

B.Sc. Chemical Engineering

Curriculum for Session 2024 and Onwards

Sample Semester Scheme

Course Code	Course Title	Credit Hours	Knowledge Area	Prerequisite Courses (if any)
Semester 1				
ChE-101	Industrial Stoichiometry – I	3 (3, 0)	Engineering: Engineering Foundation	---
CSC-106 & CSC-106L	Application of Information and Communication Technologies	3 (2, 1)	Humanities: Social Sciences	---
CY-142 & CY-142L	Physical and Analytical Chemistry	3 (2, 1)	Flexible: Non-Engineering	---
HU-111L	Communication Skills	1 (0, 1)	Humanities: English	---
IS-102	Islamic Studies or Ethics (non-Muslim students)	3 (3, 0)	Humanities: Culture	---
MA-113	Calculus and Analytic Geometry	3 (3, 0)	Natural Sciences: Mathematics	---
ME-125L	Engineering Drawing	1 (0, 1)	Engineering: Multidisciplinary Engineering Breadth	---
	Subtotal	17 (13, 4)		
Semester 2				
ChE-108	Fluid Flow – I	3 (3, 0)	Engineering: Engineering Foundation	---
ChE-109 & ChE-109L	Chemical Process Industries	3 (2, 1)	Engineering: Engineering Foundation	---

Course Code	Course Title	Credit Hours	Knowledge Area	Prerequisite Courses (if any)
CS-103 & CS-103L	Introduction to Computer Programming for Data Science	3 (2, 1)	Engineering: Computer and Information Sciences	---
MA-116	Linear Algebra and Differential Equations	3 (3, 0)	Natural Sciences: Mathematics	---
ME-100L	Workshop Practice	1 (0, 1)	Engineering: Multidisciplinary Engineering Breadth	---
PHY-113 & PHY-113L	Applied Physics	3 (2, 1)	Natural Sciences: Physics	---
QT-101	Translation of the Holy Qur'ān – I/SE-101-Social Ethics (for non-Muslims)	1 (1, 0)	---	---
	Subtotal	17 (13, 4)		
Semester 3				
ChE-201	Industrial Stoichiometry – II	3 (3, 0)	Engineering: Engineering Foundation	Industrial Stoichiometry – I
ChE-203 & ChE-203L	Particle Technology	4 (3, 1)	Engineering: Engineering Breadth	---
ChE-204 & ChE-204L	Chemical Engineering Thermodynamics – I	4 (3, 1)	Engineering: Engineering Foundation	---
CY-221 & CY-221L	Inorganic and Organic Chemistry	3 (2, 1)	Natural Sciences: Chemistry	---
HU-221	Technical Writing and Presentation Skills	3 (3, 0)	Humanities: English	---
QT-201	Translation of the Holy Qur'ān – II/SE-201-Social Ethics (for non-Muslims)	1 (1, 0)	---	---
	Subtotal	18 (15, 3)		
Semester 4				
ChE-105L	Occupation Health and Safety	1 (0, 1)	Engineering: Multidisciplinary Engineering Breadth	---

Course Code	Course Title	Credit Hours	Knowledge Area	Prerequisite Courses (if any)
ChE-208 & ChE-208L	Fluid Flow – II	3 (2, 1)	Engineering: Major Based Core Depth	Fluid Flow – I
ChE-209 & ChE-209L	Process Heat Transfer	4 (3, 1)	Engineering: Engineering Foundation	---
ChE-211	Separation Processes – I	3 (3, 0)	Engineering: Engineering Foundation	---
IS-202	Ideology and Constitution of Pakistan Or Ethics (For non-Muslims)	3 (3, 0)	Humanities: Culture	---
MA-242	Engineering Statistics	3 (3, 0)	Natural Sciences: Mathematics	---
HU-003	International Language	0 (0,0)	Humanities	---
	Subtotal	17 (14, 3)		
Semester 5				
ChE-301 & ChE-301L	Chemical Reaction Engineering	4 (3, 1)	Engineering: Major Based Core Depth	---
ChE-304	Chemical Engineering Thermodynamics – II	3 (3, 0)	Engineering: Major Based Core Depth	Chemical Engineering Thermodynamics – I
ChE-311	Engineering Materials	2 (2, 0)	Engineering: Multidisciplinary Engineering Breadth	---
ChE-312 & ChE-312L	Unit Processes	3 (2, 1)	Engineering: Engineering Breadth	---
MA-240 & MA-240L	Numerical Analysis	3 (2, 1)	Engineering: Computer and Information Sciences	---
MGT-318	Entrepreneurship and Management	2 (2, 0)	Management Sciences	---
	Subtotal	17 (14, 3)		
Semester 6				
ChE-308 & ChE-308L	Energy Engineering	4 (3, 1)	Engineering: Engineering Breadth	---

Course Code	Course Title	Credit Hours	Knowledge Area	Prerequisite Courses (if any)
ChE-322 & ChE-322L	Separation Processes – II	4 (3, 1)	Engineering: Major Based Core Depth	Separation Processes – I
ChE-319 & ChE-319L	Chemical Engineering Mathematics	3 (2, 1)	Natural Sciences: Mathematics	---
ChE-321 & ChE-321L	Chemical Process Design and Economics	4 (3, 1)	Engineering: Major Based Core Depth	---
HU-212	Civics and Community Engagement	2 (2, 0)	Humanities: Social Sciences	---
QT-301	Translation of the Holy Qur’ān – III/SE-301-Social Ethics (for non-Muslims)	1 (1, 0)	---	---
	Subtotal	18 (14, 4)		
Semester 7				
ChE-432 to ChE-444	Elective – I	2 (2, 0)	Flexible: Engineering	---
ChE-404 & ChE-404L	Instrumentation and Control	4 (3, 1)	Engineering: Engineering Breadth	---
ChE-406 & ChE-406L	Environmental Engineering	4 (3, 1)	Engineering: Engineering Breadth	---
ChE-409	Chemical Process Equipment Design and Rating	3 (3, 0)	Engineering: Major Based Core Depth	---
ChE-461	Final Year Project – I	3 (0, 3)	Engineering: Final Year Design Project	Final year standing
ChE-414	Internship	0 (0,0)	Engineering: Engineering Breadth	---
MGT-103	Sociology for Engineering	2 (2, 0)	Humanities: Social Sciences	---
	Subtotal	18 (13, 5)		
Semester 8				
ChE-413	Transport Phenomena	3 (3, 0)	Engineering: Engineering Breadth	---

Course Code	Course Title	Credit Hours	Knowledge Area	Prerequisite Courses (if any)
ChE-421 to ChE-431	Elective – III	3 (3, 0)	Flexible: Engineering	---
ChE-401	Chemical Reactor Design	2 (2, 0)	Engineering: Major Based Core Depth	Chemical Reaction Engineering
ChE-432 to ChE-444	Elective – II	2 (2, 0)	Flexible: Engineering	---
ChE-462	Final Year Project – II	3 (0, 3)	Engineering: Final Year Design Project	Final Year Project – I
MGT-320	Project Management in Engineering	2 (2, 0)	Management Sciences	---
QT-401	Translation of the Holy Qur'ān – IV/SE-401-Social Ethics (for non-Muslims)	1 (1, 0)	---	---
	Subtotal	16 (13, 3)		
	Grand Total	138 (109, 29)		

Elective Courses for Session 2024 and Onwards

Course Code	Course Title	Credit Hours
ChE-421	Gas Engineering	3 (3, 0)
ChE-422	Biochemical Engineering	3 (3, 0)
ChE-427	Biomass and Biofuels	3 (3, 0)
ChE-428	Industrial Safety and Risk Management	3 (3, 0)

Course Code	Course Title	Credit Hours
ChE-429	Clean Coal Technologies	3 (3, 0)
ChE-430	Material Characterization Techniques	3 (3, 0)
ChE-431	Maintenance Engineering	3 (3, 0)
ChE-432	Industrial Psychology and Ethics	2 (2, 0)
ChE-433	Polymer Engineering	2 (2, 0)
ChE-434	Petroleum Refinery	2 (2, 0)
ChE-435	Food Engineering	2 (2, 0)
ChE-436	Membrane Technology	2 (2, 0)
ChE-437	Computational Fluid Dynamics	2 (2, 0)
ChE-438	Computer Aided Design	2 (2, 0)
ChE-439	Process Analysis and Optimization	2 (2, 0)
ChE-440	Chemical Safety and Security	2 (2, 0)
ChE-441	Process Equipment Malfunction	2 (2, 0)
ChE-442	Machine Learning in Chemical Engineering	2 (2, 0)
ChE-443	Electrochemical Engineering	2 (2, 0)
ChE-444	Textile Technology	2 (2, 0)

Course Contents

Semester 1

ChE-101: Industrial Stoichiometry – I

(1) Introduction to Chemical Engineering (2) Dimension and units: (a) Conversion of units (b) Dimensional consistency and analysis (3) Stoichiometric and composition relations: Mole fraction, mass fraction, volume fraction, molarity, molality, normality, formality, parts per million, parts per billion (4) Stoichiometric calculations based on ideal gas laws: (a) Ideal gas mixtures and partial pressure (b) Pure component volume (c) Specific gravity and different scales (d) Composition of a gas on dry and wet basis (e) Material balance involving gases (reactive and non-reactive) (5) Humidity and saturation: (a) Vapor pressure, saturation, humidity, absolute humidity, relative humidity (b) Dew point, bubble point, wet bulb and dry bulb temperature (c) Material balance involving saturation (6) Steady state mass and energy balance: (a) Processes classification (open, closed, batch, semi-batch, continuous, transient, steady state), Unit operations (general definition, introduction of concept), Flow diagrams, General material balance equation, System boundaries, Degrees of freedom analysis (b) Material balances for non-reacting systems (c) Material balances for reacting systems (stoichiometry, conversion, excess/limiting reactant, yield, selectivity, extent of reaction) (d) Species material balance on steady state systems involving single unit and single reaction (e) Elemental material balance on steady state systems involving single unit and single reaction (f) General Energy balance equation, Energy balances for non-reacting systems, Energy balances for closed systems, Energy balances for open systems.

Recommended Books:

1. D. M. Himmelblau, and J. B. Riggs, Basic Principles and Calculations in Chemical Engineering, 8th Ed, Pearson Education, Inc.: 2012
2. O. A. Hougen, and K. M. Watson, Chemical Process Principles — Part 1: Material and Energy Balances, 7th Ed, John Wiley & Sons, Inc., New York: 1954

3. R. M. Felder, and R. W. Rousseau, "Elementary Principles of Chemical Processes, 3rd Ed, John Wiley & Sons, Inc., New York: 2004
4. G. V. Reklaitis, and D. R. Schneider, Introduction to Material and Energy Balances, 1st Ed, John Wiley & Sons, Inc., New York: 1983

CSC-106: Application of Information and Communication Technologies

(1) Introduction to Computer Systems (2) Basic Operations and Components of a Generic Computer System (3) Processing Data (4) Internet Basics (5) Introduction to Embedded Systems (6) Networking Basics (7) Database Management (8) Protecting your privacy, your computer, and your data (9) ICT Applications (10) Future Trends in ICT

Recommended Books:

1. Faithe Wempen, Computer Fundamentals: Introduction to computers, John Wiley & Sons, Inc., New York: 2014

CY-142: Physical and Analytical Chemistry

(1) Dalton's law, Henry's law, and Raoult's law (2) Antoine equation (3) Relative volatility (4) Electrochemistry, including fuel cells (5) Colloidal chemistry, reaction kinetics, and equilibrium (6) Introduction to instrumental techniques involving: (a) Potentiometry (b) pH-metry (c) Liquid-solid chromatography (d) High performance liquid chromatography (e) Ion exchange (f) Gas chromatography (g) Plane chromatography (h) Basics of spectroscopy (i) UV and visible spectroscopy.

Recommended Books:

1. H. Kuhn, H. D. Försterling, and D. H. Waldeck, Principles of Physical Chemistry, 2nd Ed., John Wiley & Sons, Inc., New York: 2009
2. L. G. Hargis, Analytical Chemistry: Principles and Techniques, 1 Ed., Prentice Hall: 1988
3. G. D. Christian, P. K. Dasgupta, and K. A. Schug, Analytical Chemistry, 7th Ed., John Wiley & Sons, Inc., New York: 2013
4. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Fundamentals of Analytical Chemistry, 2nd Ed Holt Rinehart Winston: 1969

5. R. M. Pashley, and M. E. Karaman, Applied Colloid and Surface Chemistry, 1 Ed., John Wiley & Sons, Inc., New York: 2004

HU-111L: Communication Skills

(1) Introduction to communication skills (2) Verbal communication: Languages (verbal and written), System of languages (a) Sound (b) Words (c) Sentences (d) Meaning and context (3) Study Skills (4) Presentation skills (5) Components of communication (6) Non-verbal communication: (a) signs and symbols (b) Sounds (c) Colors (Discussing different cultures) (d) Gestures, postures and body language (e) Proxemics, Kinetics, Chronemics, haptic and vocalic (7) Functional English (8) Public speaking (9) Presentation skills (10) Written communication.

