REVISED CURRICULUM
OF
CHEMICAL ENGINEERING

HIGHER EDUCATION COMMISSION
H-9, ISLAMABAD
2003

CURRICULUM DIVISION, HEC

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*Composed by **Ghafoor Ahmad**, HEC, Regional Centre, Lahore*

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PREFACE

Curriculum of a subject is said to be the throbbing pulse of a nation. By looking at the curriculum of a subject, one can judge the state of intellectual development and the state of progress of a nation. The world has turned into a global village, new ideas and information are pouring in a constant stream. It is, therefore, imperative to update our curricula by introducing the recent developments in the relevant fields of knowledge.

In exercise of the powers conferred by Sub-section (1) of section 3 of the Federal Supervision of Curricula Textbooks and Maintenance of Standards of Education Act 1976, the Federal Government vide Notification No.D773/76-JEA (Cur.), dated December 4, 1976, appointed Higher Education Commission as the Competent Authority to look after the Curriculum Revision Work beyond Class XII at Bachelor level and onwards to all Degrees, Certificates and Diplomas awarded by Degree Colleges, Universities and other Institutions of higher education.

In pursuance of the above decisions and directives, the Commission is continually performing curriculum revision in collaboration with the Universities. According to the decision of the special meeting of Vice-Chancellors' Committee, curriculum of a subject must be reviewed after every 3 years. For the purpose, various Committees are constituted at the national level comprising senior teachers nominated by the Universities. Teachers from local degree colleges and experts from user organizations, where required, are also included in these Committees.

The National Curriculum Revision Committee on **Chemical Engineering** in its meeting held in March, 2003 at the Higher Education Commission, Regional Centre, Lahore finalized the draft curriculum after due consideration of the comments and suggestions received from the Universities and Colleges where the subject under consideration is taught.

The Final draft prepared by the Curriculum Revision Committee duly approved by competent authority is being circulated for implementation by the Universities.

(PROF. DR. ALTAF ALI G. SHAIKH)
DIRECTOR GENERAL (CURRICULUM)

March, 2003

INTRODUCTION

A meeting of National Curriculum Revision Committee to finalize the draft curriculum of Chemical Engineering and its recommendations for effective implementation of revised draft was held on March 04-06th, 2003 at HEC, Regional Centre, Lahore. Earlier, a revised draft curriculum was prepared in its preliminary meeting held in August, 2002. The following attended:

1.	Prof. Dr. A. K. Salariya, Chairman, Department of Chemical Engineering, University of Engineering & Technology, Lahore.	Convener
2.	Dr. Muhammad Ibrahim Pathan, Professor, Department of Chemical Engg., Mehran University of Engg. & Tech., Jamshoro.	Member
3.	Engr. Dr. Muhammad Saleem Chaudhry, Principal, Dawood College of Engineering & Technology, M.A. Jinnah Road, Karachi.	Member
4.	Mr. Muhammad Tariq Raja, G.M – Explosives, POF Institute of Technology Pakistan Ordinance Factory, Wah Cantt.	Member
5.	Dr. Mardan Ali, SPE, ACD, Pakistan Institute of Nuclear Science & Technology (PINSTECH) P.O. Nilor, Islamabad.	Member
6.	Mr. Arshad Mahmood, Project Director, NDC, National Engineering & Scientific Commission, NESCOM, P.O. Box # 2801, Islamabad.	Member

7. Mr. Manzur-ul-Haque, Member
Dy. General Manager,
Monitoring Evaluation and Implementation Cell,
Pakistan Steel, Bin Qasim, Karachi.

8. Engr. Syed Nasir Abbas Abdi, Member
Chairman, Department of Chemical Engg.,
NFC Institute of Engineering & Technological Training,
P.O Fertilizer Project, Khanewal Road, Multan.

9. Prof. Dr. Arshad Chughtai, Member
Institute of Chemical Engineering & Technology,
University of the Punjab, Lahore.

10. Engr. Farooq Ahmad, Member/Secretary
Lecturer,
Department of Chemical Engineering,
NWFP University of Engineering & Technology,
Peshawar.

Proceeding of Preliminary Meeting held on August 27-29th, 2002 at Islamabad

The Meeting started with the recitation from the Holy Quran by Prof. Dr. Altaf Ali G. Shaikh, Director General (Curriculum). He on behalf of Chairman, HEC welcomed the members of the NCRC at HEC, Islamabad.

He added that the present scheme of refurbishing the curricula is spread over 36 months during which 48 subjects are targeted for review. He hoped that the job would be accomplished at a cost of Rs.9.00 million, as per scheme. The programme has been launched from the year 2000-2001. During first two years of execution i.e. July 2000 – June 2002, 41 curricula were refurbished which include the curricula of Information Technology, Computer Engineering, Pharmacy, Agricultural Sciences, Animal Husbandry, Veterinary Sciences & Basic Sciences etc. He informed the Committee that during the third year of execution i.e in current financial year 2002-2003 the Commission plans to review and revise 16 curricula in the disciplines of Engineering Technology and Natural Sciences. The job will be accomplished before 30th June so that the finalized curricula could be referred to universities and adopted from next academic session.

He added the present exercise of revamping the curricula is a part of the efforts of Government for Development and Training of Human Resource in Hi-tech areas of science and technology. The Government is concentrating on the task of Developing a Scientific Culture in the Country. For the purpose, updating of curricula at different levels, develop basic physical infrastructure and in service training of university faculties and expert working in R&D institutions have been taken up. The job of enhancing professional competence of university teachers and researchers in R&D institutions is being realized through institution of indigenous Ph.D. programme and by grant of some scholarships to experts to be sent abroad for studies in leading universities.

