energy Scenario; Energy Management & Energy Planning; Energy Audit and Energy Monitoring, Targeting and Conservation; Advancement In Technologies and Future Energy Alternatives; Recent advancement in energy; Fusion; Biomass; Geothermal energy; Case Studies: Energy conservation in alcohol industry, fertilizer industry, and pulp and paper industry, Energy conservation in different units of refinery.

Reference Books:

1. Murphy W.R. and Mckay G., Energy Management, Elsevier, (2007).
2. Roger A. Hinrichs and Merlin H. Kleinbach, Energy: Its Use and the Environment, Cengage Learning, (2012).
3. Barney L. Capehart, Wayne C. Turner and William J. Kennedy, Guide to Energy Management, (7th ed.), Keinnedu Fairmant Press, (2011).

Course Title: Polymer Process Machinery Technology

Course Code: PST724

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

The subject aims to provide knowledge about new polymer processing machineries, critical features of new polymer processing machineries launched by leading companies in the plastics industry in the recent years. It will also enable students to compare advantages, improvement, and limitations of new machineries.

Course Contents:

Discussion oriented course focusing on the new polymer processing machineries presented in the world-class exhibitions including National Plastics Exhibitions (NPE) in USA and K-Plast in Germany. Reviewing critical features of new polymer processing machineries launched by leading companies in the plastics industry in the recent years. Comparing advantages, improvement, and limitations of new machineries.

Reference Books:

1. Natamai Subramanian Muralisrinivasan, “Introduction to Polymer Compounding: Machinery and Technology”, 2015
2. Chris Rauwendaal, “Polymer Extrusion 4E (4th ed.)”, 2001
3. NIIR Board, “Modern Technology of Plastic & Polymer Processing Industries”, 2003
4. R. Griskey, “Polymer Process Engineering (1th ed.)”, (1995).

Course Title: Advanced Polymer Processing

Course Code: PST725

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To provide comprehensive knowledge of advanced polymer processing techniques & effect of computer aided tools in production efficiency.

Course Contents:

Polymer processing including injection molding and extrusion. Polymer Rheology and Non-Newtonian fluid mechanics. Melting of Polymers, Pressurization and Pumping mechanism during Processing of polymers, Mixing of Polymers during processing of Polymers, Single and twin rotors Machines, Die forming, Injection Molding, Design and analysis of polymer products and processing based on knowledge of the composition, physical properties and rheological behavior of the. Case studies of transport phenomena approaches on polymer conversion process analysis in rolled blown film extrusion and polymer-additive mixing. . Topics include pressurization, pumping, die forming, calendering, coating, molding, fiber spinning and elastic phenomena.

Reference Books:

1. Nicholas P. Cheremisinoff, “Advanced Polymer Processing Operations (1th ed.)”, 1999
2. Sabu Thomas, Deepalekshmi Ponnammam, Ajesh K. Zachariah, “Polymer Processing and Characterization”, 2012
3. Tim A. Osswald, Juan Pablo Hernández-Ortiz, “Polymer Processing: Modeling and Simulation”, 2006
4. Gennady E. Zaikov, Liliya I. Bazylyak, Jimsher N. Aneli, “Polymers for Advanced Technologies: Processing, Characterization and Applications”, (2013).

Course Title: Plastic Products Manufacturing

Course Code: PST726

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To provide knowledge about the key processing methods applied in the production of plastics products and parts. Subject will provide knowledge on production of plastic products including the equipment, tooling, and environment required for their production.

Course Contents:

An exploration of the science underlying polymer processes such as injection molding through a combination of theory development, practical analysis, and utilization of commercial software. Polymer chemistry and structure, material rheological behavior, processing kinetics, molecular orientation development, process simulation software development, manufacturing defects, manufacturing window establishment, manufacturing process design, manufacturing process optimization. Use of computer-aided engineering and design (CAE and CAD) in the product design and the analysis of product performance. Case studies of plastic production design.

Reference Books:

1. Suresh G. Advani and Kuang-Ting Hsiao, "Manufacturing techniques for polymer matrix composites (PMCs) (1th ed.) ", 2012
2. David Kazmer, "Plastics Manufacturing Systems Engineering: A Systems Approach", 2009
David O. Kazmer, "Plastics Manufacturing Systems Engineering", 2009
3. M. Joseph Gordon, "Industrial design of plastics products", 2003
4. Philip Mitchell, "Tool and Manufacturing Engineers Handbook: Plastic Part Manufacturing", (1996).

Course Title: Advanced Polymer Synthesis and Processes

Course Code: PST732

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To provide the knowledge of fundamental background sciences to synthesis and processing of polymeric materials, types of polymerization, and synthetic processes.

Course Contents:

Polymer synthetic methods. Advanced catalyst system. Gel and network formation. Polymer interchanges polymerization. Group transfer polymerization. Methathesis polymerization. Plasma polymerization. Coordination polymerization. Transformation reactions. High performance polymers and their synthesis. Reactors for industrial polymerization processes. Control of polymerization reactors. Case studies of new polymer synthetic processes.