Recommended Books

1. Murphi, Hide brands & Thomas, Effective business communication, 7th Ed., McGraw-Hill: 1997
2. A.J Rutherford, Basic Communication Skills for Technology, 2nd Ed., Pearson Education: 2007
3. R.V Lasiker, Basic Business Communication, 8th Ed, Irwin Professional Publishing: 1990

IS-102: Islamic Studies

(1) The holy Quran: (a) Significance of the Holy Quran (b) Topics of the Holy Quran (c) Miracles (Ijaz) of the Holy Quran (d) Principles of Interpretation (Tafseer) (e) Textual Study of Sura Al-Hujurat (complete) (f) Textual Study of Sura Al-Maida (Verse: 1 to 6) (g) Textual Study of Sura Al-Fur'qan (Verse: 63 to 77) (h) Subjective Study of Sura Al-Noor, Al-Baqra 178, 179, Al-Nisa 92, 93, Al-Maidah 8, 31-34, 38, Al-Noor 1-31, 60, Al-Ahzab 32, 33, 53, 55, 59 (2) Al-Hadith: (a) The need & Importance of Hadith (b) Compilation of Hadith (c) Brief Introduction of Sihah Sittah (d) Textual Study of Hadith: Arbaeen-e-Navavi by Imam Nawawi, Hadith: 1 to 42 (meaning of Arabic text, translation and explanation) (3) The Study of Articles of Faith& Pillars of Islam and Jihad: (a) Six Articles of Faith (b) Pillars of Islam (c) Jihad (Striving in the Cause of Allah): Importance, Significance and Its Kinds (4) Seerah-Tun-Nabi ﷺ: (a) Life of the Holy Prophet (Peace be upon him) in Makkah and Madina (b) The Holy Prophet (Peace be upon him) as a Perfect Man (c) Muhammadan Revolution (5) Islam and Modern Science: (a) The Holy Quran as a Guide for the Modern Scientific Development, Surah Al-Baqra: Verse 164, Aal-e-

Imran: Verse 190-191 (b) Importance of Science Education in the Modern Age (c) Introduction of Muslim Scientists, Contribution of Muslim Scholar towards Science (6) Islamic Ethics: (a) Kindness with Parents, Kindred, Orphans and Needy People (b) Fair Speaking to the People (c) Refrain from Evil and Shameful Deeds (d) Abstain from killing any person except by way of Law (e) Security of the Orphans Property (f) Full Justice in Measure and Weight (g) Prevention from Inventing a Lie (h) Fraud and Its Bad Effects

MA-113: Calculus and Analytic Geometry

(1) A review of differentiation: (a) Geometrical interpretation of a derivative (b) Infinitesimal (c) Differential coefficient (d) Derivatives of higher order (e) Indeterminate forms and L'Hopital's rule (f) Asymptotes (g) Curvature (h) Approximation and error estimates (2) Further techniques of integration: (a) Integration by reduction formula (b) Fundamental theorem of integral calculus (c) Definite integral and its properties (d) Area enclosed between curves (e) Arc length (f) Volume of a solid (g) Volume of a solid of revolution (h) Area of surface of revolution (i) Moments (j) Centroids (3) Cartesian, cylindrical, and spherical coordinates: (a) Ratio formula (b) Equation of a straight line in R^3 (c) Direction ratios and direction cosines (d) Angle between two straight lines (e) Distance of a point from a line (f) Equation of a plane (g) Angle between two planes (h) The sphere (i) Directional derivatives (4) The concept of limit, continuity, and differentiation in functions of several variables: (a) Geometric interpretation of partial derivatives (b) Total differential (c) Chain rule (d) Implicit differentiation (e) Maxima and minima of functions of two independent variables (f) Taylor's and Maclaurin's series for functions of two variable (5) Double integration: (a) Fubini's theorems (b) Change of order (c) Geometrical interpretation of double integral (d) Applications to find volumes and areas.

Recommended Books:

1. G. B. Thomas, and R. L. Finney, Calculus and Analytic Geometry, 9 Ed., Addison Wesley: 1995
2. E. Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons: 1967
3. Calculus" by H. Anton, I. C. Bivens, and S. Davis, 10th Ed., Wiley: 2012

ME-125L: Engineering Drawing

(1) Introduction of Drawing & Drawing tools (2) Introduction to Lettering, Lines, and Dimensioning Methods (3) To construct different regular polygons and inscribed/circumscribed Geometrical Figures (4) To learn isometric view conversion into Orthographic projection, Sheet layout Planning and dimensioning methods (5) To draw Orthographic projection of U-block and I-Beam (6) To draw Orthographic projection Brass Step & Pair of Brasses (7) To draw Orthographic projections of the Crankshaft and Crosshead (8) To draw orthographic projections of a Pair of Brasses, To convert Bearings' isometric view into orthographic projection (9) To understand details of the assembly drawing of Nut and Bolt, coupler, bearings, and hook coupling (10) To exercise assembly drawing of rivets, rivets joints and threads (11) To practice Free hand sketches of different given mechanical components/assemblies (12) To understand different mechanical standard symbols

Semester 2

QT – 101: Translation of the Holy Qur’ān -I

Translation of Parah 1 to 8 of Holy Qur’ān

Recommended Books

فتح محمد جالندهری 3. ترجمہ قرآن مجید حافظ نذر	2. فتح القرآن	شاه عبدالقادر دہلوی	. موضح القرآن احمد
مولانا محمد جونا گڑھی 6. ترجمہ	5. احسن البیان	سید شبیر حسین	4. آسان ترجمہ قرآن
مولانا اشرف تھانوی 9. کشف الرحمن	8. ترجمہ قرآن	پیر کرم شاہ الازیری	ضیا القرآن
ڈاکٹر عبدالرحمن طاہر 12. معانی	11. مصباح القرآن	مولانا محمد تقی عثمانی	7. آسان ترجمہ قرآن
ڈاکٹر فرحت ہاشمی 15. مقبول القرآن	14. قرآن مجید، لفظی ترجمہ	مولانا احمد سعید دہلوی	مولانا احمد سعید دہلوی
محمد ظفر	16. آسان ترجمہ قرآن	مولانا غلام رسول سعیدی	10. ترجمہ تبيين القرآن
	Marmaduke Pickthal	سید ابو الاعلیٰ مودودی	القرآن دارالسلام
	Abdullah Yousaf Ali	سید مقبول احمد دہلوی	13. ترجمہ قرآن
	Dr. Mohammad Mahmood Ghali		17. The meaning of Glorious Qur’ān
	Muhammad Asad		18. Qur’ān Translation English
			19. Qur’ān Translation English
			20. Qur’ān Translation English

ChE-108: Fluid Flow-I

(1) Fluid statics: (a) Nature of fluids (b) Hydrostatic equilibrium (c) Barometric equation (d) Hydrostatic equilibrium in a centrifugal field (2) Applications of fluid statics: (a) Manometer (b) Continuous gravity decanter (c) Centrifugal decanter (3) Laminar flow: (a) Velocity field (b) Shear stress (c) Shear rate (d) Laminar flow (e) Newtonian and non-Newtonian fluids (f) Viscosity (g) Relation between viscosity and momentum flux (h) Temperature and pressure dependence of viscosities of liquids and gases (i) Kinematic viscosity (4) Turbulent flow: (a) Reynolds number (b) Turbulence (c) Transition from laminar to turbulent flow (d) Velocity fluctuations in turbulent flow (e) Statistical nature of turbulence (f) Isotropic turbulence (g) Reynolds stresses (h) Eddy viscosity (5) Boundary layers: (a) Laminar and turbulent flow in boundary layers (b) Boundary layer formation in straight tubes (c) Boundary layer separation and wake formation (6) Basic equations of fluid flow: (a) Continuity equation (b) Differential momentum balance (c) Navier– Stokes equations (d) Euler’s equation (e) Couette flow (f) Macroscopic momentum balance (g) Momentum correction factor (h) Flow over an inclined surface (i) Angular momentum equation (j) Bernoulli equation (k) Kinetic energy correction factor (l) Fluid friction (6) Incompressible flow in pipes and channels: (a) Shear stress and skin friction in pipes (b) Hagen–Poiseuille equation (c) Friction factor; Flow in noncircular channels

(d) Effect of surface roughness (e) Friction factor chart (f) Friction from changes in velocity or direction, (g) Friction loss from sudden expansion or contraction of cross section (h) Effect of fittings and valves (i) Velocity heads (j) Boundary layer separation in a diverging channel.

Recommended Books:

1. McCabe, W. L.; Smith, J. C.; Harriott, P., Unit Operations of Chemical Engineering. 7th Ed., McGraw-Hill: 2005. [Chapters 2–9]
2. Abulencia, J. P.; Theodore, L., Fluid flow for the Practicing Chemical Engineer. John Wiley & Sons, Inc.: 2011.
3. Chhabra, R.; Shankar, V., Coulson and Richardson's Chemical Engineering — Vol 1A: Fluid Flow: Fundamentals and Applications. 7th Ed., Butterworth-Heinemann: 2017.
4. Deen, W. M., Introduction to Chemical Engineering Fluid Mechanics. Cambridge University Press: 2016.
5. De Nevers, N., Fluid Mechanics for Chemical Engineers. 3rd Ed., McGraw-Hill: 2005.
6. Holland, F. A.; Bragg, R., Fluid Flow for Chemical Engineers. 2nd Ed., Butterworth-Heinemann: 1995.

ChE-109: Chemical Process Industries

(1) Fundamentals of Chemical Process (2) Introduction to process flow sheeting (3) Detailed study of the following groups of industries: (a) Drinking Water treatment: Water conditioning, Environmental protection (b) Silicate industries: (a) cement: portland cement, lime, gypsum , miscellaneous calcium compound (b) glass: methods of manufacture, manufacture of special glass (c) ceramics: Basic raw material, whitewares, Refractories, Kiln (4) Agro-based industries (a) pulp and paper: manufacturing of pulp and paper, Structural boards (b) Soap and detergent (c) oil and ghee: processes for conversion, vegetable oil, animal fats and oil, sugar) (5) Acid industries (hydrochloric acid, sulfuric acid, nitric acid, phosphoric acid) (6) Alkali industries (soda ash, caustic soda, ammonia) (7) Fertilizer industries (NPK based fertilizers) (8) Nitrogen industries: Synthetic ammonia, Ammonium sulfate, Urea, Sodium Nitrate (9) Miscellaneous Chemical (insecticides, explosives, surface coating) (h) Refinery and Petrochemicals (10) Food

and food by-products: Types of food processing, Food processing Equipment (11) Industrial gases (Oxygen and Nitrogen).

Recommended Books:

1. G. T. Austin, Shreve's Chemical Process Industries, 5th Ed., McGraw-Hill: 1986.
2. G. N. Pandey, A Textbook of Chemical Technology, Vol-1, Vikas Publishing: 1974.
3. J. Moulijn, M. Makkee, and A. van Diepen, Chemical Process Technology, 2nd Ed., Wiley: 2013.
4. J. A. Kent, "Riegel's Handbook of Industrial Chemistry", 9th Ed., Springer: 1992.

CS-103: Introduction to Computer Programming for Data Science

Introduction to Computers and Python Overview of Hardware and Software, Operating Systems, Python and other Programming Languages, Internet and World Wide Web, Software Technologies, How Big Is Big Data? Test-Drive: Using Python and Jupyter Notebooks Data Science: Case Study— A Big-Data Mobile Application, Introduction to Python Programming Variables and Assignment Statements, Arithmetic operators, Function print and an Intro to Strings, Getting Input from the User, Data Science: Basic Descriptive Statistics, Programming Logic, Flow charts, program structure, logic building, algorithms, Conditional Statements Boolean Operators and, or and not, The if Statement and Comparison Operators, Algorithms, Pseudocode, Control Statements, if Statement, if...else and if...elif...else Statements, Repetition Structures, Sequence-Controlled Repetition, Sentinel-Controlled Repetition, Nested Control Statements, break and continue Statements, Data Science: Measures of Central Tendency— Mean, Median and Mode, Functions, Defining Functions, Functions with Multiple Parameters, Random-Number Generation, Case Study: A Game of Chance, Python Standard Library, math Module Functions, Default Parameter Values, Keyword Arguments, Scope Rules, import: A Deeper Look, Function-Call Stack, Data Science: Measures of Dispersion, Sequences: Lists and Tuples Lists, Tuples, Unpacking Sequences, Sequence Slicing, del Statement, Passing Lists to Functions, Sorting Lists, Searching Sequences, Simulating Stacks with Lists, Two-Dimensional Lists Data Science: Simulation and Static Visualizations, Dictionaries and Sets Creating a Dictionary, iterating through a Dictionary, Basic Dictionary Operations, Dictionary Methods keys and values,

Dictionary Comparisons, Comparing Sets, Mathematical Set Operations, Mutable Set Operators and Methods, Set Comprehensions, Data Science: Dynamic Visualizations, Array-Oriented Programming with NumPy Creating arrays from Existing Data, array Attributes, Filling arrays with Specific Values,

Creating arrays from Ranges, List vs. array Performance, NumPy Calculation Methods, Indexing and Slicing, Views: Reshaping and Transposing, Data Science: pandas Series and Data Frames, Manipulating Strings, Formatting Strings, Concatenating and Repeating Strings, Stripping Whitespace from Strings, Other String manipulation functions, Data Science: Pandas, Regular Expressions and Data Munging, Files and Exceptions, Files, Text-File Processing, Updating Text Files, Serialization with JSON, Focus on Security: pickle, Serialization and Deserialization, Handling Exceptions, Data Science: Working with CSV Files

Recommended Books:

1. Faithe Wempen, Computer Fundamentals: Introduction to computers, John Wiley & Sons, Inc., New York: 2014

MA-116: Linear Algebra and Differential Equations

A review of matrices, determinants and finding inverse of a matrix through elementary row operations; Solution of the system of linear equations; Euclidean spaces; Vector spaces; Subspaces; Linear independence and dependence; Basis and dimensions; Normed spaces, Inner product spaces, Angle and orthogonality in inner product spaces, Orthogonal basis; Linear transformations; Kernel and range; Inverse linear transformation; Rank and nullity of linear transformation; Eigenvalues and eigenvectors; Applications to relevant problems. Formation of differential equations; Solution of various types of first order differential equations; Orthogonal trajectories; Application in physical problems. Linear differential equations of second order; Complementary function and particular integral; Solution of non-homogeneous linear differential equations of second order and higher by (i) the method of undetermined coefficients (ii) the method of variation of parameters and Application of second order differential equations; System of differential equations; Laplace transform; Solution of initial value problems by Laplace transform. Formation of partial differential equations; Equations reducible to ordinary differential equations. Periodic functions. Even and odd functions. Fourier series of functions of period 2π and arbitrary period; Half range series.