The development schemes are being financed by Ministry of Science and Technology, which in most cases is playing advisory role with the help of peer committees in all Human Resource Development programmes. The HEC is presently assessing the need of financial requirement for further development of laboratories and libraries for pursuing advance research in Science and Technology. It is also working for establishing an effective linkage between universities, R&D institutions and Industries to make best use of available manpower.

The present syllabus of Chemical Engineering at B.Sc & M.Sc. level is proposed for review by the Committee in order to make it match the needs of today's requirement. The Committee before taking up the regular Agenda unanimously agreed to appoint Professor Dr. A. K. Salariya as its convener and Engineer Farooq Ahmad as Secretary.

Proceeding of Final NCRC Meeting Held at HEC, Regional Centre, Lahore

Dr. Mardan Ali,, SPE, ACD, Pakistan Institute of Nuclear Science & Technology (PINSTECH), Islamabad and Mr. Arshad Mahmood, Project Director, NDC, National Engineering & Scientific Commission, (NESCOM) , Islamabad could not attend the meeting due to their pre-engagements.

Meeting started with recitation from the Holy Quran by Dr. Chughtai.

Mr. Muhammad Riaz Cheema, Director HEC, Regional Centre, Lahore welcomed the members of NCRC on behalf of the Chairman, HEC.

Mr. Muhammad Tahir Ali Shah, Assistant Director (S & T), HEC, Islamabad was also present in the meeting all the three days. He explained objective to revise and update the existing curriculum is to bring it in the line with

national requirements and introduce innovations to ensure quality of education and uniformity of curricula in the universities and affiliated colleges of Pakistan and adjusts to the requirements of industry and bring to international standards. He also explained in detail all the related and mandatory requisites for designing curricula according to set pattern of HEC.

The members unanimously agreed to recommend the following objectives, scheme of studies and the course outline for Chemical Engineering:

OBJECTIVES FOR B.Sc./B.E. CHEMICAL ENGINEERING

The chemical engineering curriculum is designed so that its graduates are familiar with the techniques used in analyzing and solving engineering problems associated with the chemical and related industries (petroleum, pharmaceutical, metallurgical, plastics, pollution control, etc.). The goal of this curriculum is to educate men and women who, as graduates of the program, are able to analyze industrial chemical engineering problems and synthesize solutions to those problems, compare favourably in their knowledge of chemical engineering with students completing similar program nationally, and use their training as a springboard to further professional and career development. In addition to preparing students for rewarding jobs in the chemical process industries, the program provides an excellent background for graduate study in engineering, science, business administration.

The Chemical Engineering is defined as mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind. The Chemical Engineering program emphasizes application of principles from many fields of study to the solution of the solution of chemical engineering problems. Study in chemistry, mathematics, physics, and communications skills is emphasized. Courses in chemical engineering fundamentals (material and energy balances in chemical processes) are introduced, followed by intensive work in engineering science and analysis (heat, mass, and momentum transfer; chemical thermodynamics; chemical reaction engineering; continuous and stage-wise separation processes; process dynamic and control). Computer solutions and similar topics are stressed. An understanding of the ethical, social, economic, and safety considerations in engineering practice is stressed throughout the curriculum. The appreciation of these professional concepts is incorporated as a part of all engineering course work.

A. GRADUATE CURRICULUM

1. Four Academic years should be the duration of the Curriculum.

2. The minimum number of teaching weeks per academic year should be 24.

3. The minimum number of contact hours for the theory, practical and tutorial should be so determined as to make a total of 124 credit hours. For this purpose one theory hour should be one credit hours; two to three practical hours should be one credit hour and tutorial is zero credit hours.

4. The Practical/Lab work should comprise at least one third of the total credit hours .

5. All the Universities/Institutions should make arrangements for practical training of their students in industrial organizations during summer vacations specially in the Third Year.

6. The students should be evaluated during the session through tests, quizzes and assignments followed by a comprehensive examination at the end of the year.

7. A minimum of 75% attendance should be made compulsory for all years.

8. The committee determined the eligibility of the candidates seeking admission to degree of Chemical Engineering and recommended that F.Sc. (Pre Engineering) with chemistry, physics and mathematics as main subjects (12 years of education) or its equivalent should be the minimum requirement.

SCHEME OF STUDIES
FOR
B.Sc./B.E. CHEMICAL ENGINEERING

The committee proposed that at least the following courses be covered for the award of B.Sc./B.E. Chemical Engineering degree. The respective departments may however, choose to add courses/topics so as to make up for the total credit hours rating as proposed above, based on 1- Pakistan Engineering Council regulations, 2 - according to their respective specialization's available and 3 - requirements of the market.

