

# Curriculum

(Intake 2020 and onwards)

Course No. and Title		Credit Hours	Prerequisite Courses (if any)
<b>Semester 1</b>			
ChE-101	Industrial Stoichiometry – I	3 (3, 0)	---
CS-103 & CS-103L	Introduction to Computer Programming for Data Science	3 (2, 1)	---
CY-142 & CY-142L	Physical and Analytical Chemistry	3 (2, 1)	---
HU-111L	Communication Skills	1 (0, 1)	---
MA-113	Calculus and Analytic Geometry	3 (3, 0)	---
ME-122L	Engineering Drawing	2 (0, 2)	---
QT – 101	Translation of the Holy Qur’ān -I	1 (1,0)	---
<b>Subtotal</b>		<b>16 (11, 5)</b>	---
<b>Semester 2</b>			
ChE-108	Fluid Flow-I	3 (3,0)	---
ChE-104	Health and Safety at Workplace	2 (2,0)	---
ChE-109 & ChE-109L	Chemical Process Industries	3 (2, 1)	---
IS-101 or HU-101	Islamic and Pakistan Studies – I (Muslim students) or Ethics and Pakistan Studies – I (non-Muslim students)	3 (3, 0)	---
MA-118	Applied Mathematics and Statistics	3 (3, 0)	---
ME-100L	Workshop Practice	1 (0, 1)	---
PHY-113 & PHY-113L	Applied Physics	3 (2, 1)	---
<b>Subtotal</b>		<b>18 (15, 3)</b>	---
<b>Semester 3</b>			
ChE-201	Industrial Stoichiometry – II	3 (3, 0)	Industrial Stoichiometry – I
ChE-203 & ChE-203L	Particle Technology	4 (3, 1)	---
ChE-204 & ChE-204L	Chemical Engineering Thermodynamics – I	4 (3, 1)	---
CY-221 & CY-221L	Inorganic and Organic Chemistry	3 (2, 1)	---

Course No. and Title		Credit Hours	Prerequisite Courses (if any)
HU-221L	Technical Writing and Presentation Skills	1 (0, 1)	---
MA-233L	Applied Mechanics	1 (0, 1)	---
QT – 201	Translation of the Holy Qur’ān -II	1 (1,0)	---
<b>Subtotal</b>		<b>17 (12, 5)</b>	---
<b>Semester 4</b>			
ChE-208 & ChE-208L	Fluid Flow-II	3 (2, 1)	Fluid Flow-I
ChE-209 & ChE-209L	Process Heat Transfer	4 (3, 1)	---
ChE-210 & ChE-210L	Separation processes-I	4 (3,1)	---
EE-140 & EE-140L	Electrical Technology	3 (2, 1)	---
IS-201 or HU-201	Islamic and Pakistan Studies – II (Muslim students) or Ethics and Pakistan Studies – II (non-Muslim students)	3 (3, 0)	---
<b>Subtotal</b>		<b>17 (13, 4)</b>	---
<b>Semester 5</b>			
ChE-301& ChE-301L	Chemical Reaction Engineering	4 (3, 1)	---
ChE-311	Engineering Materials	2 (2, 0)	---
ChE-312 & ChE-312L	Unit Processes	3 (2, 1)	---
ChE-304	Chemical Engineering Thermodynamics – II	3 (3, 0)	Chemical Engineering Thermodynamics – I
MA-240 & MA-240L	Numerical Analysis	3 (2, 1)	---
MGT-413	Entrepreneurship	3 (3,0)	---
<b>Subtotal</b>		<b>18 (15, 3)</b>	---
<b>Semester 6</b>			
ChE-313	Chemical Process Design & Economics	3 (3,0)	---
ChE-314	Chemical Engineering Mathematics	2 (2, 0)	---
ChE-310 & ChE-310L	Separation Processes-II	3 (2, 1)	Separation Processes-I
ChE-307	Transport Phenomena	3 (3, 0)	---
ChE-308 & ChE-308L	Energy Engineering	4 (3, 1)	---

Course No. and Title		Credit Hours	Prerequisite Courses (if any)
ChE-315 L	Process Modeling and Simulation	2 (0,2)	---
QT – 301	Translation of the Holy Qur’ān -III	1 (1,0)	---
<b>Subtotal</b>		<b>18 (14, 4)</b>	---
<b>Semester 7</b>			
ChE-401	Chemical Reactor Design	2 (2, 0)	Chemical Reaction Engineering
ChE-409	Chemical Process Equipment Design and Rating	3 (3, 0)	---
ChE-432 to ChE-441	Elective-I	2 (2, 0)	---
ChE-404 & ChE-404L	Instrumentation and Control	4 (3, 1)	---
ChE-410	Engineering Management	2 (2, 0)	---
ChE-461	Final Year Project – I	3 (0, 3)	Final year standing
<b>Subtotal</b>		<b>16 (12, 4)</b>	---
<b>Semester 8</b>			
ChE-406 & ChE-406L	Environmental Engineering	4 (3, 1)	---
ChE-432 to ChE-441	Elective-II	2 (2,0)	---
ChE-421 to ChE-431	Elective-III	3 (3, 0)	---
ChE-421 to ChE-431	Elective-IV	3 (3, 0)	---
ChE-462	Final Year Project – II	3 (0, 3)	Final Year Project – I
QT – 401	Translation of the Holy Qur’ān -IV	1 (1,0)	---
<b>Subtotal</b>		<b>16 (12, 4)</b>	---
<b>Grand Total</b>		<b>136 (104, 32)</b>	

Note: As per policy, the followings are mandatory for all students.