Recommended Books:

1. "Mathematics for Engineers and Scientists" by Muhammad Iqbal Bhatti and Muhammad Nasir Ch, published by Allied Book Centre, Urdu Bazar Lahore.
2. "Advanced Engineering Mathematics" by E. Kreyszig, published by John Wiley & Sons,
3. "Advanced Engineering Mathematics" by H.K. Dass, published by S. Chand & Company, New Dehli.
4. "Ordinary Differential Equations" by N.A. Shah, A-one publishers, Urdu Bazar, Lahore.
5. "Partial Differential Equations" by N.A. Shah, A-one publishers, Urdu Bazar, Lahore.

ME-100L: Workshop Practice

(1) Basic/ Elementary Machine shop: Detailed study of center lathe and accessories, Plain and taper turning, Basic lath operations including turning, facing, simple screw cutting/treading, knurling, grooving, cutting tools and their grinding. Brief introduction of shaper, milling shaper and surface grinding machine, Assigning of practical jobs (2) Fitting and fabrication shop: use and care of fitter's tools, marking out of job, practice in metal filing, Sawing, Drilling, dieing, tapping and reaming. Brief introduction and use of power Hack Saw, Arbor Press, Sheet shaper machine, Sheet rolling machine, punching machine and drilling machine, Assigning of practical jobs (3) Carpentry Shop: Use and care of tools, types of timber, its defects and preservation methods practices in planning and Sawing, Different types of wood joints, study of sawing, planning, turning mortises and tenon machines, Assigning of practical jobs (4) Electric shocks and treatment, use and care of tools used by electrician, types and uses of cable and electrical accessories for house wiring, practices in simple house wiring, testing methods. Switch gear used on domestic installation and DB **system**, Earthing system, Assigning of practical jobs.

Recommended Books:

1. W.A.J Chapman, Workshop Technology, part-1, Taylor & Francis: 1972
2. Wood Work Technology, Lady bird Series
3. Pak Cables Limited, Wiring Manal
4. Richter and Schwan, Electrical Wiring, 13th Ed., McGraw Hill: 1984

PHY-113: Applied Physics

(1) Sound: (a) Sound waves (b) Properties, sources, and types of sound waves (c) Vibrating systems (d) Beats (e) Doppler's effect (2) Thermodynamics: (a) Temperature and heat (b) Thermal expansion (c) Absorption of heat by solids and liquids (d) Laws of thermodynamics (e) Heat transfer mechanisms (f) Ideal gases (g) Translational kinetic energy (h) Distribution of molecular speeds (i) Molar specific heats (j) Entropy (3) Magnetism: (a) Magnetic field (b) Crossed fields (c) Discovery of electron (d) Hall effect (e) A circulating charged particle (f) Magnetic forces (g) Torque on a current loop (h) Ampere's law (i) Solenoids and toroids (j) Magnetic dipoles (k) Maxwell's equations (4) Atomic physics: (a) Properties of atoms (b) Electron spin (c) Angular momenta and magnetic dipole moments (d) Stern–Gerlach experiment (e) Magnetic resonance (f) Pauli exclusion principle (g) Periodic table (h) X-rays (i) Lasers (j) Spectroscopy (5) Nuclear physics: (a) Discovering the nucleus (b) Nuclear properties (c) Radioactive decay (d) Alpha decay (e) Beta decay (f) Radioactive dating.

Recommended Books:

1. D. Halliday, R. Resnick, and J. Walker, Fundamentals of Physics, 9th Ed., Willey and Sons Inc. (USA): 2010
2. H. D. Young, R. A. Freedman, T. R. Sandin, and A. L. Ford, Sears and Zemansky's University Physics, 10th Ed., Addison-Wesley: 1999
3. D. C. Giancoli, Physics for Scientists and Engineers with Modern Physics and Mastering Physics, 4th Ed., Pearson: 2008

Semester 3

ChE-201: Industrial Stoichiometry – II

(1) Steady state Material Balance involving: (a) Recycle without chemical reaction (b) Recycle with chemical reaction (c) Bypass and purge streams (2) Energy balance calculations for reacting systems (enthalpy, reference state, heat capacity estimation, heat of reaction, heat of formation, single and multi-phase systems) (3) Combined Material and Energy balances on reacting and non-reacting systems involving multiple units and reactions.

Recommended Books:

1. D. M. Himmelblau, and J. B. Riggs, Basic Principles and Calculations in Chemical Engineering, 8th Ed., Pearson Education, Inc.: 2012
2. O. A. Hougen, and K. M. Watson, Chemical Process Principles — Part 1: Material and Energy Balances, 7th Ed., John Wiley & Sons, Inc., New York: 1954
3. R. M. Felder, and R. W. Rousseau, “Elementary Principles of Chemical Processes, 3rd Ed., John Wiley & Sons, Inc., New York: 2004
4. G. V. Reklaitis, and D. R. Schneider, Introduction to Material and Energy Balances, 1st Ed., John Wiley & Sons, Inc., New York: 1983

ChE-203: Particle Technology

(1) Characterization of the particles: (a) Shape factor and sphericity of particles (b) Mean diameters
(c) Density of mixture of solid particles (2) Screening: (a) Types of screens (b) Factors affecting screening operations (c) Screen effectiveness (d) Cumulative and differential analysis for particle size distribution (e) Size frequency curve and its importance (f) Specific number of particles (g) Specific surface of a mixture of solid particles (3) Storage and handling of solids: (a) Janssen Equation (b) Mohr’s Stress circle (c) Angles of repose, internal friction and wall friction (d) Factors affecting the choice of storage vessel (4) Mixing: (a) Types of mixers for continuous and discrete solids (b) Factors affecting mixing operation of solids (c) Mixing index (d) Axial mixing and its importance (e) Rate of mixing (5) Size reduction: (a) Basic modes of size reduction size reduction laws (b) Size reduction machines (c) Angle of nip for double role crusher and Jaw

crusher (d) Critical speed of ball mill and various actions in the ball mill operation (e) Selection criteria of size reduction machines (6) Introduction to Filtration: (a) Types of Industrial filters (b) Pressure drop calculation in filter operation (c) Time required for filtration (d) Crystallization (Should be included in the mass transfer).

Recommended Books:

1. W. L. McCabe, J. C. Smith, and P. Harriott, Unit Operations of Chemical Engineering, 7th Ed., McGraw-Hill: 2004.
2. J. F. Richardson, J. H. Harker, and J. R. Backhurst, Coulson and Richardson's Chemical Engineering —Vol 2: Particle Technology & Separation Processes, 5th Ed., Butterworth-Heinemann: 2002.
3. R. G. Holdich, Fundamentals of Particle Technology, Midland Information, Technology and Publishing: 2002.
4. M. Rhodes, Introduction to Particle Technology, 2nd Ed., Wiley: 2008.
5. Bychuan-yuwu and Jonathan P. K. Seville, Particle Technology and Engineering, Butterworth-Heinemann: 2016.

ChE-204: Chemical Engineering Thermodynamics – I

(1) Introduction to chemical engineering thermodynamics (2) Thermodynamics laws and their application in Chemical Engineering Processes: (a) 1st law of thermodynamics (b) Thermodynamic state and state functions (c) Equilibrium (d) Phase and phase rule (e) Reversible and irreversible processes (f) 2nd law of thermodynamics (g) Entropy (h) Entropy changes of an ideal gas (i) Calculation of ideal work (j) Lost work (k) 3rd law of thermodynamics (3) Volumetric Properties of pure fluids: (a) Polytropic processes (b) Cubic EOS (c) Virial EOS (d) Generalized correlations (4) Thermodynamic property diagrams and tables (5) Power cycles, refrigeration and liquefaction processes: (a) Carnot engine (b) Rankine cycle (c) Internal combustion engine (d) Vapor compression and absorption cycles.

Recommended Books:

1. J. M. Smith, H. G. van Ness, and M. M. Abbott, Introduction to Chemical Engineering Thermodynamics, 7th Ed., McGraw-Hill: 2004

2. S. I. Sandler, Chemical and Engineering Thermodynamics, 3rd Ed., John Wiley and Sons Inc.: 1998
3. Elliot & Lira, Introductory Chemical Engineering Thermodynamics, 2nd Ed., Prentice-Hall Inc.: 1999
4. Milo D. Koretsky, Engineering and Chemical Thermodynamics, 2nd Ed., John Wiley and Sons Inc.: 2013

CY-221: Inorganic and Organic Chemistry

(1) Overview of periodic table (2) Molecular orbital theory (3) Chemistry of solutions (4) Chemistry of transition metals, coordination compounds, and radioactive elements (5) Crystalline state of metals and lattice structure (6) Industrial inorganic chemistry (7) Qualitative and group theory of inorganic chemistry (8) Functional groups (9) Interconversion of functional groups (10) Unit processes: Reaction mechanism of (a) Sulfonation (b) Nitration (c) Hydrogenation (d) Amination (e) Halogenation (f) Oxidation (g) Polymerization

Recommended Books:

1. P. H. Groggins, Unit Processes in Organic Synthesis, 2nd Ed., McGraw-Hill: 2002
2. G. L. Miessler, P. J. Fischer, and D. A. Tarr, Inorganic Chemistry, 5 Ed., Pearson: 2013

HU-221: Technical Writing and Presentation Skills

(1) Introduction to technical communication: (a) What is technical communication (b) Factors to consider in technical communication (c) Examining your purpose (d) Determining how to provide content (2) Writing process: (a) Writing effective paragraphs for technology (b) Developing a clear pattern of organization (3) Making writing effective: (a) Achieving parallelism in writing (b) Constructing effective sentences (4) Paragraph Writing (5) Business Correspondence (6) Interview Skills (7) Writing Technical Reports (8) Types of Reports (9) Publishing and Presenting Reports

Recommended Books:

1. Raymond V. Lesikar & Marie E. Flatley. Basic Business Communication. McGrawHill/Irwin [2001].

2. Sharon J. Gerson & Steven M. Gerson. Technical Communication: Process and Product. Boston: Pearson Inc. [2017].
3. Suzan Last; Candice Neveu & Monika Smith. Technical Writing Essentials: Introduction to Professional Communications in the Technical Fields. [2019]
4. Andrea J. Rutherford. Basic Communication Skills for Technology. Pearson [2000].

QT – 201: Translation of the Holy Qur’ān -II

Translation of Parah 9 to 16 of Holy Qur’ān

Recommended Books

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|-----------------------|-----------------------------|--|------------------------|---|
| فتح محمد جالندھری | 3. ترجمہ قرآن مجید حافظ نذر | 2. فتح القرآن | شاه عبدالقادر دہلوی | . موضح القرآن احمد |
| مولانا محمد جونا گڑھی | 6. ترجمہ | 5. احسن البیان | سید شبیر حسین | 4. آسان ترجمہ قرآن |
| مولانا اشرف تھانوی | 9. کشف الرحمن | 8. ترجمہ قرآن | پیر کرم شاہ الازہری | ضیا القرآن |
| ڈاکٹر عبدالرحمن طاہر | 12. معانی | 11. مصباح القرآن | مولانا محمد تقی عثمانی | 7. آسان ترجمہ قرآن |
| ڈاکٹر فرحت ہاشمی | 15. مقبول القرآن | 14. قرآن مجید، لفظی ترجمہ | مولانا احمد سعید دہلوی | مولانا احمد سعید دہلوی |
| محمد ظفر | 16. آسان ترجمہ قرآن | Marmaduke Pickthal
Abdullah Yousaf Ali
Dr. Mohammad Mahmood Ghali
Muhammad Asad | مولانا غلام رسول سعیدی | 10. ترجمہ تبيين القرآن
القرآن دارالسلام |
| | | | سید ابو الاعلیٰ مودودی | 13. ترجمہ قرآن |
| | | | سید مقبول احمد دہلوی | سید مقبول احمد دہلوی |
| | | | | 17. The meaning of Glorious <i>Qur’ān</i> . |
| | | | | 18. <i>Qur’ān</i> Translation English |
| | | | | 19. <i>Qur’ān</i> Translation English |
| | | | | 20. <i>Qur’ān</i> Translation English |

Semester 4

ChE-105L: Occupation Health and Safety

Module-1: Develop an OHS Policy for an organization, Module-2: Devise strategies for promoting positive health and safety culture at workplace, Module-3-4: Identify and communicate the hazards at various workplaces, Module-5: Design Safety Posters and Signs for a workplace, Module-6-7-8: Carry out the Area OH&S Risk Assessment and suggest risk control measures, Carry out the Task/Activity Risk Assessment and develop a safe system of work and Carry out the fire risk assessment, Module-9: Develop the emergency response plan for Fire and Carry out the Fire Drill, Module-10: Conduct the laboratory safety Inspection and give recommendations based on the 5-S method.