CHEMICAL ENGINEERING

A: BASIC COURSES

1.	Engineering Mathematics	2 Courses	6 hours
2.	Chemistry	2 Courses	6 hours
3.	Engineering Mechanics	1 Course	3 hours
4.	Pakistan Studies & Islamic Studies/Ethics	1 Course	3 hours
5.	Physics	1 Course	3 hours
6.	Computer Programming	1 Course	3 hours
7.	Chemical Engineering Mathematics (Numerical Analysis)	1 Course	3 hours 27

B: CORE COURSES

1.	Chemical Process Technology (CPT)	2 Courses	8 hours
2.	Chemical Process Principles (CPP)	2 Courses	8 hours
3.	Chemical Engineering Thermodynamics	1 Courses	4 hours
4.	Chemical Reaction Engineering	1 Course	4 hours
5.	Fuels & Combustion	1 Course	4 hours
6.	Transport Phenomenon	1 Course	4 hours
7.	Particulate Technology	1 Course	4 hours

8.	Fluid Flow	1 Course	4 hours
9.	Heat Transfer	1 Course	5 hours
10.	Mass Transfer	1 Course	5 hours
11.	Simultaneous Heat and Mass Transfer	1 Course	4 hours
12.	Chemical Plant Design	1 Course	5 hours
13.	Process Engineering Economics	1 course	4 hours
14.	Process Instrumentation and Control	1 Course	4 hours
15.	Chemical Plant Design Project	1 Course	5 hours
16.	Environmental Engineering	1 Course	4 hours

C: ALLIED COURSES

1.	Engineering drawing and graphics	1 Course	3 hours
2.	Engineering materials	1 Course	3 hours
3.	Communication Skills	1 Course	3 hours
4.	Industrial Management	1 Course	3 hours
5.	Electrical/Mechanical Technology	1 Course	3 hours
6.	Maintenance Engineering	1 Course	3 hours
			18 hours

D: SPECIALIZED COURSES

At least one subject may be selected out of the following;

1.	Biochemical Engineering	
2.	Nuclear Engineering	
3.	Polymer Engineering	
4.	Petroleum Refinery Engineering	
5.	Minerals Processing technology	3 hours
6.	Computer Aided Design	
7.	Gas Engineering	
8.	Process Analysis and Optimization	
9.	Petrochemicals	

DETAILS OF BASIC COURSES
FOR
B.Sc./B.E. CHEMICAL ENGINEERING

1. ENGINEERING MATHEMATICS 2 Courses

Complex number: Arithmetic operations, complex conjugate, modulus and argument. Geometrical representations of simple expressions, polar form and Argand diagrams. De Moiver's theorem for rational powers. Roots of complex numbers. Exponential and circular functions with a complex argument. Solution of polynomial equations with complex coefficients.

Calculus: Revision of differentiation and integration. Curve sketching, local maxima and minima, asymptotes, behavior of curves for large mod(x). standard forms for circle, ellipse, parabola and hyperbola. Limits of real functions. Mean value theorem, Taylor's theorem, L'Hospital's rule and standard limits.

Sequences and series: Intuitive and rigorous definition of limit of convergence of a sequence. Convergence of series, absolute convergence ratio and comparison tests. Convergence of alternating series, Power series, radius of convergence.

Differential equations: First order equations. Standard methods of solution: variables separable, homogeneous, and linear and Bernoulli equations. Second order linear equations, complementary function and particular integral, reduction to a first order equation. Second order linear equations with constant coefficients, methods for finding complementary functions, particular integrals for simple cases.

Laplace transforms: Definition, calculation of transforms of simple functions.

Inverses by inspection. Application to control systems analysis.

Matrices: Definition, matrix addition and multiplication. Determinants of 2x2 matrices, extended inductively to higher orders. Reduction by row and column operations. Matrix inversion. Eigenvalues and eigenvectors. Application to systems of autonomous differential equations.

Hyperbolic functions: Definition in terms of exponential functions. Addition formulae. Differentiation and integration. Inverse hyperbolic functions. Standard integrals involving hyperbolic functions. Relation to circular functions.

Statistics: Summary and presentation of data. The normal distribution. Confidence intervals and significance testing. Design and analysis of simple comparative experiments. One-way and tow-way analysis of variance. Regression analysis. Determination of optimum conditions. Evolutionary operation. Quality control.

Partial differentiation and PDEs: Notion of limits and continuity extended to functions of several variables. Partial derivatives of function of two variable. Higher order derivatives. Equality of mixed partial derivatives. Extension to functions of three or more variables. Conversion of Laplace's equation from Cartesian to cylindrical coordinates. Application to theory of errors. Chain rule. Implicit function theorem. Application to maximum and minimum in two variable cases, saddle points.

PDEs: One dimensional heat conduction equation. Two dimensional Laplace's equation. Classification of linear homogeneous PDEs into hyperbolic, parabolic and elliptic. Separation variable. Fourier series. Odd and even functions. Sine and cosine series. Use of Fourier series as approximations. Use of cylindrical polar coordinates, use of Bessel functions. Singular solution treated simply. Boundary conditions, homogeneous and otherwise. Illustration of well and ill posed boundary value problems.

Vector algebra: Addition of vectors, resolution of vectors, and the unit vector. Vector equation of a line, intersection of two lines. Vector equation of a plane. Scalar product. Equation of plane using scalar product. Distance from origin to a line and to a plane. Vector product. Scalar and vector triple products. Time dependent vectors. Differentiation and integration of vectors.

Vector calculus: Directional derivative and gradient of scalar field. Definition of divergence and curl of vector. Vector formulae. Line, surface and volume integrals. Divergence theorem. Stokes' theorem. Evaluation of grad, div and curl in cylindrical and spherical polar

coordinates. Applications of vector calculus to derive heat conduction and diffusion equations. Continuity equation for fluids, acceleration of fluid particle in Eulerian coordinates. Euler's equation of motion for inviscid fluid.

Books Recommended

1. George B. Thomas JR. "Calculus & Analytical Geometry" 1993, 9th Ed, Addison-Wesley Publishing Co.
2. Kreyszig Erwin. "Advanced Engineering Mathematics" 18993, 7th Ed. John Willey & Sons.