1. Internship
2. Community/Research Project
3. International Language

## Elective Subjects

(One subject required)

Course No. and Title		Credit Hours	Prerequisite Courses (if any)
ChE-421	Gas Engineering	3 (3, 0)	Final year standing
ChE-422	Biochemical Engineering	3 (3, 0)	Final year standing
ChE-427	Biomass and Biofuels	3 (3,0)	
ChE-428	Industrial Safety and Risk Management	3 (3,0)	
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)	

## Course Contents

(Alphabetical listing of course codes)

### Semester 1

#### ChE-101: Industrial Stoichiometry – I

(1) Dimension and units: (a) Conversion of units (b) Dimensional consistency and analysis (2) Stoichiometric and composition relations: Mole fraction, mass fraction, volume fraction, molarity, molality, normality, formality, parts per million, parts per billion (3) 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) (4) 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 (5) 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

### **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

**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

### **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-122L: Engineering Drawing

(1) Introduction (2) Types of lines (3) Lettering (4) Dimensions (5) Use of pencil and drawing instruments (6) Planning of drawing sheet (7) Projections (8) Types of projections (9) Orthographic projections (10) Plane of projections (11) Four quadrant (12) Sections of joints (13) Screw thread system (14) Nuts and bolts (15) Coupling and simple bearings (16) Pipe connections and engine details (17) Preparation of assembly drawings.

## Recommended Books:

1. L.B. Cook, Basic Engineering Drawing, 2nd Ed., Longmans: 1990

## 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 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 | 10. ترجمہ تبیان القرآن              |
| محمد ظفر              | 16. آسان ترجمہ قرآن         | Marmaduke Pickthal<br>Abdullah Yousaf Ali<br>Dr. Mohammad Mahmood Ghali<br>Muhammad Asad | مولانا غلام رسول سعیدی | 13. ترجمہ قرآن                      |
|                       |                             |  |                        | 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      |

## Semester 2

### 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 (7) Incompressible flow in pipes and channels: (a) Shear stress and skin friction in pipes (b) Friction factor; Flow in noncircular channels (c) Equivalent diameter (d) Velocity distribution in laminar flow in a pipe (e) Hagen–Poiseuille equation (f) Velocity distribution in turbulent flow (g) Universal velocity distribution equations and their limitations (h) Effect of surface roughness (i) Friction factor chart (j) Drag reduction in turbulent flow (k) No isothermal flow (l) Laminar flow in an annulus.

### 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-104: Health and Safety at Workplace**

(1) Health and safety foundations: (a) Nature and scope of health and safety (b) Reasons/benefits and barriers for good practices of health and safety (c) Legal frame work and OHS Management System (2) Fostering a safety culture: (a) Four principles of safety- RAMP (b) Re-thinking safety-learning from incidents (c) Safety ethics and rules (d) Roles and responsibilities towards safety (e) Building positive attitude towards safety (f) Safety cultures in academic institutions (3) Recognizing and communicating hazards: (a) Hazards and Risk (b) Types of hazards: Physical (mechanical and non-mechanical), Chemical (Toxic and biological agents), Ergonomics, Electrical, Fire (4) Learning the language of safety: Signs, symbols and labels (5) Finding hazard information: (a) Material safety data sheets (b) Safety data sheets and the GHS (6) Assessing and Minimizing the Risks from Hazards: (a) Risk Concept and Terminology (b) Risk assessment procedure (c) Risk Metric's (d) Risk Estimation and Acceptability Criteria (e) Principles of risk prevention (f) Selection and implementation of appropriate Risk controls (g) Hierarchy of controls (7) Preparing for Emergency Response: (a) Fire (b) Chemical Spill (c) First Aid (8) Chemical Management: Inspections, storage, wastes and security (9) Incident investigating, recording and reporting, Monitoring, Review and Auditing Health and Safety

#### **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 Hand book for the NEBOSH General Certificate, Butterworth-Heinemann publications

#### **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.

#### **IS-101: Islamic and Pakistan Studies – I**

(1) Islam and basic beliefs (2) Islamic teachings regarding social behavior (3) Prophetic life as a role model (4) History of Holy Quran (5) Importance of Hadith (6) Prophetic ethical behaviors (7) Islam and halal and haram (8) Islamic rules of purity and cleanliness (9) Relationship with other religions (10) Islam and ethics (11) Islam and modern Sciences (12) Ideology of Pakistan: (a) Definition and explanation (b) With reference to Allam Iqbal and Quaid-e- Azam (c) Aim and objectives of creation of Pakistan (13) Muslim rule in South Asia: Muhammad Bin Qasim, Tolerance, religious freedom and kind treatment towards Non-Muslims (14) Services of Sir Syed Ahmad Khan (15) Services of Mujadid Alf Sani (16) Services of All India Muslim League (17) Pakistan Movement.