Reference Books:

1. Dietrich Braun, Harald Cherdrón, Matthias Rehahn and Helmut Ritter, "Polymer Synthesis: Theory and Practice: Fundamentals, Methods, Experiments" (5th ed.), 2012
2. Dieter A. Schlüter, Craig Hawker and Junji Sakamoto, "Synthesis of Polymers (Materials Science and Technology: (A Comprehensive Treatment))", 2012
3. Robert J. Young, Peter A. Lovell, "Introduction to Polymers (3th ed.)", (2011).

Course Title: Polymer Reaction Technology

Course Code: PST733

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To provide the understanding of applying technological principles in analysis and design of polymerization processes. To enable students analyze heat and mass transfer, reactor dynamics and optimization and mixing effects during different polymer reactions. They will learn to perform mathematical modeling of polymerization kinetics, ideal polymerization reactors. To solve case studies of different polymer processes under changing reaction conditions.

Course Contents:

Technological principles applied to the analysis and design of polymerization processes. Mathematical modeling of polymerization kinetics, ideal polymerization reactors, heat and mass transfer, reactor dynamics and optimization, mixing effects. Case studies of important industrial processes.

Reference Books:

1. Jose Asua, "Polymer Reaction Engineering (1th ed.)", 2007 Stoyko Fakirov, "Fundamentals of Polymer Science for Engineers", 2017
2. James C. Gerdeen, PhD, PE, Ronald A.L. Rorrer, "Engineering Design with Polymers and Composites (2th ed.)", 2011
3. Robert O. Ebewele, "Polymer Science and Technology", (2000).

Course Title: Advanced Polymer Characterization

Course Code: PST752

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To provide the knowledge of recent development of functional polymers and their range of applications, advanced structural and functional property characterization techniques, and the history of polymer processing and its influence on the structural and functional properties of these polymers.

Course Contents:

Polymer morphology-processing-property relationship. Deformation mechanisms and orientation characterization. Polymer characterization techniques for determination of thermal, physical and mechanical properties of polymers. Applications of light spectroscopy, x-ray scattering technique, scanning electron microscopy, and transmission electron microscopy to determine crystal structure and morphology of polymers. Application of Infrared (IR), Raman and Nuclear Magnetic Resonance (NMR) spectroscopy to determine microstructural features quantitatively. Case studies of current research in polymer structural analysis by polymer characterization technique.

Reference Books:

1. Dan Campbell, Richard A. Pethrick and Jim R. White, "Polymer Characterization: Physical Techniques (2th ed.)", 2000
2. Clara D. Craver and Theodore Provder, "Polymer Characterization: Physical Property, Spectroscopic, and Chromatographic Methods Advances in Chemistry, (2th ed.)", 2000
3. Rui Yang, "Analytical Methods for Polymer Characterization", 2018 Rui Yang, "Polymer Surface Characterization", 2014
4. B.J. Hunt, M.I. James, "Polymer Characterization", (2012).

Course Title: Polymers Surfaces and Interfaces

Course Code: PST754

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To provide comprehensive knowledge about the principles that govern polymer phase behavior in bulk, thermodynamics of polymers in thin films and at interfaces and characterization techniques to assess polymer behavior in thin films and at interfaces. It will also enable students to illustrate the morphologies of polymer thin films and other dimensionally-restricted structures relevant to polymer science and engineering.

Course Contents:

This course is designed for graduate students to gain a fundamental understanding of the surface and interfacial science of polymeric materials. Beginning with a brief introduction of the principles governing polymer phase behavior in bulk, it develops the thermodynamics of polymers in thin films and at interfaces, the characterization techniques to assess polymer behavior in thin films and at interfaces, and the morphologies of polymer thin films and other dimensionally-restricted structures relevant to polymer science and engineering. Field trips to national user facilities, laboratory demonstrations and hands-on experiments, and guest lectures will augment the course lectures.

Reference Books:

1. I, "Polymer Surface Characterization", 2014 Manfred Stamm, "Polymer Surfaces and Interfaces: Characterization, Modification and Applications, (1th ed.)", 2010
2. Isaac C. Sanchez, "Physics of Polymer Surfaces and Interfaces", 2013
3. Richard A. L. Jones, Randal W. Richards, "Polymers at Surfaces and Interfaces", (1999).

Course Title: Emulsion Polymers

Course Code: PST762

Credit Hours: 3(3, 0)

Pre-requisites: Nil

Course Objectives:

To provide knowledge of fundamental concepts important in the manufacture, characterization, and application of polymer latexes, polymerization mechanisms and kinetics of emulsion polymers, reactor design and characterization of particle surfaces, latex rheology, morphology considerations, polymerization with functional groups and film formation.

Course Contents:

Examination of fundamental concepts important in the manufacture, characterization, and application of polymer latexes. Topics to be covered will include colloidal stability, polymerization mechanisms and kinetics, reactor design, characterization of particle surfaces, latex rheology, morphology considerations, polymerization with functional groups, film formation and various application problems.

Reference Books:

1. Peter A. Lovell and Mohamed S. El-Amasser, Emulsion Polymerization and Emulsion Polymers, (1st ed.), 1997
2. Chorng-Shyan Chern, "Principles and Applications of Emulsion Polymerization (1st ed.)", 2008
3. A. M. van Herk, "Chemistry and Technology of Emulsion Polymerization (2nd ed.)", 2013
4. Robert D. Athey, "Emulsion Polymer Technology (Plastics Engineering)" (2nd ed.), (1991).