2. CHEMISTRY 2 Course

Kinetic Theory of Gases; Chemistry of Solutions; Electrochemistry including fuel Cells; Colloids; Chemical Equiliria; Phase Equilibria; Surface Phenomenon and Catalysis. Introduction to Bio-Chemistry; Organic Chemistry; Sulfonation; Nitration; Hydrogenation; Amination; Halogenation, etc. etc. Introduction to instrumental methods of analysis and their applications.

Books Recommended

1. Finar I. L., "Organic Chemistry- The Fundamental Principles" 1975, Vol-I, The English Language Book Society and Longman Group Limited.
2. Glasstone S. "Textbook of Physical Chemistry" 1951, 2nd Ed. Macmillan and Co. Limited.
3. Paula Brown "Biochemistry"
4. Volhardt K. Peter C. "Organic Chemistry" W.H.Freeman and Company.
5. Maron Samuel H., Prutton Carl F. "Principles of Physical Chemistry" 4th Ed. Machmillan Publishing Co.
6. Younis, M. "Organic Chemistry"
7. Atkins P.W., "Physical Chemistry" 5th Ed. W.H.Freeman and Co. New York.
8. Iqbal Zafar "Physical Chemistry"
9. Barrow "Physical Chemistry" 5th Ed. McGraw Hill Book Company.
10. Vogal " In-Organic Practical Chemistry" Addison Wesely.
11. Cann Stumpf Bruening " Out Line of Bio-Chemistry" John Willey and Sons, New York.

3. ENGINEERING MECHANICS 1 Course

Strength of materials: Stress and strain. Hook's law, Young's modulus and Poisson's ratio. Loading: tension, compression, torsion and shear. Stress/strain diagrams. Yield and ultimate stresses. Proof and design stresses. Safety factors. Strain energy. Stress concentration. Bending and bending moments. Buckling. Longitudinal and circumferential stresses. Stresses in cylinders and spheres. Principal stresses and theories of failure.

Principles of Static's, Force systems, Equilibrium, Structures, Friction, Moment Of inertia, Radius of Gyration. Definition of work, Energy, power, Efficiency, Mechanical Advantage, Momentum, Impulse, Horsepower.

Books Recommended

1. Temoskinko " Engineering Mechanics"
2. Beer & E. Russel Johnson "Vector Mechanics for Engineers (Static & dynamics), McGraw Hill.

4. PAKISTAN STUDIES, ISLAMIC STUDIES /ETHICS 1 Course

As recommended by the Higher Education Commission.

5. PHYSICS 1 Course

Motion of particle - transitional and angular; Angular momentum, its conservation; Centrifugation; Simple Harmonic motion; Gravitation; Energy in transit; Heat Capacity of solids; Heat Capacity of an ideal gas; Reversible and irreversible changes; Concept of enthalpy and entropy; Types of energy; Basic electronics; Kinetic theory of matter; Nuclear Physics; Application of Radio-isotopes; Radiation and their industrial applications; Fibre optics.

Books Recommended

1. Sear Zemarky "Applied Physics"
2. Theraja B.L. "A Textbook of Electrical Technology" 1971
3. Admiralty "Examples in Electrical Calculations"
4. Sears. "Optics"

6. COMPUTERS AND COMPUTATION 1 Course

Introduction to Computers: CPU, Memory, I/O devices and data storage. Logging in. proper usage, access and security. General features of Operating, graphic and interface usage systems. Menus and window operations. Use of on-line help and tutorials.

General operations: File and directories naming, handling and good practice.
Copying, cutting and pasting. Operating systems in practice.

Word processors: Document creation and editing. Formatting, layout, use of fonts. Spell checking.

Spreadsheets: Data, formulae and label input and management. Layout and good practice. Graphs: creation and presentation of different types.

Graphics: Basic use of graph making and drawing packages.

Integration: Cutting and pasting via the clipboard and by direct import from compatible software to create composite documents.

Network operations: use of printer servers and drivers. Internet, Electronic mail for receiving and submitting assignments.

COMPUTER LANGUAGES
Introduction: History and development of languages. Elements of a language: instructions, data and addresses. Syntax and instruction sets. Mnemonics and arguments.

Variable types: Names and character sets. Constants and variable. Real and integer data types. Double precision, character, complex and logical variable. Arrays and subscripted variables. Effective choice of variable types. Declaration statements, e.g. common, data and dimension. Format: read, write and print.

Arithmetic operations: Operator symbols. Arithmetic expressions. Assignment statements. Library functions. Algorithms.

Program structure: Declarations, main program and termination. Input and output requirements. Use of subroutines and functions. Program

flow: use of DO loops, IF statements, GOTO and labels. Nesting. Structured programming.

File handling: Editing. Compiling, linking, loading and executing. Opening and closing of files. Program development: Sequential modular layout. Choice of step length and run time. Initial and boundary conditions. Flow diagrams. Importance of comments. Debugging. Interpretation of error messages. Functional testing and validation. Good practice. C++ and other advanced Computer Languages.

Books Recommended

1. Grauer Robert T., Barber Maryann. "Exploring Microsoft Excel for Windows 95" Prentice Hall International Editions.
2. Lafore " Programming for PC using Turbo C++" SAMS
3. Douglas "Computer Networks and Internets" Prentice Hall.
4. Tanenbaum "Modern Operating systems" Prentice Hall

7. CHEMICAL ENGINEERING MATHEMATICS 1 Course

Numerical methods: Numerical integration. Trapezium and Simpson's rules, error estimates. Numerical solution of ordinary diff"1 equations. Simple predictor-corrector methods and Runge-Kutta method to fourth order. Numerical stability, treated by example. Extension to higher order systems. Boundary value problems: direct solution for linear equation, iterative for nonlinear equations. : Finite difference approximations to derivatives for functions of several variables. Explicit method of solution of one dimensional unsteady state heat conduction. Crank-Nicolson method. Alternating direction implicit method (ADI) for two dimensional unsteady heat conduction problems. Solution of tridiagonal matrix: Choleski decomposition. Alternative boundary conditions. Compatibility, convergence and stability of Fourier series method. Iterative solution of algebraic equations: Gauss-Siedel and successive over relaxation (SOR) methods.