Alternatively, HU-101: Ethics and Pakistan Studies – I is compulsory for non-Muslim students.

### **Recommended Books:**

1. Selected Surahs and Verses from the Holy Quran
2. Abu Zakrya Yahya bin Sharf Al NAWazi, Arbaeen Nawawi, \*Indian Printed BEST Quality: 2009
3. Shibli Nomani, Seerat ul Nabi, 1914
4. Ikram Rabbani, Comprehensive book of Pakistan Studies, Caravan Book House, Lahore: 2011 (1989)

### **MA-118: Applied Mathematics and Statistics**

(1) Product and quotient of complex numbers in polar form (2) Properties of complex numbers (3) Logarithm of a complex number (4) De Moivre's theorem (5) The nth roots of a number (6) Solution of equations (7) A review of matrices: (a) Determinants and finding inverse of a matrix through elementary row operations (b) Solution of systems of linear equations (c) Eigenvalues and eigenvectors (8) Formation of differential equations: (a) Solution of various types of first order differential equations (b) Orthogonal trajectories (c) Application in physical problems (d) Linear differential equations of second order (e) Complementary function and particular integral (9) Formation of partial differential equations (10) Solution of equations reducible to ordinary differential equations (11) Periodic functions: (a) Even and odd functions (b) Fourier series of functions of period 2 (c) Arbitrary period (d) Half range series (12) Scalar and vector triple products: (a) Scalar and vector point functions (b) Differentiation and integration of vector point functions (c) Motion along a straight line with uniform acceleration (d) Motion along a curved path (e) Tangential and normal components of acceleration (f) Simple harmonic motion (13) Introduction and role of statistics in engineering: (a) Frequency distributions (b) Measures of central tendency and dispersion (c) Regression (d) Probability with basic theory of distributions (e) Nomograms.

### **Recommended Books:**

1. Thomas Finney, "Calculus & Analytical Geometry" 9th Ed., Addison Wesley Publishing Co: 1995
2. Erwin Kreyszig, "Differential Geometry", 1st Ed., Dover Publications: 2013

3. J. L. Devore, N. R. Farnum, and J. A. Doi, Applied Statistics for Engineers and Scientists, 3rd Ed., Duxbury Press: 2013
4. L. L. Pennisi, Elements of Complex Variables, 2nd Ed., Holt, Rinehart and Winston: 1976
5. N. A. Shah, Vector and Tensor Analysis, A-One Publishers: 1973

### **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 Manual
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-221L: 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) Getting started with technical writing: (a) Recognizing different audiences (b) Involving the audience (4) Making writing effective: (a) Achieving parallelism in writing (b) Constructing effective sentences.

### **Recommended Books:**

1. Anderson. V. Paul, Technical Communication: A Reader Approach, 5th Ed., Thomas Wadsworth: 2003
2. Gerson and Gerson, Technical Writing: Process and Product, 5th Ed., Pearson Education Inc. 2006
3. Huckin and Oslen, English for science and technology, McGraw-Hill Inc: 1983

4. McMurrey. D. Power, Tool for Technical Communication, Wadsworth Publishing Company: 2001

### MA-233L: Applied Mechanics-1

(1) Experimental work related to the following core areas of mechanics: (a) Inertia and moment of inertia of flywheel (b) Determination of coefficient of friction for different systems (c) Basiler suspension (d) Mechanics of Weston differential pulley (e) Performance evaluation of tie-and-jib and force analysis (f) Mechanical advantage and its applications (g) Estimation of efficiency losses for various systems and study of techniques to improve efficiency

### Recommended Books:

1. S. Timoshenko, D. H. Young, and J. V. Rao, Engineering Mechanics, 5th Ed., Pearson: 2007

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

Translation of Parah 9 to 16 of Holy Qur’ān

### Recommended Books

- |                              |                             |  |                                       |   |
|------------------------------|-----------------------------|--|---------------------------------------|---|
| فتح محمد جالندهری            | 3. ترجمہ قرآن مجید حافظ نذر | 2. فتح القرآن  | شاه عبدالقادر دہلوی                   | 1. موضح القرآن احمد                           |
| مولانا محمد جونا گڑھی        | 6. ترجمہ                    | 5. احسن البیان   | 4. آسان ترجمہ قرآن سید شبیر حسین      | 4. آسان ترجمہ قرآن سید شبیر حسین              |
| 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 مولانا محمد تقی عثمانی     |
| ڈاکٹر فرحت ہاشمی             | 15. مقبول القرآن            | 14. قرآن مجید، لفظی ترجمہ  | مولانا احمد سعید دہلوی                | 10. ترجمہ تبیان القرآن مولانا احمد سعید دہلوی |
| 16. آسان ترجمہ قرآن محمد ظفر |                             | Marmaduke Pickthal<br>Abdullah Yousaf Ali<br>Dr. Mohammad Mahmood Ghali<br>Muhammad Asad | 13. ترجمہ قرآن سید ابو الاعلیٰ مودودی | 10. ترجمہ تبیان القرآن مولانا احمد سعید 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                |