Recommended Books:

1. Robert H. Hill, Jr., David C. Finster “Laboratory Safety for Chemistry Students” 2nd Ed. John Willey and Sons Inc. (USA), 2016.
2. Phil Hughes, Ed Ferrett, “Introduction to health and safety at Work: The Handbook for the NEBOSH General Certificate”, Butterworth-Heinemann Publications

ChE-208: Fluid Flow-II

(1) Compressible Flows: Fundamental concepts, general governing equations of compressible flow. Isentropic flow through nozzles, adiabatic frictional flow, and isothermal frictional flow. (2) Flow Past Immersed Objects: Mechanics of motion of particles, drag, drag coefficients, and stagnation points. Governing equation of free and hindered settling. pressure drops through beds of solids. (3) Fluidization: Conditions of fluidization, minimum fluidization velocity, fluidized bed height calculation, types of fluidizations, applications of fluidization. (4) Transportation of Fluids: Selection of pipe sizes, joints and fittings, allowances for expansion, prevention of leakage around moving parts, various types of valves, pumps, fans, blowers, compressors, and ejectors. (5) Measurement of Flowing Fluids: Differential pressure flow meters, velocity flow meters, mass flow meters, other special types of flow meters. (6) Agitation and Mixing: Mixing mechanisms, impeller, and mixer design, mixing efficiency and power requirements of mixers.

Recommended Books:

3. McCabe, W. L.; Smith, J. C.; Harriott, P., Unit Operations of Chemical Engineering. 7th Ed., McGraw-Hill: 2005 [Chapters 2–9]
4. Abulencia, J. P.; Theodore, L., Fluid flow for the Practicing Chemical Engineer. John Wiley & Sons, Inc.: 2011
5. Chhabra, R.; Shankar, V., Coulson and Richardson's Chemical Engineering — Volume 1A: Fluid Flow: Fundamentals and Applications. 7th Ed., Butterworth-Heinemann: 2017
6. Deen, W. M., Introduction to Chemical Engineering Fluid Mechanics. Cambridge University Press: 2016
7. De Nevers, N., Fluid Mechanics for Chemical Engineers. 3rd Ed., McGraw-Hill: 2005
8. Holland, F. A.; Bragg, R., Fluid Flow for Chemical Engineers. 2nd Ed., Butterworth-Heinemann: 1995

ChE-209: Process Heat Transfer

(1) Introduction to heat transfer; (a) Applications and importance of heat transfer, (b) Modes of heat transfer. (2) Heat transfer by conduction: (a) Fourier's law (b) Thermal conductivity (c) Steady state heat conduction through a flat or cylindrical wall (d) Unsteady state heat conduction with constant or variable surface temperature (3) Heat transfer by convection: (a) Newton's law (b) Free and forced convection (c) dimensional analysis, (d) overall heat transfer coefficient, (e) with and without phase change, (f) Momentum and heat transfer analogies, (g) Boiling and condensation (4) Radiation heat transfer; (a) laws of radiation, (b) black and non-black body radiation. (5) Introduction to heat transfer equipment for process industries (a) Selection and performance evaluation criterion, (b) types of heat exchangers (6) Process and mechanical design of heat exchangers; (a) double-pipe, (b) shell-and-tube, (c) gasketed-plate, (d) plate-fin and tube-fin. (7) Design of evaporators.

Recommended Books

1. Kakaç, S.; Liu, H.; Pramuanjaroenkij, A., Heat Exchangers: Selection, Rating, and Thermal Design. 3rd Ed., CRC Press: 2012. [Chapters 1–4, 6–12]
2. McCabe, W. L.; Smith, J. C.; Harriott, P., Unit Operations of Chemical Engineering. 7th Ed., McGraw-Hill: 2005. [Chapters 10–14]
3. Cao, E., Heat Transfer in Process Engineering. McGraw-Hill: 2010

4. Chhabra, R.; Shankar, V., Coulson and Richardson's Chemical Engineering — Volume 1B: Heat and Mass Transfer: Fundamentals and Applications. 7th Ed., Butterworth-Heinemann: 2017
5. Nitsche, M.; Gbadamosi, R. O., Heat Exchanger Design Guide: A Practical Guide for Planning, Selecting and Designing Shell and Tube Heat Exchangers. Butterworth-Heinemann: 2015
6. Serth, R. W.; Lestina, T. G., Process Heat Transfer: Principles, Applications, and Rules of Thumb. 2nd Ed., Academic Press: 2014
7. Theodore, L., Heat Transfer Applications for the Practicing Engineer. John Wiley & Sons, Inc.: 2011

ChE-211: Separation Processes-I

(1) Overview of Separation Processes and classification; (2) Phase Equilibria: Liquid – liquid, Liquid – Vapor, Liquid – Gas, Liquid – Solid, Phase Diagrams; (3) Diffusion: Laws and Applications; (4) Mass Transfer theories; (5) General Design Consideration of separation processes; (6) Liquid – Liquid Separation processes; (7) Adsorption; (8) Leaching; (9) Humidification and Dehumidification; (10) Drying; (11) Ion Exchange

Recommended Books

1. McCabe, W. L.; Smith, J. C.; Harriott, P., Unit Operations of Chemical Engineering. 7th Ed., McGraw-Hill: 2005 [Chapter 19]
2. Seader, J. D.; Henley, E. J.; Roper, D. K., Separation Process Principles: Chemical and Biochemical Operations. 3rd Ed., John Wiley & Sons, Inc.: 2011. [Chapters 1, 3–4, 8, 14–16, 18]
3. Benítez, J., Principles and Modern Applications of Mass Transfer Operations. 2nd Ed., John Wiley & Sons, Inc.: 200.
4. Chhabra, R.; Shankar, V., Coulson and Richardson's Chemical Engineering — Volume 1B: Heat and Mass Transfer: Fundamentals and Applications. 7th Ed., Butterworth-Heinemann: 2017
5. Khoury, F. M., Multistage Separation Processes. 4th Ed., CRC Press: 2015
6. King, C. J., Separation Processes. 2nd Ed., Dover Publications, Inc.: 2013

IS-202 Ideology and Constitution of Pakistan

(1) Ideology of Pakistan: (a) Definition and Explanation of Ideology, (b) Historical Background with Reference to Shah Wali Ulah, Sir Syed Ahmad Khan, Ali Garh and Other Movements, (c) References from the Speeches and Statements of Allama Dr. Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah, (d) The Role of Women and Students in Freedom Movement, Aims and Objectives of the Creation of Pakistan, (2) Ideological Awakening During 20th Century of British Colonial India: (a) Evolution of Two Nation Theory, Urdu-Hindi Controversy, Partition of Bengal, Simla Deputation, (b) Establishment of All India Muslim League, (c) Khilafat Movement and Non-Cooperation Movement, (d) 14 Points of Jinnah, Iqbal's Allahabad Address 1930 and Pakistan Resolution 1940, (e) Emergence of First Ideological Muslim State, (3) The Constitutions of Islamic Republic of Pakistan, (a) Basic Concept of State and Constitution, Nationalism, Polity and Types of Governments, Organs of the State, (b) Distribution of Powers in Constitution, (c) Major Causes of Delay in the Process of Constitution Making in Pakistan, (d) The First Constituent Assembly 1947-1954, (e) The Second Constituent Assembly and Parliamentary Constitution of 1956, (f) The Presidential Constitution of 1962, (g) The Constitution of 1973, (h) Procedures of Amending the Constitution, Major Amendments in the Constitution of 1973 and Their Impacts on Pakistan Polity.

Recommended Books:

1. Ahmad, Jamil-ud-Din. (1960) "Speeches and Writings of Mr. Jinnah" Lahore: Sheikh Muhammad Ashraf
2. Ahmed, Ishtiaq. (1987). "The Concept of An Islamic State: An Analysis of Ideological Controversy in Pakistan" New York: Continuum International Publishing.
3. Ali, Ausaf. (1988). "Broader Dimensions of the Ideology of Pakistan" Karachi: Royal Book Company
4. Iqbal, Dr. Javed. (2011). "Ideology of Pakistan" Lahore: Sang-e-Meel Publications.
5. Khan, Hamid. (2009). "Constitutional and Political History of Pakistan" Second Edition, Karachi: Oxford University Press.
6. Rizvi, Justice Syed Shabbar Raza. (2021). "Reading: The Constitution of Pakistan" Lahore: Manzoor Law Book House.
7. Waseem, Muhammad. (2021). "Political Conflict in Pakistan" London: Hurst and Company.

MA-242 Engineering Statistics

(1) Introduction & role of statistics in engineering. (2) Population & samples, Variables, Methods of displaying data sets, Stem & leaf display, Histogram, Histogram shapes, Boxplot, Bar chart, Pareto diagram, Dot diagram, Frequency distributions & their graphs, Outlier. (3) Mean, Median, Quartile, Percentile, Range, Deviation from mean, Sample variance, Sample standard deviation, Coefficient of variation. (4) Probability, Concepts & definitions, Basic theorems of probability, Law of total probability, Bayes theorem, Discrete and continuous random variables and their probability distributions, Density and distribution functions; Expectation. (5) Mean & variance of discrete & continuous random variables, Binomial distribution, Poisson distribution, Normal distribution, t-distribution, Chi- square distribution, F-distribution. (6) Sampling techniques and sampling distribution; Point estimation and interval estimation of parameters, Least square linear & polynomial regression, Linearization of nonlinear models, Correlation, Design of experiments, Analysis of variance.

Recommended Books

1. Applied Statistics for Engineers & Scientists by Devore/Farnum, 3rd Ed. Thomas.
2. Probability and Statistics for Engineers and Scientists, Ronald E. Walpole, 8th Ed. Pearson Educational International, 2007.
3. Probability and Statistics for Engineering and Sciences, 8th Ed. CENGAGE Learning.
4. Advanced Engineering Mathematics by Erwin Kreyszig, 11th Ed. John and Wiley and Sons.
5. Applied Statistics and Probability for Engineers by Montgomery, Runger, 3rd Ed. John and Wiley and Sons.
6. Probability and Random Variables and Stochastic Processes, Papoulis Athanasios, 3rd Ed. McGraw-Hill Inc.
7. Introduction to Statistical Theory by Muhammad Shehzad and Sher Muhammad, Ilmi Kitab Khana Urdu Bazar Lahore.

Semester 5

ChE-301: Chemical Reaction Engineering

(1) Overview of chemical reaction engineering: (a) Classifications of reactions (b) Rate of reactions and variable affecting rate of reaction (2) Kinetics of homogenous reactions: (a) Elementary and non-elementary reactions (b) Order and molecularity of reaction (c) Kinetic model development for non-elementary reactions (d) Temperature dependency of rate equation (Arrhenius factor and energy of activation) (3) Interpretation of batch reactor data: (a) Constant and variable batch reactor under isothermal conditions (b) Integral method of analysis (c) differential method of analysis (d) fractional life method (e) initial rates method (4) Rate laws and stoichiometry: (a) Ideal reactors for single reaction (b) Mixed flow reactor (c) Plug flow reactor (d) Batch flow reactor (e) Residence time/space time (5) Reactor systems: (a) Optimum configuration of reactors (b) Recycle reactor (c) Autocatalytic reactions.

Recommended Books:

1. O. Levenspiel, Chemical Reaction Engineering, 3rd Ed., John Wiley and Sons Inc.: 1999
2. H. S. Fogler, "Elements of Chemical Reaction Engineering, 4th Ed., Prentice- Hall Inc:2005
3. J. M. Smith, Chemical Engineering Kinetics, 3rd Ed., McGraw-Hall: 1981
4. R. W. Missen, C. A. Mims, and B. A. Saville, Introduction to Chemical Reaction Engineering and Kinetics, 1st Ed., John Wiley and Sons Inc.: 1998

ChE-311: Engineering Materials

(1) Fundamental concepts of stress and strain, their estimation and applications (2) Mechanical and thermal properties and phase behavior of the following materials of construction: (a) Iron, Chromium and Aluminum and their Alloys (b) Lead and Titanium (c) Coinage materials (Gold, Copper and Silver) (d) Platinum, Palladium (3) Polymeric and Composite materials: (a) Organic Polymers (plastics and Rubbers) (b) Inorganic Polymers (Ceramic Materials and refractories) (c) Biopolymers (Wood) (4) Novel Engineering Materials: (a) Functional Materials (b) Smart

Materials (c) Nanomaterials (5) Selection of materials of construction (6) Corrosion: (a) Mechanism of Corrosion (b) Types of Corrosion (c) Control and prevention of Corrosion

Recommended Books:

1. C. M. Srivastava, and C. Srinivansan, Science of Engineering Materials, 1st Ed., John Wiley and Sons Inc: 1987
2. V. John, Introduction to Engineering Materials, 4th Ed., Palgrave Macmillan UK: 2003
3. W. F. Smith, "Principles of Materials Science and Engineering, 3rd Ed., McGraw-Hall: 1995
4. R. A. Flinn, and P. K. Trojan, Engineering Materials and Their Applications, 1st Ed., Houghton Mifflin Co.: 1975

ChE-312: Unit Processes

(1) Industrial application of the following unit processes with emphasis on their kinetic behavior and economic importance: (a) Nitration: Introduction, Nitrating agent, Aromatic nitration, Kinetic and mechanism of aromatic nitration, Nitration of paraffinic hydrocarbons, Nitrate esters, N-nitro compounds, Thermodynamics of nitration, Process equipment for technical nitration, Mixed acid for nitration, Typical industrial nitration processes (b) Esterification: Esterification by organic acids, Esterification of carboxylic acid derivatives, Esters by addition to unsaturated system, Esters of inorganic acids, Esterification practices (c) Amination: Introduction and definition, Methods of reduction, Iron and acid reduction, Other metal and acid reduction, Catalytic hydrogenation, sulfide reduction, Electrolytic reductions, Metal and alkali reduction, Sulfite reduction, Miscellaneous reduction (d) Halogenation: Introduction, Kinetics and thermodynamics of halogenation, Survey of halogenations, Chlorination in the presence of catalyst, Photo halogenation, Design and construction of equipment, Technical halogenations (e) Sulfonation: Introduction, Sulfonating agents and their principal applications, Chemical and physical factors in sulfonation and sulfation, Kinetics, mechanism and thermodynamics, Desulfonation reaction, Working up procedures, Industrial equipment and techniques, Transition from batch to continuous processing, Technical preparation of sulfonates and sulfates (f) Oxidation: Types of oxidation reaction, Oxidizing agents, Liquid phase oxidation with oxidizing

compounds, Liquid phase oxidation with oxygen, Vapor phase oxidation of aliphatic compounds, Vapor phase oxidation of aromatic hydrocarbons, Kinetics and thermochemistry, apparatus for oxidation (g) Hydrogenation: Introduction, Hydrogen production and properties, Catalytic hydrogenation and hydrogenolysis type reactions, Kinetics and thermodynamics of hydrogenation catalyst, Apparatus and material of construction, Industrial processes (h) Fermentation