Solution by Series: Solutions of second order equations. Regular and singular points. Expansion near regular point. Regular singularity, series expansions near a regular singular point for non equal roots, indicial equation, and recurrence formula.

Books Recommended

1. Mickley Harold S., Sherwood Thomas K., and Reed Charles E. "Applied Mathematics in Chemical Engineering" 15th Ed., 2001. McGraw-Hill Book Company Inc.
2. Sharma J.N., Singh Kehar, "Partial Differential Equations for Engineers and Scientists" 1st Ed. 2001. Narosa Publishing House.
3. Verue "Chemical Engineering Mathematics.
4. Rao K. Sankara. "Introduction to Partial Differential Equations". 1997. Prentice Hall of India (Pvt) Limited.
5. Deo S.G., Lakshmikantham V. and Raghavendra V. "Textbook of Ordinary Differential Equations" 2nd Ed. 1997. Tata McGraw Hill Publishing Company Limited.
6. Carnahan, "Applied Numerical Methods in Chemical Engineering"

DETAILS OF CORE COURSES
FOR
B.Sc./B.E. CHEMICAL ENGINEERING

1. CHEMICAL PROCESS TECHNOLOGY (CPT) 2 Courses

Introduction and Historical development of Chemical Process Industry in Pakistan; its nature, size, number of units, location, investment and number of employees; Basic Industries: Silicate and allied products, Glass, Ceramics and Cement; Phosphorus, Soap and Detergents, Sugar, Paints and Varnishes; Heavy Chemicals: Sulfuric Acid, Nitric Acid, Sodium carbonate and sodium hydroxide; Water conditioning: Water purification for steam raising and for other industrial purposes; Fermentation Industries: Industrial alcohol and industrial solvents. Fertilizers; Urea, Potassium Nitrate, Super phosphate. Di-ammonium Phosphate; Insecticides; Introduction, Types, mode of action, impact on environment; Explosives; Introduction, Types, Manufacture, Uses; Refractories; Introduction, Types, properties, Manufacture and Major uses; Gas & Oil processing; Oil refining and gas purification; Industrial gases; Carbon dioxide, Hydrogen, Nitrogen; Food processing industry; Introduction, Types of food processing, Food by products, Leather tanning, processing and uses; Plastic industry; Plastics, Types and their properties, Polymerization, Manufacture of plastics, Uses, synthetic fiber's; Pulp and paper; Introduction, Pulp and its manufacture, Comparison, description of different methods available; Industrial Solvents.

Books Recommended

1. Austin George T. "Shreve's Chemical Processes Industries" 5th Ed. 1984, McGraw Hill International Edition.
2. Groggins P.H. "Unit Processes in Organic Synthesis" 4th Ed. 1952, McGraw Hill Book Company, Inc.
3. Haidari Iqbal "Chemical Industry in Pakistan" .1992. Industrial Research Service Karachi, Pakistan.
4. Pandey G.N. "A Textbook of Chemical Technology" 2nd Ed. Vol-I & II. 1994. Vikas Publishing House (Pvt) Limited
5. Riegel, "Industrial Chemistry" 2000.

2. CHEMICAL PROCESS PRINCIPLES (CPP) 2 Courses

Units, dimensions and conversions, Pressure scales, Composition of mixtures, Ideal gas laws, Equation of State and its Deviations; Dalton,s law, Henry's Law and Raoult,s. Antoine equation. Relative volatility. Heat capacity, latent heat and enthalpy.

Nature of balances: Concept of a balance. Input-output relationships. Steady state considerations. Black box approach. Sub-systems and interconnections. Concept of integrated pollution control. Case studies on balances for a selection of important industrial processes. Familiarization with flow sheets. Mass and energy balance diagrams and tables.

Mass and energy balances: Mass balances for unit operations. Mass balances for items of plant. Choice of basis/datum for balances. Overall and component balances. Tie components. Balances for batch and continuous plant. Simultaneous mass and energy balances. Use of steam tables. Sensible, latent and total heats. Temperature and pressure dependence. Balances for condensing systems. Introduction to dynamic balances.

Balances with reaction: Principles of stochiometric combination. Mass energy balances for reacting systems. Balances for combustion processes. Environmental balances. Limiting and excess reactants. Balances for systems with recycle, purge and by-pass streams. Efficiency and conversion. Thermo-chemistry, Flame temperature etc. Standard states. Heats of formation and reaction. Temperature dependence. Heat Effects. Application of Computers in stoichiometric calculations.