## Semester 4

### ChE-208: Fluid Flow-II

(1) Friction from changes in velocity or direction: (a) Friction loss from sudden expansion or contraction of cross section (b) Effect of fittings and valves (c) Velocity heads (d) Boundary layer separation in a diverging channel (2) Flow of compressible fluids: (a) Mach number (b) Continuity equation (c) Total energy balance equation (d) Mechanical energy balance equation (e) Acoustical velocity (f) Stagnation temperature (g) Isentropic flow through nozzles (h) Adiabatic friction flow (i) Isothermal friction flow (3) Flow past immersed objects: (a) Drag and drag coefficients (b) Stokes' law; Streamlines (c) Stagnation point (d) Stagnation pressure (e) Flow through beds of solids (f) Darcy's law (g) Kozeny–Carman equation (h) Burke–Plummer equation (i) Ergun equation (j) Motion of particles through fluids (k) Terminal velocity (l) Criterion for settling regime (m) Hindered settling (n) Settling and rise of bubbles and drops (4) Fluidization: (a) Conditions for fluidization (b) Minimum fluidization velocity (c) Types of fluidization (d) Expansion of fluidized beds (e) Bubbling fluidization (f) Applications of fluidization (g) Hydraulic and pneumatic transport using continuous fluidization (5) Transportation of fluids: (a) Selection of pipe sizes (b) Joints and fittings (c) Allowances for expansion (d) Prevention of leakage around moving parts (e) Various types of valves (6) Fluid moving machinery: (a) Various types of pumps (b) Developed head (c) suction lift and cavitation in pumps (d) Power requirements for pumps (e) Fans and blowers (f) Various types of compressors (g) Power requirements for adiabatic, isothermal, and polytropic compression (h) Ejectors (7) Measurement of flowing fluids: (a) Venturi meter (b) Orifice meter (c) Rotameter (d) Turbine meter (e) Magnetic and ultrasonic meters (f) Coriolis meter (g) Pitot tube (h) Insertion meters (8) Agitation and mixing of liquids: (a) Types of impellers (b) Flow patterns in agitated vessels (c) Prevention of swirling (d) Flow number (e) Froude number (f) Power requirements for agitation (g) Blending of miscible liquids (h) Jet mixers (i) Static mixers (j) Suspension of solid particles (k) Liquid–liquid and gas–liquid dispersion operations (l) Agitator selection and scaleup.

### 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 — Volume 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-209: Process Heat Transfer**

(1) Modes of heat transfer: (a) Conduction (b) Free and forced convection (c) Radiation (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) Enthalpy balance in heat exchangers with and without phase change (c) Log-mean temperature difference (d) Individual and overall heat-transfer coefficients (e) Dimensionless numbers in heat transfer (4) Convective heat transfer to fluids without phase change: (a) Laminar and turbulent heat-transfer regimes (b) Thermal boundary layer (c) Heat transfer by forced convection in laminar and turbulent flows inside and outside tubes (d) Natural convection (5) Analogies between momentum and heat transfer: (a) Eddy diffusivity of heat (b) Reynolds analogy (c) Colburn analogy (6) Convective heat transfer from condensing vapors: (a) Drop-wise and film-type condensation (b) Estimation of heat-transfer coefficients (c) Condensation of superheated and mixed vapors (d) Effect of noncondensables (7) Convective heat transfer to boiling liquids: (a) Boiling regimes (b) Maximum and minimum heat flux (c) Estimation of heat-transfer coefficients (d) Thermosiphon (8) Heat transfer by radiation: (a) Wavelength of radiation (b) Emissivity (c) Black-body radiation (d) Stefan-Boltzmann law (e) Planck's law (f) Wien's displacement law (g) Radiative heat transfer to opaque and semi-transparent materials (9) Combined heat transfer by conduction, convection, and radiation (10) Classification of heat exchangers: (a) Recuperation and regeneration (b) Direct-contact heat exchangers (c) Direct-transfer heat exchangers (d) Flow arrangements in heat exchangers (e) General guidelines for selection of heat exchangers (11) Heat exchanger analysis:

LMTD method (b)  $\epsilon$ -NTU method (12) Estimation of heat-transfer coefficients in laminar and turbulent flow without phase change (13) Pressure drop in heat exchangers: (a) Circular tubes (b) Helical coils (c) Spiral coils (d) Shell side with crossflow (e) Shell side with counterflow (f) Sudden contraction and expansion (14) Fouling in heat exchangers: (a) Effect on heat transfer and pressure drop (b) Types, mechanism, and control of fouling (c) Fouling correction in heat exchanger design (15) Design of double-pipe heat exchangers: (a) Tube-side design (b) Shell-side design with bare and finned tubes (c) Series–parallel arrangements of hairpins (d) Pressure drop (16) Shell-and-tube heat exchangers: (a) Types of shell (b) Types of tube bundles (c) Tube pitch and layout (d) Types of baffles (e) Allocation of hot and cold streams (17) Design of shell-and-tube heat exchangers: (a) Kern method (b) Wills–Johnston method (c) Bell–Delaware method (18) Design of gasketed-plate heat exchangers (19) Design of plate-fin and tube-fin heat exchangers (20) Design of condensers: (a) Condensation on a tube bundle (b) Condensation inside horizontal tubes (c) Condensation inside vertical tubes (21) Design of evaporators: (a) Onset of nucleate boiling (b) Estimation of heat transfer coefficients.