Recommended Books:

1. P. H. Groggins, Unit Processes in Organic Synthesis, 2nd Ed., McGraw-Hill: 2002
2. G. T. Austin, Shreve's Chemical Process Industries, 5th Ed., McGraw-Hill: 1986
3. G. N. Pandey, A Textbook of Chemical Technology, Vol-1, Vikas Publishing: 1974
4. J. Moulijn, M. Makkee, and A. van Diepen, Chemical Process Technology, 2nd Ed., Wiley: 2013
5. J. A. Kent, "Riegel's Handbook of Industrial Chemistry", 9th Ed., Springer: 1992

ChE-304: Chemical Engineering Thermodynamics – II

(1) Thermodynamic properties of pure fluids: (a) Properties relations for homogenous phases (b) Residual Properties (c) Residual Properties by Equations of State (d) Thermodynamic Diagrams
(2) Solution thermodynamics: (a) partial molar properties (b) Generalized correlation for fugacity and activity co-efficient (c) excess/residual Gibbs free energy (d) Solution Thermodynamics Applications
(3) V-L phase equilibrium: (a) Raoult's Law and its modified form (b) K-values (c) Dew/bubble point calculations (d) Flash point calculations
(4) Chemical Reaction Equilibrium
(5) Vapor Liquid Equilibrium using Equations of State and Gamma-Phi relations.

Recommended Books:

1. J. M. Smith, H. G. van Ness, and M. M. Abbott, Introduction to Chemical Engineering Thermodynamics, 7th Ed., McGraw-Hill: 2004
2. S. I. Sandler, Chemical and Engineering Thermodynamics, 3rd Ed., John Wiley and Sons Inc.: 1998
3. Robert C. Reid, J. M. Prausnitz, Thomas Kilgore Sherwood, The Properties of liquid and gases, 3rd Ed., McGraw-Hill: 1977

MA-240: Numerical Analysis

(1) Basic concepts: (a) Round-off errors (b) Floating point arithmetic (c) Convergence (2) Solution of nonlinear equations: (a) Simple iterations (b) Bisection method (c) Newton's method (d) Secant method (e) Method of false position (3) Solution of linear simultaneous equations: (a) Jacobi's method (b) Gauss–Seidel method (4) Finite differences: (a) Difference operators and tables (b) Newton's interpolating techniques for equally spaced data (c) Newton's divided difference table and interpolation (d) Lagrange's formulation of interpolation (5) Numerical differentiation: approximating the derivative (6) Numerical integration: (a) Review of integration concepts and their physical significance for engineering (b) Trapezoidal and Simpson's rules (7) Solution of differential equations: (a) Euler's methods (b) Runge–Kutta methods (8) Computations: numerical techniques in the context of engineering applications and solutions of problems by using MATLAB®

Recommended Books:

1. S. Chapra, and R. Canale, Numerical Methods for Engineers, 6th Ed., McGraw-Hill: 2009
2. J. H. Mathews, and K. K. Fink, Numerical Methods using MATLAB, 4th Ed., 2004
3. J. D. Hoffman, and S. Frankel, Numerical Methods for Engineers and Scientists, 2nd Ed., CRC Press: 2001
4. S. A. Bhatti, A First Course in Numerical Analysis with Fortran and C, 3rd Ed., Lahore Shaharyar: 1996

MGT-318 Entrepreneurship and Management

Introduction to management and entrepreneurship; functions of management; developing successful business ideas; recognizing opportunities and generating ideas; feasibility analysis; developing an effective business model; industry and competitor analysis; writing a business plan; moving from an idea to an entrepreneurial firm; preparing the proper ethical and legal foundation; assessing a new venture's financial strength and viability.

Recommended Books:

1. Entrepreneurship _ successfully launching new ventures, Barringer and Ireland, Prentice Hall (2016)

2. Absolute Essentials of Business and Economics, Nerys Fuller-Love, Absolute Essentials of Entrepreneurship-Routledge (2020)
3. Essentials of Entrepreneurship and Small Business Management, Jeffrey R. Cornwall Norman M. Scarborough, Pearson (2018)
4. Entrepreneurship and Management in an Islamic Context, Veland Ramadani, Léo-Paul Dana, Shqipe Gërguri-Rashiti, Vanessa Ratten (eds.), Springer International Publishing (2017)

Semester 6

ChE-321: Chemical Process Design & Economics

(1) General design considerations: (a) Process design development (b) Flowsheet development (c) Computer-aided design (d) Cost estimation (e) Profitability analysis of investments (f) Optimum economic design (g) Optimum operation design (h) Practical constraints in process and equipment design (i) Ethics in design (2) Health and safety hazards: (a) Sources of exposure (b) Exposure evaluation and control (c) Fire and explosion (d) Personnel safety (e) Safety regulations (3) Loss prevention: (a) HAZOP study (b) Fault-tree analysis (c) Failure mode and effect analysis (d) Safety indexes (e) Safety audits and Maintenance (4) Environmental protection: (a) Environmental regulations (b) Air pollution control (c) Water pollution control (d) Solid waste disposal (e) Thermal pollution control (f) Noise control (5) General considerations for plant location, layout, operation, and control (6) Process design development: (a) Development of design database (b) Process creation and design (c) Process flow diagrams (d) Piping and instrumentation diagrams (e) Isometrics (f) Equipment design and specification sheets (g) At least one comprehensive tutorial on preliminary process design guiding through all steps (7) Flowsheet synthesis and development: (a) General procedure for flowsheet synthesis (b) Development, evaluation, and selection with comprehensive tutorials for each step (c) Use of algorithms and simulation software for flowsheet synthesis (8) Use of software in process design, chemical property estimation, process simulation and optimization, process control, and economic evaluation (9) Cost and asset accounting: (a) Financial sheets, (b) Financial ratios, (c) Inventory costing (10) Process economics: (a) Cash flow concepts (b) Factors affecting fixed and operating costs (c) Components of capital investment and methods for estimation (d) Cost indexes (e) Estimation of total production costs, revenues, and profits (11) Interest: (a) Simple and compound interest (b) Nominal and effective interest rates (c) Continuous interest (d) Effect of income tax and loan payments on cost of capital (12) Time value of money: (a) Discrete and continuous cash flows (b) compounding and discounting factors (13) Income tax: (a) Taxable income (b) Capital gains tax (c) Sales tax (d) Non-income taxes (14) Fixed charges: (a) Depreciation (b) Current value (c) Salvage value (d) Recovery period (e) Methods for calculating depreciation (f) Insurance (15) Profitability analysis: (a) Minimum acceptable rate of return (b) Methods for calculating return on investment with and without considering time value of money; Effect of inflation (c) Evaluation of alternative investment and replacement scenarios (16)

Optimum design: (a) Objective function (b) Structural and parametric optimization (c) Sub optimization (d) Linear and nonlinear programming methods (e) Comprehensive tutorials on solving process optimization problems (17) Pinch technology analysis and heat exchanger network design

Recommended Books

1. Peters, M. S.; Timmerhaus, K. D.; West, R. E., Plant Design and Economics for Chemical Engineers. 5th Ed., McGraw-Hill: 2003 [Chapters 1–9]
2. Seider, W. D.; Lewin, D. R.; Seader, J. D.; Widagdo, S.; Gani, R.; Ng, K. M., Product and Process Design Principles: Synthesis, Analysis and Evaluation. 4th Ed., John Wiley & Sons, Inc.: 2016
3. Silla, H., Chemical Process Engineering: Design and Economics. Marcel Dekker, Inc.: 2003
4. Smith, R., Chemical Process Design and Integration. 2nd Ed., John Wiley & Sons, Inc.: 2016
5. Towler, G.; Sinnott, R., Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design. 2nd Ed., Butterworth-Heinemann: 2012
6. Turton, R.; Shaeiwitz, J. A., Bhattacharyya, D., Whiting, W. B., Analysis, Synthesis, and Design of Chemical Processes. 5th Ed., Prentice Hall: 2018

ChE-319: Chemical Engineering Mathematics

(1) Application of the following to chemical engineering problems: (a) Ordinary differential equations (b) Simultaneous differential equations (c) Partial differential equations (d) Series solution (e) Laplace transformation

Recommended Books:

1. D. M. Himmelblau, and J. B. Riggs, Basic Principles and Calculations in Chemical Engineering, 8th Ed., Pearson Education, Inc.: 2012
2. O. A. Hougen, and K. M. Watson, Chemical Process Principles — Part 1: Material and Energy Balances, 7th Ed., John Wiley & Sons, Inc., New York: 1954

ChE-322: Separation Processes-II

(1) Introduction of Equipment for vapor-liquid separations; (2) Absorption and Stripping; (3) General design consideration for binary distillation column; (4) HETP and HTU methods for

design of packed distillation column; (5) Ponchon-Savarit method & McCabe Thiele method for design of distillation columns; (6) Multicomponent distillation: ((a) Fenske -Underwood Gilliland method (b) bubble point method (c) sum-rates method (d) inside-out method); (7) Advanced distillation processes: (distillation boundaries (b) residue-curve maps (c) extraction distillation (d) pressure – swing distillation (e) homogeneous and heterogeneous azeotropic distillation (f) reactive distillation); (9) Advanced membrane processes

Recommended Books

1. Seader, J. D.; Henley, E. J.; Roper, D. K., Separation Process Principles: Chemical and Biochemical Operations. 3rd Ed., John Wiley & Sons, Inc.: 2011. [Chapters 6–7, 9–11]
2. Benítez, J., Principles and Modern Applications of Mass Transfer Operations. 2nd Ed., John Wiley & Sons, Inc.: 2009.
3. Chhabra, R.; Shankar, V., Coulson and Richardson's Chemical Engineering — Volume 1B: Heat and Mass Transfer: Fundamentals and Applications. 7th Ed., Butterworth-Heinemann: 2017.
4. Górak, A.; Olujić, Ž., Distillation: Equipment and Processes. Academic Press: 2014
5. Górak, A.; Sorensen, E., Distillation: Fundamentals and Principles. Academic Press: 2014
6. Khoury, F. M., Multistage Separation Processes. 4th Ed., CRC Press: 2015
7. King, C. J., Separation Processes. 2nd Ed., Dover Publications, Inc.: 2013
8. McCabe, W. L.; Smith, J. C.; Harriott, P., Unit Operations of Chemical Engineering. 7th Ed., McGraw-Hill: 2005

ChE-308: Energy Engineering

(1) Perpetual energy source: (a) Solar (b) Wind (c) tidal (2) Non-renewable Energy Resources: (a) Fossil fuels (b) Solid, liquid and gaseous fuels (c) Nuclear (3) Renewable energy resources: (a) Hydropower (b) Biomass (c) geothermal energy (4) Hydrocarbon fuel properties: Viscosity, Flash point, Fire point, Octane number, Cetane number, Swelling index, Proximate and ultimate analysis (5) Availability of these energy resources in Pakistan (6) Environmental impacts of energy resources (7) Fuel processing: (a) Carbonization (b) Combustion (c) Gasification (d) Refinery operations

Recommended Books:

1. J. R. Backhurst, and J. H. Harker, Fuel and Energy, 1st Ed., Academic Pr: 1981
2. M. L. Smith, and K. W. Stinson, Fuels and Combustion, 1st Ed., McGraw-Hill: 1952
3. J. F. Griffiths, and J. A. Bernard, Flame and Combustion, 3rd Ed., CRC Press: 1998
4. S. R. Turns, An Introduction to Combustion: Concepts and Applications, 3rd Ed., McGraw-Hill: 2011
5. R. F. Probstein, and R. E. Hicks, Synthetic Fuels, 1st Ed., Dover Publications: 2006

QT – 301: Translation of the Holy Qur’ān -III

Translation of Parah 17 to 24 of Holy Qur’ān

Recommended Books

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|-----------------------|-----------------------------|--|------------------------|------------------------------------|
| فتح محمد جالندهری | 3. ترجمہ قرآن مجید حافظ نذر | 2. فتح القرآن | شاه عبدالقادر دہلوی | . موضح القرآن احمد |
| مولانا محمد جونا گڑھی | 6. ترجمہ | 5. احسن البیان | سید شبیر حسین | 4. آسان ترجمہ قرآن |
| مولانا اشرف تھانوی | 9. کشف الرحمن | 8. ترجمہ قرآن | پیر کرم شاہ الازہری | ضیا القرآن |
| ڈاکٹر عبدالرحمن طاہر | 12. معانی | 11. مصباح القرآن | مولانا محمد تقی عثمانی | 7. آسان ترجمہ قرآن |
| ڈاکٹر فرحت ہاشمی | 15. مقبول القرآن | 14. قرآن مجید، لفظی ترجمہ | مولانا احمد سعید دہلوی | مولانا احمد سعید دہلوی |
| محمد ظفر | 16. آسان ترجمہ قرآن | Marmaduke Pickthal
Abdullah Yousaf Ali
Dr. Mohammad Mahmood Ghali
Muhammad Asad | مولانا غلام رسول سعیدی | 10. ترجمہ تبيين القرآن |
| | | | سید ابو الاعلیٰ مودودی | 13. ترجمہ قرآن |
| | | | سید مقبول احمد دہلوی | سید مقبول احمد دہلوی |
| | | | | 17. The meaning of Glorious Qur’ān |
| | | | | 18. Qur’ān Translation English |
| | | | | 19. Qur’ān Translation English |
| | | | | 20. Qur’ān Translation English |