Books Recommended

1. Himmelblau David M. "Basic Principles and Calculations in Chemical Engineering". 6th Ed. 2001. Prentice Hall PTR
2. Felder Richard M., Rousseau Ronald W. "Elementary Principles of Chemical Processes" 2nd Ed. 1986. John Willey & Sons.
3. Reklaitis G.V., Schneider Daniel R. "Introduction to Material and Energy Balances" 1983. John Wiley & Sons.
4. Hougen Olaf A., Watson Kenneth M. "Chemical Processes Principles" 6th Ed. 1946, John Wiley and Sons Inc.
5. Chopy & Hicks, "Handbook of Chemical Engineering Calculations"

3. CHEMICAL ENGINEERING THERMODYNAMICS 1 Course

Chemical thermodynamics: Scope and definitions; Isolated, closed and open systems; Intensive and extensive properties; State and functions of state; First law; Internal energy U; Enthalpy H; Reversibility; Calorimetry; Enthalpies of formation; Bond dissociation energy and mean bond energy; Dependence of U and H on temperature; Kirchhoff's equation; First law as applied to ideal gases; Isothermal; Isometric; isobaric; polytropic and adiabatic processes involving an ideal gas; P-V-T relationships for non ideal gases. Compressibility factors; Heat engines, various cycles and turbine.

Second and Third Laws: Second law; Entropy; Equilibrium and observable change; Changes in S with changes in P, V, and T; Measurement of entropy; Third law. Equilibrium (reversible) and spontaneous (irreversible) change. Helmholtz function A. Gibbs function (free energy) G. Fundamental equations for closed systems. Maxwell'' relationships. properties of mixtures of ideal gases. G for ideal and non-ideal gases. Fugacity. Partial molar quantities. Chemical potential. Excess Thermodynamic Functions.

Phase equilibria: Phase rule; One component systems; Clapeyron and Clausius-Clapeyron equations. Two component systems. Liquid-vapor equilibria. Ideal and Non-ideal solutions; Composition of vapor in equilibrium with liquid; Fractional distillation. Azeotropes. Mixing. Liquid-solid equilibria. Eutectic. Compound formation. Solid solutions.

Chemical equilibria: equilibrium constants for gas phase reactions. Temperature dependence of dG° and K°. factors affecting degree of conversion. Equilibria involving condensed phases. Equilibria in solution. Thermodynamics of cells.
Liquification; Refrigeration and airconditioning.

Books Recommended

1. Smith J.M., Van Ness H.C., Abbott M.M. "Chemical Engineering Thermodynamics" 6th Ed. 2001. McGraw Hill International Edition.
2. Daubert Thomas E. "Chemical Engineering Thermodynamics", 1st Ed. 1985, McGraw Hill Book Company.
3. Sandler Stanley I. "Chemical and Engineering Thermodynamics" 3rd Ed. John Wiley and sons, Inc.
4. Eastop, Mc Conkey "Applied Thermodynamics" National Book Foundation

4. CHEMICAL REACTION ENGINEERING 1 Course

Kinetics of homogeneous reactions: Rate of reaction, variables affecting the rate of reaction, order of reaction, rate constant; searching for a mechanism of reaction, activation energy and temperature dependency, Interpretation of batch reactor data for single and multiple reactions. Integral Method and differential method of analysis for constant volume and variable volume batch reactors, Search for a rate equation. Design of Homogeneous Reactors, Batch, Mixed Flow, Plug Flow reactors, Comparison of single reactor, Multiple Reactor Systems in parallel/series. Temperature and pressure effects. Adiabatic and non-adiabatic operations. Heterogeneous Reacting Systems, Rate equations for heterogeneous reactions, Fluid Particle reactions, Determination of Rate controlling steps, Catalysis desorption Isotherms, Kinetics of Solid Catalyzed Reactions, Design of Fluid-Solid Catalytic reactors.

Books Recommended

1. Levenspiel Octave. "Chemical Reaction Engineering" 2nd Ed. 1976, John Willey & Sons Inc.
2. Smith J.M. "Chemical Engineering Kinetic".
3. Fogler H. Scott. "Elements of Chemical Reaction Engineering" 2nd Ed. 2001. Prentice Hall PTR.

5. FUELS AND COMBUSTION 1 Course

Introduction and survey of locally available fuels, quantity, quality, prices and uses. Industrial fuels. Classification and storage of solid, liquids and gaseous fuels. Criteria for the selection of fuels for industrial purposes; Coke and its industrial manufacture and uses; Petroleum and its distillation products; Synthetic fuels; Testing of fuels; Combustion calculations; Furnaces, Burners and their performance.

Books Recommended

1. Brame J.S.S., King J.G. "Fuel Solid Liquid and Gaseous" 6th Ed. 1967. Edward Arnold (Publishers) Ltd. London
2. Harker J.H., Backhurst J.R. "Fuel and Energy" , 1981, Academic Press"
3. Himus, "Fuels and Combustion.
4. Probstein, "Synthetic Fuels", McGraw Hill.
5. Marion Smith, "Fuels and Combustion", McGraw Hill.

6. TRANSPORT PHENOMENON 1 Course

Transfer processes: A review of the mechanisms of momentum, energy and mass transport.

Momentum transport: Derivation of equations of continuity and motion (Navier-Stokes). Application to laminar flow problems.

Energy transport: Derivation of energy equation. Application to heat transfer problems involving conduction, forced and free convection.

Mass transport: Derivation of species conservation equations for binary and multi-component mixtures. Application to mass transfer problems with and without chemical reaction.

Transport in turbulent flow: Fluctuations and time-averaged quantities. Time averaged form of the governing equations of momentum, energy and mass transport. Expressions for the Reynolds stresses, turbulent energy and mass flux. Temperature and concentration distribution in turbulent pipe flows.