### **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-210: Separation processes-I**

(1) Separation processes: (a) Importance in chemical industry (b) Basic separation techniques (c) Molecular, thermodynamic, and transport properties exploitable for separation system design (2) Separations using phase creation or addition (a) Separations using barriers (b) Separations using solid agents (c) Separations using external fields and gradients (d) Separation sequencing (3) Separation targets: (a) Component recovery (b) Product purity (c) Split fraction (d) Separation factor (4) Comparison and selection of feasible separation processes (5) Diffusion: (a) Fick's law (b) Species velocities in diffusion (c) Equimolar counter diffusion (c) Unimolecular diffusion (d) Diffusion coefficients (e) Estimation of diffusivities in gas mixtures, nonelectrolyte liquid mixtures, electrolytes, biological solutes in liquids, and in solids (6) Applications of Fick's law: (a) Examples of steady and unsteady state mass transfer through stationary media (b) Examples of mass transfer in laminar flow (c) Mass-transfer coefficient (d) Dimensionless groups in mass transfer (e) Examples of mass transfer in turbulent flow (f) Reynolds analogy (g) Chilton–Colburn analogy (7) Mass transfer across fluid–fluid interface: (a) Film theory (b) Penetration theory (c) Surface-renewal theory (d) Film-penetration theory (e) Two-film theory (f) Overall mass-transfer coefficients across gas–liquid and liquid–liquid interfaces (8) Mass transfer without concentration gradient: (a) Postulates of nonequilibrium thermodynamics (b) Maxwell–Stefan equations (9) Vapor–liquid equilibrium: (a) Gibbs phase rule (b) Degrees of freedom (c) Binary vapor–liquid equilibrium (d) Binary azeotropes (e) Isothermal and adiabatic flash calculations for multicomponent systems (f) Bubble- and dew-point calculations for multicomponent systems (10) Liquid–liquid equilibrium: Ternary liquid–liquid equilibrium; Ternary diagram (11) Solid–liquid equilibrium: (a) Leaching (b) Crystallization (c) Liquid adsorption (12) Gas–liquid equilibrium: Henry's law (13) Gas–solid equilibrium: (a) Sublimation (b) Gas adsorption (14) Liquid–liquid extraction equipment: (a) Mixer-settlers (b) Spray columns (c) Packed columns (d) Plate columns (e) Agitated columns (15) Liquid–liquid extraction system design: (a) Graphical equilibrium-stage method (b) Minimum and maximum solvent-to-feed ratio (c) Extract and raffinate reflux (16) Theory and scaleup of extractor performance (17) Membrane separations: (a) Membrane materials (b) Membrane modules (c) Membrane cascades (d) Transport through porous membranes (e) Liquid and gas diffusion through porous membranes (f) Transport through nonporous membranes (18) Advanced membrane separations: (a) Dialysis (b) Electrodialysis (c) Reverse osmosis (d) Pervaporation (19) Adsorption: (a) Selection of sorbent (b) Linear, Freundlich, and Langmuir isotherms (c) Extended isotherms for gas mixtures (d) Liquid adsorption (e) General design

considerations (f) Kinetic and transport considerations (g) Convection–dispersion model (h) Estimation of transport-rate coefficients (i) Equipment for adsorption (j) Temperature and pressure-swing adsorption (20) Ion exchange: (a) Selection of ion exchange agent (b) Ion-exchange equilibria (c) Equipment for ion-exchange (21) Leaching: (a) Equipment for leaching (b) Equilibrium-stage model (c) McCabe–Smith method (22) Psychrometry: (a) Wet-bulb temperature (b) Adiabatic-saturation temperature (c) Moisture-evaporation temperature (d) Psychrometric chart (23) Drying: (a) Equilibrium-moisture content of solids (b) Constant-rate and falling-rate drying periods (c) General design considerations (d) Equipment for drying (24) Humidification and dehumidification: (a) Fundamental concepts (b) Operation and design of cooling towers

### **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

### **EE-140: Electrical Technology**

(1) Layout of power generation and distribution (2) Concepts of current, voltages, energy and power (3) Types of sources ( dependent and independent) (4) Passive sign convention (5) Tellegen’s Theorem (6) Charge and current waveforms (7) Energy and power waveforms (8) Graphical questions related to differentiation and integration of electrical quantities (9) Ohm’s Law (10) Concept of node, loop and branch (11) Kirchoff’s current law with independent and dependent sources (12) KCL for surfaces (13) ) Kirchoff’s voltage law with independent and



dependent sources (14) Voltages division rule for single loop circuits (15) Voltage division rule for multiple source resistance networks (16) Current division rule for single and multiple source resistance networks (17) Equivalent resistance method and application on circuit containing series and parallel connection of resistors (18) Inter conversion of circuits to VDR from CDR and vice versa (19) Nodal analysis: Independent sources, Dependent sources, Super node technique with independent and dependent sources between two non-reference nodes (20) Loop analysis (21) Superposition theorem.