HU-212: Civics and Community Engagement

- (1) Introduction to Civics and Community.
- (2) Introduction to Citizenship.
- (3) State, Government, and Civil Society.
- (4) Rights of Pakistani Citizens under the Constitution.
- (5) Sustainable Development Goals, Social Issues and Media.
- (6) Civic Responsibilities/Duties.
- (7) Community Engagement and Approaches to Effective Community Engagement.
- (8) Advocacy and Activism.
- (9) Digital Citizenship and Technology.
- (10) Environment and Society.
- (11) Diversity Inclusion and Social Justice

Recommended Books:

1. Krista M. Soria, Tania D. Mitchell (Eds.). Civic Engagement and Community Service at Research Universities: Engaging Undergraduates for Social Justice, Social Change and Responsible Citizenship. Palgrave Macmillan UK, 2016.
2. Will Kymlicka and Wayne Norman (Eds.), Citizenship in Diverse Societies, Oxford-New York, Oxford University Press, 2000.
3. Christine M. Cress; Peter J. Collier; Vicki L. Reitenauer. Learning Through Serving: A Student Guidebook for Service-Learning and Civic Engagement Across Academic Disciplines and Cultural Communities. Taylor & Francis, 2023.
4. Carole Cox, Tina Maschi. Human Rights and Social Justice: Key Issues and Vulnerable Populations. Routledge, 2022.
5. Muslim Volunteering in the West: Between Islamic Ethos and Citizenship. Springer International, 2020

Semester 7

ChE-409: Chemical Equipment Design and Rating

(1) Review of fluid flow principles: (a) Mass balance (b) Mechanical energy balance (c) Force balance (2) Selection of fluid flow equipment: (a) Pipes (b) Valves (c) Pumps (d) Compressors (e) Mixers (f) Ejectors (g) Pneumatic conveying systems (3) Review of heat transfer principles: (a) Modes of heat transfer (b) Laws of heat transfer (c) Heat-transfer coefficient (4) Heat exchanger analysis: (a) LMTD method (b) ϵ -NTU method (5) Estimation of pressure drop, fouling, and overall heat-transfer coefficients in heat exchangers (6) Selection, design, and performance evaluation of heat exchangers: (a) Double-pipe heat exchangers (b) Shell-and-tube heat exchangers (c) Gasketed-plate heat exchangers (d) Plate-fin and tube-fin heat exchangers (e) Condensers (f) Evaporators (g) Furnaces (7) Review of mass transfer principles: (a) Mass balance (b) Phase equilibrium (c) Bubble- and dew-point calculations (d) Mass transfer coefficient (8) Design and performance evaluation of distillation columns: (a) McCabe–Thiele method (b) Ponchon–Savarit method (c) HETP method (d) HTU method (e) Fenske–Underwood–Gilliland method (9) Design and performance evaluation of countercurrent liquid–liquid and solid–liquid extractors (10) Review of reaction engineering principles: Rate equation (11) Design and performance evaluation of reactors: (a) Batch reactor (b) Mixed-flow reactor (c) Plug-flow reactor (d) Packed-bed reactor (e) Fluidized-bed reactor (12) Design of pressure vessels: (a) Vapor–liquid separators (b) Vapor–liquid–liquid separators (13) Properties and selection of materials of construction.

Recommended Books:

1. Peters, M. S.; Timmerhaus, K. D.; West, R. E., Plant Design and Economics for Chemical Engineers. 5th Ed., McGraw-Hill: 2003 [Chapters 10, 12–15]
2. Turton, R.; Shaeiwitz, J. A., Chemical Process Equipment Design. Prentice Hall: 2017 [Chapters 1–5]
3. Coker, A. K., Ludwig's Applied Process Design for Chemical and Petrochemical Plants — Volume 1. 4th Ed., Gulf Professional Publishing: 2007
4. Coker, A. K., Ludwig's Applied Process Design for Chemical and Petrochemical Plants — Volume 2. 4th Ed., Gulf Professional Publishing: 2010

5. Couper, J. R.; Penney, W. R.; Fair, J. R.; Walas, S. M., Chemical Process Equipment: Selection and Design. 3rd Ed., Butterworth-Heinemann: 2012
6. Górak, A.; Olujić, Ž., Distillation: Equipment and Processes. Academic Press: 2014
7. Kakaç, S.; Liu, H.; Pramuanjaroenkij, A., Heat Exchangers: Selection, Rating, and Thermal Design. 3rd Ed., CRC Press: 2012
8. Lieberman, N. P.; Lieberman, E. T., A Working Guide to Process Equipment. 3rd Ed., McGraw-Hill: 2008
9. Towler, G.; Sinnott, R., Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design. 2nd Ed., Butterworth-Heinemann: 2012

ChE-406: Environmental Engineering

(1) Ecosystems and biomes: (a) Types of Ecosystems and biomes (b) Nutrient Cycles (c) Biodiversity (2) Sustainable energy, minerals and soil resources (3) Water Pollution: (a) Harmful effects on nature and society (b) Water treatment (c) Municipal wastewater Treatment (d) Industrial Waste water Treatment (4) Air Pollution: (a) Harmful effects on nature and society (b) Air pollution control techniques (5) Noise Pollution: (a) Effects of noise on people (b) Noise control Strategies (6) Solid and hazardous Waste Management: (a) Waste to energy (b) Treatment technologies (7) Environmental Impact Assessment (EIA) and Sustainable Development (8) Life Cycle Assessment (9) Green Engineering and Cleaner Production Techniques: (a) Green Chemistry (b) Strategies for implementing cleaner productions

Recommended Books:

1. M. L. Davis, and D. A. Cornwell, Introduction to Environmental Engineering, 5th Ed., McGraw-Hill: 2012.
2. P. A. Vesilind, S. M. Morgan, and L. G. Heine, Introduction to Environmental Engineering, 3rd Ed., Cengage Learning: 2010.
3. R. F. Weiner, and R. A. Matthews, Environmental Engineering, 4th Ed., Butterworth Heinemann: 2003.
4. K. Saravanan, S. Ramachandran, and R. Baskar Principles of Environmental Science and Technology, 1st Ed., New Age International Pub.: 2008

5. N. P. Cheremisinoff, Handbook of Water and Wastewater Treatment Technologies, 1st Ed., Butterworth Heinemann: 2001.

MGT-103: Sociology for Engineering

- (1) Introduction To Sociology;
- (2) Group, Community, Society, Associations;
- (3) Organization;
- (4) Social Interaction;
- (5) Types of Social Groups;
- (6) Culture;
- (7) Socialization & Personality;
- (8) Deviance and Social Control;
- (9) Collective Behavior

Recommended Books:

Brown, Ken 2020. Sociology. Uk: Polity Press

ChE-432: Industrial Psychology and Ethics

- (1) Introduction to Industrial/Organizational Psychology and ethics
- (2) Job Analysis and Evaluation, Legal Issues and Employee Selection
- (3) Employee Selection: Recruitment and interviews
- (4) Employee Selection: (a) References and testing (b) Evaluating Selection Techniques and Decisions
- (5) Evaluating Employee Performance
- (6) Designing and Evaluating Training Systems
- (7) Employee Motivation
- (8) Employee Satisfaction and Commitment
- (9) Organizational Communication, Leadership
- (10) Group Behavior, Teams, and Conflict
- (11) Organizational Development
- (12) Stress Management: dealing with the demands of Life and Work
- (13) Stress Management: dealing with the demands of Life and Work

Recommended Books:

1. Michael G. Aamodt, "Industrial/Organizational Psychology", 6th Ed., M. G.: 2015
2. Belmont, CA, "Industrial/organizational psychology: An applied approach" 8th Ed., Muchinsky, P. M.: 2011
3. Summerfield, "Psychology Applied to Work" ,10th Ed., NC: Hypergraphic: 2011
4. Joel Lefkowitz, "Ethics and Values in Industrial-Organizational Psychology" 2nd Ed., CRC Press: 2017

ChE-433: Polymer Engineering

(1) Basic Principles of polymerization processes, polymer molecular weight and structure (2) Polymer synthesis & characterization (3) Types of polymerization (4) Dependence of properties on molecular structure & microstructure (5) Polymer rheology (6) Unit processing operations, formulation & uses of polymers (7) Mechanical properties (8) Degradation & failure methods (9) Analysis and identification of polymers

Recommended Books:

1. A. Rudin, The Elements of Polymer Sciences and Engineering, 2nd Ed., Academic Press; 1999.
2. F. Rodriguez, C.Cohen, C. Ober, L. A. Archer, Principles of polymer Systems, 5th Ed., Taylor & Francis: 2003

ChE-434: Petroleum Refinery

(1) Introduction: (a) Composition of petroleum (b) Laboratory tests (c) Refinery feed stocks and products (d) Characterization of crude oil (2) Design of crude oil distillation column (3) Thermal and Catalytic cracking (4) Catalytic reforming (5) Delayed coking (6) Furnace design (7) Hydro processing and Hydrocracking (8) Isomerization, Alkylation and Polymerization (9) Lube oil manufacturing (10) Energy conservation in petroleum refineries (11) Environmental issues and New Trends in petroleum refinery operations (12) Pyrolysis of hydrocarbons: modeling.

Recommended Books:

1. W.L..Nelson, Petroleum Refining Engineering, 4th Ed., Mc Graw- Hill: 2001
2. R.N.Watkins, Petroleum Refinery distillation, 2nd Ed., Gulf Publishing Co: 1979
3. Robert A Mayers, Hand book of petroleum refining process, 3rd Ed., McGraw-Hill: 2003.
4. James G Speight, The chemistry and technology of petroleum, 5th Ed., CRC Press: 2014.
5. J.H. Gary and G.E. Handwerk " Petroleum Refinery Technologies and economics, 5th Ed., CRC Press: 2007.

ChE-435: Food Engineering

(1) Introduction, general aspects of food industry, world food demand (2) Food additives, standards, deteriorative factors and their control, preliminary processing methods, conversion and preservation operation (3) Energy Engineering in Food Processing: (a) Generation of Steam

(b) Fuel Utilization (c) Electric Power Utilization (d) Process Controls in Food Processing (e) Systems for Heating and Cooling Food Products. (4) General Method for Process Calculation: Preservation by heat and cold dehydration, concentration, frying, irradiation, microwave heating Sterilization and pasteurization, fermentation and pickling, packing methods (5) Food preservation techniques and separation processes in food processing: (a) Reverse Osmosis Membrane Systems (b) Membrane Performance (c) Drying Processes (d) Dehydration Systems (e) Dehydration System Design (f) Sedimentation and Centrifugation (6) Packaging: (a) Introduction (b) Product Containment (c) Mass Transfer in Packaging Materials Food canning technology

Recommended Books:

1. Stanley Charm, Fundamentals of Food Engineering, 2nd Ed., Avi Pub. Co.: 1971.
2. R.Paul Singh, Dennis R. "Introduction to Food Engineering, 5th Ed., Academic Press: 2014.
3. Heid, J.L. and Joslyn, M.A., Fundamentals of Food Processing Operation, The AVI Publishing Co; Westport: 1967.
4. Heldman, D.R., Food Process Engineering, The AVI Publishing Co; Westport: 1975.

ChE-436: Membrane Technology

(1) Introduction and definitions (2) General transport models (3) Reverse osmosis and nanofiltration (4) Membrane polymers/preparation (5) Pervaporation (pv) / vapor permeation /gas separation (6) Ultrafiltration (uf) and microfiltration (mf) (7) Membrane reactors / bioreactors /dialysis/sensors (8) Membrane contactors / liquid membranes (9) Case studies on the selection of membrane for particular application (10) Membrane applications for water/wastewater treatment and system design/other applications.

Recommended Books:

1. Ho and Sirkar, Membrane Handbook, 1st Ed., Chapman Hall: 1992
2. Mulder, M., Basic Principles of Membrane Technology, 2nd Ed., Kluwer Academic Publishers: 1996
3. Sourirajan, S. and Matsuura, T., Reverse Osmosis/Ultrafiltration Principles, National Research Council of Canada, Ottawa, Canada: 1985
4. Rautenbach, R. and Albrecht, R., Membrane Processes, John Wiley: 1989

5. Noble, R. D. and Stern, S. A., Membrane Separations Technology: Principles and Applications, Elsevier: 1995
6. Howell, J.A., Sanchez, V., and Field, R. W., Membranes in Bioprocessing, Chapman Hall: 1993
7. Kesting, R. E., Synthetic Polymeric Membranes: A structural Perspective, John Wiley, 1985
8. D. A. Butterfield, Biofunctional Membranes, Plenum Press: 1996

ChE-437: Computational Fluid Dynamics

(1) Illustration of the CFD approach as an engineering analysis tool (2) Derivation of flow governing equations: (a) Turbulence modeling (b) Modeling approaches for multiphase flow (c) Initial and boundary conditions (3) Discretization of the governing equations using finite difference/volume/element methods: (a) Concepts of consistency, stability and convergence (b) Template for the discretization of a generic unsteady transport equation (c) Solution of discretized equations, direct methods, classical iterative methods, advanced methods for structured matrices, conjugate gradient techniques and multigrid methods (4) Solution of coupled equations: methods for compressible flows: (a) Evaluation of pressure in incompressible flows (b) Pressure-velocity coupling algorithms (5) Structured and unstructured grids (6) Benchmarking (7) calibration.