Books Recommended

1. Bennett C.O., Myers J.E. "Momentum, Heat & Mass Transfer" 3rd Ed. 1983. McGraw Hill Book Company.
2. Bird R. Byron, Stweart Warren E., Lightfoot Edwin N. "Transport Phenomena" , 1976, John Wiley & Sons Inc.
3. Brodkey Robert S., Hershey Harry C. "Transport Phenomena –A unified Approach", 1988, McGraw Hill International Editions.
4. Wilty, "Heat Mass and Momentum Transfer"

7. PARTICLE TECHNOLOGY 1 Course

Solids handling: Characteristics of particulate materials. Particle size distribution. Classification screening and sieving. Mechanism of size reduction. Study of machinery for crushing & grinding, Closed/open circuit grinding operations. Electrostatic precipitation;. Solids storage and handling. Pneumatic and hydraulic conveying. Screw, vibratory, belt conveyors and elevators.

Mixing and agitation: Survey of principal types of mixers and agitators for use in cylindrical vessels. Mixing with propellers and turbines. Flow patterns and baffles. Rate of mixing and power consumption. Scale-up considerations. Power and modified Reynolds numbers and correlations thereof.

Filtration: Mechanism of filtration. Filter media. Preliminary treatment. Flow through filter cake and/or cloth. Cake resistance and relation between thickness of cake and volume of filtrate. Compressible cakes. Operation at constant pressure or throughput. Optimum time cycle. Studies of different types of filter including the filter presses, Nutsch filter and drum filter. Combination with washing and spraying. Integrated pressure and vacuum operations.

Liquid-solid separations: Nature of flow around particles. Concept of drag force and terminal velocity; Settling rates. Stokes' law and correlations for spherical particles. Sedimentation. Types of suspension and settling. Specification of vessel diameter. Design of thickeners. Coagulation and flocculation.

Centrifugation: Basic theory for liquid - liquid and solid - liquid separation. Shape of liquid surface. Filtration in a centrifuge. Study of different types of centrifuges: Batch and continuous operation.

Crystallization: Growth and properties of crystals. Saturation and nucleation. Crystallization rate. Impurities. Effect of temperature on solubility. Solubility and phase diagrams. Fractional crystallization. Caking. Crystallizers: principle features of construction, e.g. tank, evaporators, vacuum, Oslo. Principles of operation: batch and continuous.

Books Recommended

1. M Cabe Warren L., Smith Julian C., Harriott Peter "Unit Operations of Chemical Engineering" 6th Ed. 2001. McGraw Hill Inc.
2. Coulson J.M., Richardson J.F., "Chemical Engineering" Vol-II, 1972. The English Book Society and Pergamon Press.
3. Perry Robert H., Green Don W. "Perry's Chemical Engineering handbook" 7th Ed. 1997. McGraw Hill Inc.
4. Foust and Wenzel "Unit Operations of Chemical Engineering"
5. George Granger Brown, "Unit Operatios" CBS Publishers & Distributors.

8. FLUID FLOW 1 Course

Fluid static's: Pressure distribution. Head calculations. Manometry. Dimensions: Concept and use of dimensionless groups. Rayleigh's method of indices. Introduction to dimensional analysis.

Nature of flow: Definition of viscosity. Concept of Newtonian and non Newtonian flow. Concepts of streamline and turbulent flow. Reynolds number and its significance. Flow profiles. Concept of a boundary layer. Simple analogies between electrical systems and fluid flow, heat transfer and mass transfer.

Fluid Motion: Derivation and use of continuity, momentum and Bernoulli equations. Flow through nozzles and orifices. Flow in open channels and over weirs. Flow through circular tubes, parallel plates and inclined planes. Hagen-Poiseuille equation.

Piping: Flow/pressure drop relationship. Friction factors and correlation with Reynolds number. Roughness. Sizing calculations for incompressible flow. Systems with branches. Energy losses across bends and fitting. Entry and exit losses. Siphon flow.

Pumping: Principal features of positive displacement and centrifugal pumps, Principles of operation. Flow-head characteristics. Effect of pipework. Suction head and cavitation. Sizing and specification. Compressors and blowers; principles, operation and sizing.

Flow through packed beds: Specific surface and viodage. Analogy with pipe flow. Carman-Kozeny equations. Modified Reynolds number. Wall effects. Significance of particle shape & size. Pressure drop calculations in beds.

Fluidization: Its types, basic principles and its application.

Compressible flow: Analysis and calculations of pressure drop for isothermal and adiabatic flow of gases through pipes. Sonic flow.

Flow Measurement: The principles, description, calculation and specification of flow measuring instruments including Venturi and Orifice meters, Pitot tubes, Area meters, Nozzles, notch and manometers.

Books Recommended

1. McCabe Warren L., Smith Julian C., Harriott peter "Unit Operations of chemical Engineering" 6th Ed. 2001. McGraw Hill Inc.
2. Coulson J.M., Richardson J.F. "Chemical Engineering" Vol-I, 1985. The English Book Society and Pergamon Press.
3. Hehn Anton H. "Fluid Power Handbook" Vol-II. 1993. Gulf Publishing Company.
4. Perry Robert H., Green Don W. "Perry's Chemical Engineering Handbook" 7th Ed. 1997. McGraw Hill Inc.
5. Noel-de-Nevers "Fluid Mechanics for Chemical Engineers" McGraw Hill
6. Chopy & Hicks, "Handbook of Chemical Engineering Calucations, McGraw Hill Co. 1994.