### **Recommended Books:**

1. J. David Irwin, Basic Engineering Circuit analysis, Wiley: 1741
2. Stephen J. Chapman, Electric Machinery Fundamentals, 5th Ed., McGraw-Hill Education: 2011
3. Allan R. Hambley, Electrical Engineering Principles and Applications, Prentice Hall: 1747 [Chapter 15-16]
4. A.K. Theraja and B.L. Theraja, Textbook of Electrical Technology, 23rd Ed., Chand (S.) & Co Ltd (India): 2006

### **IS-201: Islamic and Pakistan Studies – II**

(1) Characteristics of righteous people (2) Advices of Luqman a wise man (3) scientific study of the universe (4) Pillars of Islam (5) Striving in the cause of Allah (Jihad) (6) Social manners (7) Qur'an sciences (8) History of Hadith (9) Human Rights (10) Islamic criminal law: Introduction of laws of Islam. Classification, concept of crime, Drinking intoxicating liquors and narcotics, Theft, Dacoity & robbery, rebellion, Murder, Retaliation, Apostasy (11) Prophetic life as a role model (12) National integration (13) Initial problems of Pakistan and efforts to resolve (14) Land of Pakistan (15) Resources of Pakistan (16) State and Constitution of Pakistan (17) Human Rights (18) Foreign Policy of Pakistan (19) Relations with Neighboring countries (19) Relations with Muslim World (20) Pakistan and contemporary World (21) Principles of foreign policy (22) Pakistan and regional organizations.

Alternatively, HU-201: Ethics and Pakistan Studies – II is compulsory for non-Muslim students.

### **Recommended Books**

1. Selected Surahs and Verses from the Holy Quran

2. Abu Zakrya Yahya bin Sharf Al NAWazi, Arbaeen Nawavi, \*Indian Printed BEST Quality: 2009
3. Shibli Nomani, Seerat ul Nabi, 1914
4. Ikram Rabbani, Comprehensive book of Pakistan Studies, Caravan Book House, Lahore: 2011 (1989)
5. Stanley Wolpert, Jinnah of Pakistan, Oxford University Press Inc: 1744
6. M. Hanif Shahid, Quaid-i- Azam aur Akliyatain
7. Fazal-i-Karim, Pakistan Geography, Economy and People, Oxford University Press: 2006

## 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, 3<sup>rd</sup> 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-413: Entrepreneurship**

(1) Entrepreneurship: an evolving concept (2) Understanding strategic issues in business plan development (3) Understanding strategic issues in business plan development (4) understanding the entrepreneurial perspective in individuals (5) Entrepreneurial perspective in organizations – corporate entrepreneurship (6) Social entrepreneurship and the ethical challenges of entrepreneurship (7) Innovation: the creative pursuit of ideas (8) Pathways to entrepreneurial ventures (9) Legal challenges for entrepreneurial ventures (10) Sources of capital for entrepreneurial ventures (11) Assessment of entrepreneurial plan (12) Marketing challenges for entrepreneurial ventures (13) Financial preparation for entrepreneurial ventures (14) Developing an effective business plan (15) Strategic entrepreneurial growth (16) Valuation of entrepreneurial ventures (17) Harvesting the entrepreneurial venture.

### **Recommended Books:**

1. Donald F. Koratko, Entrepreneurship – Theory Process Practice, 8th Ed., Cengage Learning, 2013
2. Kawasaki, Guy “The Art of the Start 2: The Time-tested, Battle-hardened Guide for Anyone Starting Anything”, ISBN: 1591840562; Portfolio – a member of Penguin Group: 2014.

3. R. Eric, “The LEAN Startup: How Today’s Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses” ISBN: 978-0-307-88789-4; eISBN: 978-0-307-88791-7; Crown Business: 2011.
4. Spence, John “Awesomely Simple: Essential Business Strategies for Turning Ideas Into Action”, ISBN-10: 0470494514 and ISBN-13: 978-0470494516; Jossey-Bass: 1st Ed.: 2009.