Recommended Books:

1. C Hirsch, Numerical Computation of Internal and External Flows, Vol. 1 and 2, John Wiley: 1990
2. J H Ferziger and M Peric, Computational Methods for Fluid Dynamics, Springer: 2002.
3. Ferziger, J., and M. Peric, Computational Methods for Fluid Dynamics, Third Ed., Springer: 2001

ChE-438: Computer Aided Design

(1) Modeling of chemical engineering design problems (2) Using spreadsheet software for design calculations (3) User-defined functions, formulas, and data replication (4) Iterative and selective structures implementation (5) Macro application (6) Graphical output (7) Flow sheeting fundamentals (8) Representing a design problem in flow sheeting codes (9) Using flow sheeting software for solving design problems (10) Physical property estimation (11) Cost estimation (12)

Heat and mass balances computations (13) Degree of freedom and thermodynamic properties calculations (14) Size determination (15) Regression analysis and graphical output of results using flow sheeting software

Recommended Books:

1. Biegler, L. T., Grossmann, I. E.; Westerberg, A. W., Systematic Methods of Chemical Process Design. Prentice Hall, 1997
2. Chaves, I. D. G.; López, J. R. G.; Zapata, J. L. G.; Robayo, A. L.; Niño, G. R., Process Analysis and Simulation in Chemical Engineering. Springer, 2016
3. Kemp, I. C., Pinch Analysis and Process Integration: A User Guide on Process Integration for the Efficient Use of Energy. 2nd Edition; Butterworth-Heinemann, 2007
4. Seider, W. D.; Seader, J. D.; Lewin, D. R.; Widagdo, S., Product and Process Design Principles: Synthesis, Analysis, and Evaluation. 3rd Ed., John Wiley & Sons, 2009
5. Sundmacher, K.; Kienle, A.; Seidel-Morgenstern, A., Integrated Chemical Processes: Synthesis, Operation, Analysis, and Control. Wiley-VCH, 2005
6. Turton, R.; Bailie, R. C.; Whiting, W. B.; Shaeiwitz, J. A.; Bhattacharyya, D., Analysis, Synthesis, and Design of Chemical Processes. 4th Ed., Pearson Education, 2012

ChE-439: Process Analysis and Optimization

(1) Importance and hierarchy of optimization (2) Significance of optimization in chemical engineering (3) Classification and model development (4) Solution and interpretation of optimization models (5) Economic and time value of objective functions (6) Linear programming application to chemical processes in multi-variant situations (7) Unconstrained functions with one-dimensional search (8) Nonlinear mixed integer optimization (9) Application of optimization in heat transfer and energy conservation (10) Optimal design and operation of conventional mass transfer operations (11) Optimal design of fluid flow in pipes with and without pumping and compressing devices (12) Optimization of medium scale plants along with integrated planning and control in process industries

Recommended Books

1. Biegler, L. T., Nonlinear Programming: Concepts, Algorithms, and Applications to Chemical Processes. SIAM, 2010

2. 2. Buzzi-Ferraris, G.; Manenti, F., Nonlinear Systems and Optimization for the Chemical Engineer: Solving Numerical Problems. John Wiley & Sons, 2013
3. 3. Corsano, G.; Montagna, J. M.; Iribarren, O. A.; Aguirre, P. A., Mathematical Modeling Approaches for Optimization of Chemical Processes. Nova Science Publishers, 2009
4. 4. Edgar, T. F.; Himmelblau, D. M.; Lasdon, L. S., Optimization of Chemical Processes. 2nd Edition; McGraw Hill, 2001
5. 5. Floudas, C. A., Nonlinear and Mixed-Integer Optimization: Fundamentals and Applications. Oxford University Press, 1995
6. 6. Rangaiah, G. P.; Bonilla-Petriciolet, A., Multi-objective Optimization in Chemical Engineering: Development and Applications. John Wiley & Sons, 2013
7. 7. Schneider, J. J.; Kirkpatrick, S., Stochastic Optimization. Springer, 2006

ChE-440: Chemical Safety and Security

(1) Fundamentals of chemical safety and security (2) CPCW overview-chemical safety and security (3) Physical security principles and vulnerability assessment tools and techniques (4) Information security management and employment reliability procedures (5) Principle of transportation security and safety (6) Overview of Procurement and transportation facilities (7) Secure Chemical management and principles (8) Pakistani Prospective: Current chemical Secure Management processes, organizations and goals and incident prevention strategies.

Recommended Books:

1. L. Moran and T. Masciangioli, Chemical Laboratory Safety and Security-A Guide to Prudent Chemical Management, The National Academies Press, Washington, DC: 2010

ChE-441: Process Equipment Malfunction

(1) Introduction (2) Distillation Tray Malfunctions (3) Packed Tower Problems (4) Distillation Tower Pressure and Composition Control (5) Reboiled and Steam Side Strippers (6) Inspecting Tower Internals-Checklist (7) Process Reboilers—Shell and Tube (8) Condenser Limitations (9) Air Coolers—Forced- and Induced-Draft Air Side Malfunctions (10) Steam Quality Problems (11) Level Control Problems (12) Process Plant Corrosion (13) Centrifugal Pump and Driver Capacity Limits: Lubrication Failures.

Recommended Books:

1. N. P. Lieberman, Process Equipment Malfunctions: Techniques to Identify and Correct Plant Problems, McGraw-Hills, 2011

ChE-404: Instrumentation and Control

(1) Importance of instrumentation and control in process industry (2) Parts of instruments: sensor, modifier, and recorder (3) Dynamic and static properties of instruments (4) Available technology of instrumentation for (a) Temperature (b) Flow (c) Level (d) Weight (e) Load (f) Pressure (g) Composition (5) Standard symbols for instrumentation & control systems (6) Selection, installation, and calibration for process instrumentation (7) Design and hardware elements of control (8) Feedback and feed forward control configurations (9) Dynamics of first and second order systems (10) Stability analysis of chemical processes (11) Frequency response Analysis (12) Multiple control loops: Cascade, ratio, and over-riding control (13) Computer control systems (14) Introduction to distributed control systems (15) Software tools for instrumentation sizing such as Fischer Valve Specification Manager, orifice sizing, level, pressure and temperature transmitter calibration etc (16) Use of MATLAB Simulink to study process dynamics of typical chemical engineering processes

Recommended Books

1. G. Stephanopoulos, Chemical Process Control: An Introduction to Theory and Practice, Prentice Hall, 1984
2. D. O de Sa, Instrumentation Fundamentals for Process Control, 1st Ed., CRC Press: 2001
3. B. A. Ogunnaike, and W. H. Ray, Process Dynamics, Modeling, and Control, 1st Ed., Oxford University Press: 1994
4. D. R. Coughanowr, and L. B. Koppel, Process Systems Analysis and Control, International Ed., Graw-Hill: 1965
5. C. A. Smith, and A. Corripio, Principles and Practice of Automatic Process Control, Wiley: 1700
6. W. L. Luyben, and M. L. Luyben, Essentials of Process Control, McGraw-Hill College: 1996
7. C. D. Johnson, Process Control: Instrumentation Technology, 8th Ed., Pearson: 2005

8. T. E. Marlin, Process Control: Designing Processes and Control Systems for Dynamic Performance, 2 Ed., McGraw-Hill Science/Engineering/Math: 2000

ChE-461: Final Year Project– I

Plant design project is the practical demonstration of a student's theoretical knowledge. In plant design project, a group of students is assigned a project that includes process selection, capacity selection, overall material and energy balance, design of different units or equipment, instrumentation and control, economic analysis of plant, hazard assessment and HAZOP study, etc. Students are required to present their project in front of class and faculty in a seminar to help improve their interpersonal and communication skills.

Semester 8

ChE-413 Transport Phenomena

(1) Importance and levels of transport phenomena (2) Momentum transport: (a) Newton's law of viscosity in 1 and 3 dimensions (b) Pressure and temperature dependence of viscosity (c) Theory of viscosity of gases at low density (d) Theory of viscosity of liquids (e) Estimation of viscosity of suspensions and emulsions (f) Convective momentum transport (3) Velocity distributions in laminar flow using shell energy balances: (a) Boundary conditions for shell momentum balances (b) Flow of a falling film (c) Flow through a circular tube (d) Flow through an annulus (e) Flow of adjacent immiscible liquids (f) Creeping flow around a sphere (4) Equations of change for isothermal systems: (a) Equation of continuity (b) Equation of motion (c) Substantial derivative (d) Solution of isothermal flow problems using equations of change (e) Dimensional analysis of the equations of change for isothermal systems (5) Energy transport: (a) Fourier's law of heat conduction (b) Pressure and temperature dependence of thermal conductivity (c) Theory of thermal conductivity of gases at low density (d) Theory of thermal conductivity of liquids (e) Thermal conductivity of pure and composite solids (f) Convective transport of energy (g) Work from molecular motions (6) Temperature distributions in solids and laminar flow using shell energy balances: (a) Boundary conditions for shell energy balances (b) Heat conduction with electrical, nuclear, viscous, and chemical reaction heat sources (c) Heat conduction through rectangular and circular composite walls (d) Heat conduction in a cooling fin (e) Energy transport in forced and free convection (7) Equations of change for nonisothermal systems: (a) Energy equation; Boussinesq equation of motion for forced and free convection (b) Solution of steady state energy transport problems using equations of change (8) Mass transport: (a) Fick's law of binary diffusion (b) Pressure and temperature dependence of diffusivities (c) Theory of diffusion of gases at low density (d) Theory of diffusion in binary liquids (e) Theory of diffusion in colloidal suspensions (f) Convective transport of mass (g) Multicomponent diffusion in gases at low density (9) Concentration distributions in solids and laminar flow using shell mass balances: (a) Boundary conditions for shell mass balances (b) Diffusion through a stagnant gas film (c) Diffusion with heterogeneous and homogeneous chemical reactions (d) Gas absorption and solid dissolution into a falling liquid film (e) Diffusion and chemical reaction inside a porous catalyst (f) Diffusion in a 3-component gas system (10) Equations of change for multicomponent

systems: (a) Equations of continuity for a multicomponent mixture (b) Multicomponent fluxes (c) Applications of the equations of change for mixtures.

Recommended Books

1. Bird, R. B.; Stewart, W. E.; Lightfoot, E. N., Transport Phenomena. 2nd Ed., John Wiley & Sons, Inc.: 2002 [Chapters 0–3, 9–11, 17–19]
 2. Bird, R. B.; Stewart, W. E., Lightfoot, E. N., Klingenberg, D. J., Introductory Transport Phenomena. John Wiley & Sons, Inc.: 2014
 3. Deen, W. M., Analysis of Transport Phenomena. 2nd Ed., Oxford University Press: 2011
 4. Plawsky, J. L., Transport Phenomena Fundamentals. 3rd Ed., CRC Press: 2014
 5. Thomson, W. J., Introduction to Transport Phenomena. Prentice Hall: 2000
- Welty, J. R.; Rorrer, G. L.; Foster, D. G., Fundamentals of Momentum, Heat and Mass Transfer. 6th Ed., John Wiley & Sons, Inc.: 2014

ChE-401: Chemical Reactor Design

(1) Non-isothermal reactor design for single reaction: (a) Equilibrium conversions and optimum temperature progression (b) Multiple steady states (c) Adiabatic reactor design (2) Solid catalyzed reactions: (a) Overview of heterogeneous reactions (b) Rate equation for surface kinetics (c) Pore diffusion resistance combined with surface kinetics (d) Performance equations for reactors containing porous catalyst particles (e) Experimental methods for finding rates of heterogeneous reactions (3) Fluid particle reactions (Non-catalytic systems): kinetics and design: (a) Shrinking core model for spherical particle of unchanging/changing size (b) Determination of rate controlling steps (4) Effect of particle size distribution and flow pattern of solid and fluids on the reactor design.

Recommended Books:

1. O. Levenspiel, Chemical Reaction Engineering, 3rd Ed., John Wiley and Sons Inc.: 1999
2. H. S. Fogler, Elements of Chemical Reaction Engineering, 4th Ed., Prentice- Hall Inc: 2005
3. C G Hill, An Introduction to Chemical Engineering Kinetics & Reactor Design, 2nd Ed.S, John Wiley and Sons Inc.: 2014

MGT-320: Project Management in Engineering

(1) Introduction of Project Management; (2) Challenges to Effective Project Management; (3) Fundamentals of Project Management; (4) Nine Knowledge Areas of Project Management; (5) Project Management Process Groups; (6) Project Management Life Cycles; (7) Project Scope Planning; (8) Project Planning; (9) Project Launching; (10) Project Monitoring and Controlling; (11) Project Management Infrastructure; (12) Project Portfolio Management; (13) Continuous Process Improvement.

Recommended Books

1. Robert, K. Wysocki (2013). Effective Project Management: Traditional, Agile, Extreme. (7th Edition).
2. Wiley.-Pmbok Guide (2021). A Guide to The Project Management Body of Knowledge. (7th Edition). Pmi.

ChE-431: Maintenance Engineering

(1) Types of maintenance and their applications (a) Preventive Maintenance Cycle (2) Maintenance management (3) Maintenance of pumps, machines, and piping (4) Lubrication programs (5) Forms of corrosion, its prevention, and inhibition (6) Design considerations: layout and construction (7) Overall safety of plant and personnel (8) Fire and explosion (9) Health hazards (10) Accident prevention (11) Government regulations for industrial safety (12) Plant start up and shut down safety reviews.