## Semester 6

### ChE-313: 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) 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 (10) 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 (11) Time value of money: (a) Discrete and continuous cash flows (b) compounding and discounting factors (12) Income tax: (a) Taxable income (b) Capital gains tax (c) Sales tax (d) Non-income taxes (13) Fixed charges: (a) Depreciation (b) Current value (c) Salvage value (d) Recovery period (e) Methods for calculating depreciation (f) Insurance (14) 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 (15) 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 (16)  
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-314: 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-310: Separation Processes-II**

(1) Equipment for vapor–liquid separations: (a) Packed columns (b) Types of packing (c) Tray columns (d) Types of trays (e) Spray and bubble columns (2) Absorption and stripping: (a) Graphical design method for tray columns (b) Algebraic design method for tray columns (c) HETP design method for packed columns (d) Stage efficiency and column height (e) Estimation of stage

efficiencies from column performance data and empirical correlations (f) Flooding, pressure drop, and tray diameter (g) Weeping, entrainment, and downcomer backup (3) General design considerations for binary distillation columns (4) McCabe–Thiele method for design of trayed distillation columns: (a) Operating lines; Minimum number of stages (b) Minimum reflux ratio (c) Feed location (d) Pinch point (e) Effect of column pressure, condenser type, reflux temperature, reboiler type, and feed preheating (f) Estimation of condenser and reboiler duties (g) Design of distillation columns with multiple feeds, side streams, and open steam (5) Estimation of stage efficiencies from column performance data and empirical correlations for distillation columns (6) HETP and HTU methods for design of packed distillation columns (7) Ponchon–Savarit method for design of trayed distillation columns (8) Multicomponent distillation: (a) Fenske–Underwood–Gilliland method (b) Bubble-point method (c) Sum-rates method (d) Inside-out method (9) Advanced distillation processes (a) Distillation boundaries (b) Residue-curve maps (c) Extractive distillation (d) Pressure-swing distillation (e) Homogeneous and heterogeneous azeotropic distillation (f) Reactive distillation.

### **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-307: 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 (c) Dimensional analysis of the equations of change for nonisothermal systems (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 (d) Dimensional analysis of the equations of change for nonreacting binary 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
6. Welty, J. R.; Rorrer, G. L.; Foster, D. G., Fundamentals of Momentum, Heat and Mass Transfer. 6th Ed., John Wiley & Sons, Inc.: 2014

### **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

### **ChE-315L: Process Modeling and Simulation**

(1) Aspen Plus® user interface: (a) Properties environment (b) Simulation environment (c) Building and manipulating complex process flowsheets (2) Selection of components (a) Conventional and nonconventional components (b) Pseudo-components (3) Selection of property

methods: (a) Equations of state (b) Activity models (c) Searching, importing and regressing experimental data (4) Predicting pure-component and mixture properties: (a) T–x,y and P–x,y diagrams (b) P–T envelopes (c) Ternary LLE diagrams (d) Residue-curve maps (e) Searching for azeotropes (5) Simulation of single-stage separators: (a) Flash2 block (b) Flash3 block (c) Decanter block (6) Short-cut simulation of heat exchangers: (a) Heater block (b) HeatX block (7) Rigorous simulation of heat exchangers (a) EDR module (b) Short-cut simulation of reactors (c) RStoic block (d) RYield block (e) REquil block (f) RGibbs block (8) Rigorous simulation of reactors: (a) RBatch block (b) RCSTR block (c) RPlug block (9) Short-cut simulation of distillation columns (a) DSTWU block (b) Distil block (c) ConSep block (10) Rigorous simulation of distillation columns (a) RadFrac block (b) PetroFrac block (11) Identifying and troubleshooting convergence problems (a) Algorithms (b) Design specifications (c) Convergence loops and sequences (12) Process optimization: (a) Calculator block (b) Sensitivity analysis (c) Optimization block (13) Simulation of whole process flowsheets: (a) Steam cycle; Refrigeration cycle (b) Two-column azeotropic distillation system (c) Two-column extractive distillation system (d) Two-column pressure-swing distillation system

### Recommended Books

1. Al-Malah, K. I. M., Aspen Plus®: Chemical Engineering Applications. John Wiley & Sons, Inc.: 2017 [Chapters 1–10]
2. Jana, A. K., Process Simulation and Control using Aspen™. 2nd Ed., PHI Learning: 2012
3. Luyben, W. L., Distillation Design and Control using Aspen™ Simulation. 2nd Ed., John Wiley & Sons, Inc.: 2013
4. Sandler, S. I., Using Aspen Plus® in Thermodynamics Instruction: A Step-by-Step Guide. John Wiley & Sons, Inc.: 2015

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

Translation of Parah 17 to 24 of Holy Qur’ān

### Recommended Books

- |                       |                             |                |  |                                  |
|-----------------------|-----------------------------|----------------|--|----------------------------------|
| فتح محمد جالندهری     | 3. ترجمہ قرآن مجید حافظ نذر | 2. فتح القرآن  | شاه عبدالقادر دہلوی                              | . موضح القرآن<br>احمد            |
| مولانا محمد جونا گڑھی | 6. ترجمہ                    | 5. احسن البیان | سید شبیر حسین<br>پیر کرم شاہ الازہری             | 4. آسان ترجمہ قرآن<br>ضیا القرآن |
| مولانا اشرف تھانوی    | 9. کشف الرحمن               | 8. ترجمہ قرآن  | مولانا محمد تقی عثمانی<br>مولانا احمد سعید دہلوی | 7. آسان ترجمہ قرآن               |

10. ترجمہ تبيان القرآن  
القرآن دارالسلام  
مولانا غلام رسول سعیدی
11. مصباح القرآن  
ڈاکٹر عبدالرحمن طاہر
12. معانی
13. ترجمہ قرآن  
سید ابو الاعلیٰ مودودی  
سید مقبول احمد دہلوی
14. قرآن مجید، لفظی ترجمہ  
ڈاکٹر فرحت ہاشمی
15. مقبول القرآن
16. آسان ترجمہ قرآن  
محمد ظفر
- Marmaduke Pickthal  
Abdullah Yousaf Ali  
Dr. Mohammad Mahmood Ghali  
Muhammad Asad
- The meaning of Glorious *Qur'ān*.17  
*Qur'ān* Translation English .18  
*Qur'ān* Translation English .19  
*Qur'ān* Translation English .20

## Semester 7

### **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, 3<sup>rd</sup> 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

### **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)  $\epsilon$ -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-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 Commitment, Organizational Communication, Leadership, Group Behavior, Teams, and Conflict, Organizational Development (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. Buzzi-Ferraris, G.; Manenti, F., *Nonlinear Systems and Optimization for the Chemical Engineer: Solving Numerical Problems*. John Wiley & Sons, 2013
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. Edgar, T. F.; Himmelblau, D. M.; Lasdon, L. S., *Optimization of Chemical Processes*. 2nd Edition; McGraw Hill, 2001
5. Floudas, C. A., *Nonlinear and Mixed-Integer Optimization: Fundamentals and Applications*. Oxford University Press, 1995
6. Rangaiah, G. P.; Bonilla-Petriciolet, A., *Multi-objective Optimization in Chemical Engineering: Development and Applications*. John Wiley & Sons, 2013
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) Fundamentals of electrical technology and digital logic employed in measurement (2) Review of scientific principles employed in instruments (3) Parts of instruments: sensor, modifier, and recorder (4) Dynamic and static properties of instruments (5) Selection and calibration of instruments (6) Instrument identification and line symbols (7) Available technology of instrumentation for (a) Temperature (b) Flow (c) Level (d) Weight (e) Load (g) Pressure (h) Composition (8) Transducers (9) Advanced measurement devices employing (a) Piezoelectric current (b) Ultrasonic (c) Laser (d) Microwave (10) Installation and installation costs (11) Instrumentation case studies (12) Introduction and significance of control (13) Feedback and feed forward control (14) Design and hardware elements of control (15) Dynamics of first and second order systems (16) Overall transfer function testability (17) Controllers (P, PI, PID, etc.) and final control elements (18) Representation of control systems (19) Multiple control loops (20) Cascade, ratio, and over-riding control (21) Introduction to stability of chemical processes (22) Introduction

to frequency response techniques (23) Routh's criterion and Bode plots (24) Nyquist method (25) Computer control (26) Introduction to distributed control systems (27) Case study: development of control scheme of a complete plant

### **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-410: Engineering Management**

(1) Resources and management processes (2) Environment of engineering organizations and the role of managers (3) Social, ethical, global, and multicultural environment (4) Elements of planning and decision making (5) Decision making and its types (6) Managing strategy and strategic planning (7) Elements of an organization (8) Organization design, change, and innovation (9) Human resource management (10) Managing motivation and performance (11) Managing workgroups and teams (12) Organization communication and interpersonal relations in engineering organizations (13) Types of control (14) Managing operation, quality, and productivity of an engineering organization.

### **Recommended Books:**

1. R. Griffin, "Management", 8th Ed., Houghton Milfflin: 2005

### **ChE-411: 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-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.

### **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<sub>x</sub> (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-412: Final Year Project– II**

Same as ChE-411: 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**

- |                             |                |                     |                    |
|-----------------------------|----------------|---------------------|--------------------|
| فتح محمد جالندهری           | 2. فتح القرآن  | شاه عبدالقادر دہلوی | . موضح القرآن      |
| 3. ترجمہ قرآن مجید حافظ نذر |                | احمد                |                    |
| مولانا محمد جونا گڑھی       | 5. احسن البیان | سید شبیر حسین       | 4. آسان ترجمہ قرآن |
| 6. ترجمہ                    |                | پیر کرم شاہ الازہری | ضیا القرآن         |

7. آسان ترجمہ قرآن مولانا محمد تقی عثمانی  
مولانا احمد سعید دہلوی
8. ترجمہ قرآن
9. کشف الرحمن مولانا اشرف تھانوی
10. ترجمہ تبيين القرآن مولانا غلام رسول سعیدی  
القرآن دارالسلام
11. مصباح القرآن ڈاکٹر عبدالرحمن طاہر
12. معانی
13. ترجمہ قرآن سید ابو الاعلیٰ مودودی  
سید مقبول احمد دہلوی
14. قرآن مجید، لفظی ترجمہ ڈاکٹر فرحت ہاشمی
15. مقبول القرآن
16. آسان ترجمہ قرآن محمد ظفر
- Marmaduke Pickthal  
Abdullah Yousaf Ali  
Dr. Mohammad Mahmood Ghali  
Muhammad Asad
- The meaning of Glorious *Qur'ān*.17  
*Qur'ān* Translation English .18  
*Qur'ān* Translation English .19  
*Qur'ān* Translation English .20