Recommended Books

1. B.S. Dhillon, "Engineering Maintenance-A modern Approach, CRC Press: 2002

ChE-421: Gas Engineering

(1) Properties and Composition of Natural gas: (a) Thermodynamic and transport properties (b) Critical properties (c) CNG (d) LNG (e) LPG (f) SNG (g) Associated and non-associate gas (h) Dry and wet natural gas (i) Sweet and Sour gas (2) Phase behavior of natural gas systems: (a) PVT behavior (b) Retrograde Phenomena (3) Treatment of Crude gas: (a) Dehydration (b) Sweetening of gas (4) Gas hydraulics: (a) General flow equation and their modified forms (b) Average Pressure in Pipelines (c) Erosion Velocity (d) Pipe and series and Parallel (e) Locating

pipe loops (f) Effect of pipeline Elevation and pipe delivery pressure on Pressure drop (g) Compressor station (h) Multistage Compression along with inter-stage cooling (i) Location of Compressor Station (j) Corrosion protection of gas pipelines (k) Pipeline economics.

Recommended Books:

1. D. L. Katz, Handbook of Natural Gas Engineering, 1st Ed., McGraw-Hill: 1959
2. K. Arnold, and M. Stewart, "Surface Production Operations —Vol 2: Design of Gas Handling Systems and Facilities, 2nd Ed., Gulf Publishing: 1999
3. S. Mokhatab, W. A. Poe, and J. G. Speight, Handbook of Natural Gas Transmission and Processing, 1st Ed., Gulf Publishing: 2006
4. E. S. Menon, Gas Pipeling Hydraulics, 1st Ed., CRC Press: 2005

ChE-422: Biochemical Engineering

(1) Introduction to chemical engineering and biotechnology (2) Enzyme production and kinetics (3) Substrate and its utilization (4) Biomass production and product formation (5) Experimental techniques (6) Immobilization materials and techniques (7) Biochemical reactors (8) Downstream processing (9) Applications and future of biotechnology

Recommended Books

1. J. E. Bailey, D. F. Ollis, "Biochemical Engineering Fundamentals, 2nd Ed., McGraw-Hill: 1986
2. G. Najafpour, "Biochemical Engineering and Biotechnology", 1st Ed.: 2006
3. D. S. Clark, H. W. Blanch, "Biochemical Engineering", 2nd Ed., CRC Press: 1997

ChE-427: Biomass and Biofuels

(1) Fundamental concepts in understanding biofuels/bioenergy systems (2) Renewable feed stocks, their production, availability and attributes for biofuel/bioenergy production (3) Types of biomass derived fuels and energy (4) Thermochemical conversion of biomass to heat, power and fuel (5) Biochemical conversion of biomass to fuel (6) Environmental aspects of biofuel

production (7) Economics and life-cycle analysis of biofuel (8) Value adding of biofuel residues (9) Case studies on biofuel production.

Recommended Books:

1. Robert C. Brown, *Biorenewable Resources: Engineering New Products from Agriculture*, Wiley-Blackwell Publishing: 2003.
2. Samir K. Khanal, “*Anaerobic Biotechnology for Bioenergy Production: Principles and Applications*”. Wiley-Blackwell Publishing: 2008.
3. O. Konur. “*Bioenergy and biofuels*”, 1 Ed., CRC Press, 2017
4. S. K. Khanal, R. Y. Surampalli, T. C. Zhang, B. P. Lamsal, R. D. Tyagi and C. M. Kao “*Bioenergy and Biofuel from Biowastes and Biomass*” American Society of Civil Engineers, 2010
5. Shibu Jose and Thallada Bhaskar, “*Biomass and biofuels, Advanced biorefineries for sustainable production and distribution*” 1 Ed., CRC Press, 2015
6. Anju Dahiya, “*Bioenergy, Biomass to biofuels*” Elsevier Publishing Co. Inc, 2014

ChE-428: Industrial Safety and Risk Management

(1) Introduction (2) Identification of hazards and basic definitions (3) Fire protection (4) Explosions and detonations (5) Toxicity and safe handling of materials (6) Hazard and operability studies (HAZOP) (7) Risk analysis (8) Strengths and limitations of quantitative risk assessment, modelling, a systematic approach to risk reduction, human factors, management of process safety, insurance (9) Industrial hygiene, identification MSDS, evaluating exposure to volatile toxicants (10) Source models, flow of liquid through a hole, liquids through pipes - 2K method, vapor and gases through pipes, flashing liquids (11) Toxic release and dispersion models, parameters affecting dispersion (12) Fires and explosions, Definitions, Flammability characteristics of liquids and vapors.

Recommended Books:

1. Tweeddale, Mark, *Managing risk and reliability of process plants*”, Gulf Professional Publishing: 2003

2. Kletz, Trevor, What went wrong, Case histories of process plant disasters”, 2nd Ed., Gulf Professional Publishing: 1998
3. Kletz, Trevor, Still going wrong, Case histories of process plant disasters and how they could have been avoided, Gulf Professional Publishing: 2003
4. Crowl, Daniel A. and Louvar, Joseph F., “Chemical process safety, Fundamentals with applications”, 2nd Ed., Prentice Hall: 2002
5. Ammerman, Max, The Root Cause Analysis Handbook: A Simplified Approach to Identifying, Correcting, and Reporting Workplace Errors.
6. Crawley, Frank., Preston, Malcolm., and Tyler, Brian., HAZOP Guide to Best Practice, 2nd Edition, IChemE, 2008
7. Hopkins, Andrew, Lessons from Longford: The Esso Gas Plant Explosion, North Ryde, N.S.W. CCH Australia: 2000

ChE-429: Clean Coal Technologies

(1) Introduction to combustion fundamentals: (a) Reaction kinetics (b) Combustion chemistry (c) Flames (d) Power generation systems such as, gas-fired furnaces, premixed-charged engines, oil-fired furnaces, gas-turbines, direct injection engines, fixed-bed combustors, pulverized fuel combustors, and fluidized bed combustors (2) Conventional Technologies: (a) Coal washing (b) Wet scrubbers (c) Low NO_x (nitrogen oxide) burners (d) Electrostatic precipitators (3) Oxy-fuel combustion (4) Flue gas Separation techniques (5) Carbon dioxide capture technologies (6) Carbon dioxide Sequestration (7) Environmental impact of advanced clean coal technologies.

Recommended Books:

1. B. Miller, Clean Coal Engineering Technology, 2nd Ed., Butterworth-Heinemann: 2016
2. P. J. Reddy Clean Coal Technologies for Power Generation, 1st Ed., CRC Press, 2013

ChE-430: Material Characterization Techniques

(1) Introduction to materials and Techniques (2) Structure analysis tools: X-ray diffraction (3) Microscopy techniques: Optical microscopy (4) Thermal analysis technique: Differential thermal analysis (DTA), Thermo gravimetric analysis (TGA) (5) Electrical characterization techniques (6) Magnetic characterization techniques (7) Spectrophotometry (8) Chromatography (9) Optical

and electronic characterization techniques: (a) Fourier transform infrared spectroscopy (b) X-ray photoelectron spectroscopy.

Recommended Books:

1. D.K.Schroder, Semiconductor Material and Device Characterization, 3rd Edition, Wiley-IEEE Press: 2006
2. S Zhang, L. Li and Ashok Kumar, “Materials Characterization Techniques”, CRC Press :2008
3. P.E. J. Flewitt and R K Wild, “Physical methods for Materials Characterization”, IOP Publishing: 2003
4. Ed. Z LWang, “Characterization of Nanophase materials”, Willet-VCH: 2000

ChE-444: Machine Learning in Chemical Engineering

(1) Introduction to Machine Learning: Supervised learning, Unsupervised learning, Reinforcement learning concepts, Applications of Machine Learning in Chemical Engineering (process optimization, safety prediction, etc.). (2) Data Preprocessing in Chemical Engineering: Data Cleaning: Addressing missing data, outliers, and data normalization. Feature Engineering: Selecting relevant features, creating new informative features, and data transformation. (3) Supervised Learning Algorithms: Introduction to Linear Regression and its applications in Chemical Engineering, Classification Techniques: Logistic Regression, Support Vector Machines (SVM), Decision Trees and Random Forests Regression for property prediction, reaction engineering. (4) Unsupervised Learning Algorithms: Principal Component Analysis (PCA) for dimensionality reduction, Clustering algorithms (K-Means) for process monitoring and anomaly detection. (5) Deep Learning in Chemical Engineering: Introduction to Artificial Neural Networks (ANNs), Convolutional Neural Networks (CNNs) for image analysis in Chemical Engineering (microscopy, reaction monitoring), Introduction to CNN architectures for object detection (e.g., YOLO, R-CNN). (6) Case Studies and Project Development: Case studies of Machine Learning applications in the Chemical Industry, Student project, Formulate and implement a machine learning solution for a specific chemical engineering problem.

Recommended Books:

1. Eklas Hossain, Machine Learning Crash Course for Engineers, Springer 2024, <https://doi.org/10.1007/978-3-031-46990-9>
2. Sanchez Medina, Edgar Ivan and del Rio Chanona, Ehecatl Antonio and Ganzer, Caroline, Machine Learning in Chemical Engineering, Year 2023 <https://doi.org/10.5281/zenodo.7986905>
3. Ryan G. McClarren, Machine Learning for Engineers, using data to solve problems for physical systems, Springer 2021 <https://doi.org/10.1007/978-3-030-70388-2>

ChE-443: Electrochemical Engineering

(1) Basic Principles of Electrochemical system: (a) Electrochemical Cell (b) Characteristics of electrochemical reactions, (c) Faraday's Law, (d) Potential and Ohm's law (2) Cell Potential and Thermodynamics: (a) Electrochemical reaction, (b) Cell Potential, (c) Use of cell potential, (d) Equilibrium Constants & Nernst Equation (3) Electrochemical Kinetics: (a) Reaction fundamentals (b) Butler-Volmer equation, (c) Use of kinetic expression in full cells (d) Current efficiency (4) Electrode Structure and Configuration: (a) Porous electrodes, (b) Gas/liquid interface in porous electrodes, (c) Three-phase electrodes (5) Batteries: (a) Components of a battery cell (b) types and classifications of batteries (c) Theoretical capacity and state of charge (d) Thermal management in batteries (6) Fuel Cells: (a) Types of fuel cells (b) Membrane-electrode assembly (c) Current-Voltage characteristics (d) Fuel cell stack and system (7) Electrodeposition: (a) Faraday's law and deposit thickness (b) Electrodeposition fundamentals (c) Deposit morphology (d) Electroplating and its applications (8) Industrial Electrolysis: (a) Examples of industrial electrolytic processes (b) Designs of electrochemical reactors for industrial applications (c) Electrolytic processes for sustainable future (9) Corrosion: (a) Corrosion fundamentals (b) thermodynamics of corrosion (c) Corrosion rate and its mitigations

Recommended Books:

1. Thomas F. Fuller and John N. Harb, (2018), Electrochemical Engineering, Willey
2. Carlos M. Marschoff and Pablo D. Giunta, (2023), An Introduction to Electrochemical Science and Engineering, Cambridge Scholars Publishing

ChE-444: Textile Technology

(1) Textile Fiber, (2) Yarn Formation, (3) Fabric Formation, (4) Wool and Silk, (5) Cotton Bleaching, (6) Weaving, (7) Chemical Processing of Textile, (8) Desizing, (9) Scouring, (10) Types of Dyeing, Yarn, and Fabric Dyeing, (11) Dyeing Equipments, (12) Fabric Printing and Finishing Processes and their Equipments, (13) Textile Testing and Instruments, (14) Textile Mill Management.

Recommended Books:

1. Manual of Cotton Spinning (Opening & Cleaning) by C. Shrigley
2. Principles of Weaving by Marks & Robinson
3. Sizing – Materials, Methods, Machinery by Ajoankar, Talukdar & Wadekar
4. Textile Chemistry, Vol. II by R.H. Peters
5. Dyeing and Chemical Technology of Textile Fibres by E.R. Trotman
6. Chemical Technology of Fibrous Materials by F. Sadov, M. Korchagin and A. Matetsky
7. Textile Testing by Skinkle
8. Testing and Quality Management by V.K. Kothari

ChE-462: Final Year Project– II

Same as ChE-461: Final Year Project – I.

QT – 401: Translation of the Holy Qur’ān -IV

Translation of Parah 25 to 30 of Holy Qur’ān

Recommended Books

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|-----------------------------------|--|---|---|
| فتح محمد جالندهری | 2. فتح القرآن | شاه عبدالقادر دہلوی | . موضح القرآن احمد |
| 3. ترجمہ قرآن مجید حافظ نذر | 5. احسن البیان | 4. آسان ترجمہ قرآن سید شبیر حسین | ضیا القرآن |
| 6. ترجمہ مولانا محمد جونا گڑھی | 8. ترجمہ قرآن | پیر کرم شاہ الازہری | 7. آسان ترجمہ قرآن مولانا محمد تقی عثمانی |
| 9. کشف الرحمن مولانا اشرف تھانوی | 11. مصباح القرآن | 10. ترجمہ تبیان القرآن مولانا غلام رسول سعیدی | مولانا احمد سعید دہلوی |
| 12. معانی ڈاکٹر عبدالرحمن طاہر | 14. قرآن مجید، لفظی ترجمہ ڈاکٹر فرحت ہاشمی | 13. ترجمہ قرآن سید ابو الاعلیٰ مودودی | سید مقبول احمد دہلوی |
| 15. مقبول القرآن ڈاکٹر فرحت ہاشمی | 16. آسان ترجمہ قرآن محمد ظفر | Marmaduke Pickthal | The meaning of Glorious Qur’ān.17 |
| | | Abdullah Yousaf Ali | Qur’ān Translation English .18 |
| | | Dr. Mohammad Mahmood Ghali | Qur’ān Translation English .19 |
| | | Muhammad Asad | Qur’ān Translation English .20 |