9. PROCESS HEAT TRANSFER: 1 Course

Conduction-Steady state and unsteady state, in one and two dimensions. Convection-thermal boundary layer, Relation between fluid friction and heat transfer for free and forced convection in laminar and turbulent flow regimes. Concept of film and overall heat transfer coefficients. Radiation-Surface behavior and shape factor for black and non-black body radiation. Laws of radiation and their applications. Heat transfer equipment's, their types and selection criteria, Heat Exchanger design. Heat transfer with phase change; Condensation and boiling heat transfer and designing of single phase condensers. Evaporation; Theory and calculations of evaporators and waste heat recovery boilers.

Books Recommended

1. Kern Donald Q. "Process Heat Transfer" , 1965, McGraw Hill Book Company.
2. Cengel Yunus A. "Heat Transfer-A Practical approach" , 1988, McGraw Hill Book Company.
3. Incropera Frank P., De Witt David P. "Fundamentals of Heat and Mass Transfer" 3rd Ed. 1990. John Wiley and Sons.
4. Coulson J.M., Richardson J. F. "Chemical Engineering" Vol. I & II. 1983. The English Book Society and Pergamon Press.

10. MASS TRANSFER 1 Course

Mass transfer: Diffusion through gases and liquids. Fick's law. Mechanism of absorption and desorption. Mass transfer at gas/liquid interfaces. The two-film theory and other theories, concentration profiles. Calculation of rate of absorption. Concept of resistance to mass transfer. Overall and film coefficients. Film dominance and solubility. Schmidt, Sherwood and Stanton numbers. Countercurrent mass transfer and concept of transfer units.

Vapor-liquid equilibria: Partial vaporization and condensation. T-X-Y and X-Y diagrams. Composition calculations.

Distillation: Differential and flash distillation, rectification. The fractionating column. Concept of constant molal overflow. Calculation of number of plates required for binary separations. Lewis-Sorel, McCabe-Thiele. Concept of operating lines. Intersection of operating lines and location of feed plate. Importance of the reflux ratio. Calculation of minimum reflux ratio. Number of plates at total reflux. Underwood and Fenske equations. Selection of economic reflux ratio. Effect of multiple feeds and sidestreams. Plate efficiency and Murphree's formula. Concept of a theoretical plate and HETP. Method of transfer units and HTU. Batch distillation: operation at constant product composition or constant reflux ratio. Calculation of column, diameter and height.

Absorption: Extension of design techniques to absorption as appropriate. Wetted wall columns and calculation of transfer coefficients. Use of absorbers for scrubbing. Spray towers.

Liquid-liquid extraction: Introduction to liquid/liquid Extraction and Equipment. Use of immiscible and partially miscible solvents. Batch and continuous separations. Single and multiple stage separations. Co-current and countercurrent contacting. Solvent recovery. Ternary systems and triangular diagrams. Equilibrium conditions, the lines and their extrapolation. Tow phase regions and the plait point. Use of graphical methods for calculating number of theoretical stages required. Extension to packed and pulsed columns. Spray towers, etc.

Leaching: Basic principles, techniques, equipment, and its application.

Adsorption: Basic principles, techniques, equipment, and its application.

Books Recommended

1. MeCabe Warren L., Smith Julian C., Harriott peter "Unit Operations of chemical Engineering" 5th Ed. 2001. McGraw Hill Inc.
2. Coulson J.M., Richardson J.F. "Chemical Engineering" Vol-II, 1985. The English Book Society and Pergamon Press.
3. Incropera Frank P., De Witt David P. "Fundamentals of Heat and Mass Transfer" 3rd Ed. 1990. John Wiley and Sons.
4. Treybal Robert E. "Mass Transfer Operations" , 1953, McGraw Hill Book Company.
5. Schweitzer, "Handbook of Separation Techniques for Chemical Engineers", 1979, McGraw Hill Book Co.

11. SIMULTANEOUS HEAT AND MASS TRANSFER 1 Course

Drying: Psychometry: definition of humidity, saturation, etc. Interpretation of psychometric charts. Internal mechanisms of flow: liquid diffusion and capillary theory. Periods of drying: constant and falling rate. Estimates of drying time. Survey of batch, tunnel, rotary and drum dryers. Introduction to design and operation spray dryers. Humidification and De-humidification.

Cooling Towers: Basic principles, types, features and operation of various cooling towers.
Cooling tower design. Alternative sinks for waste heat. Design of equipment based on worst case studies. Water and air based systems. Environmental effects.

Multi-component distillation: Degrees of freedom in separation specifications. Key components in multi-component mixtures and recovery fraction. Continuous flash distillation with heat balancing. Equilibrium and enthalpy expressions. Multi-stage distillation separations. Minimum stages in ideal systems (Fenske equation) and minimum reflux ratio calculations (Underwood equation). Approximate calculation of stages for partial reflux from the Gilliland and Erbar-Maddox correlations. The column rating approach to rigorous distillation models. The Wang-Henke model as applied to an ideal mixture for both simple and complex columns. Numerical examples of multi-component separation problems. Side streams and partial condensers.

Column Design: Tray design; hydraulics and performance.

Azeotropic and Extractive distillation: Heterogeneous azeotropes. Illustrative examples of azeotropic distillations. Condensation of steam-hydrocarbon-inert gas mixtures with two liquid phases. Decanter design for separation of the phase.

Books Recommended

1. MeCabe Warren L., Smith Julian C., Harriott peter "Unit Operations of chemical Engineering" 5th Ed. 2001. McGraw Hill Inc.
2. Coulson J.M., Richardson J.F. "Chemical Engineering" Vol-I, II and VI, 1985. The English Book Society and Pergamon Press.
3. Foust Alan S., Wenzel Leonard A., Clump Curtis W., Maus Louis and Anderen L. Bryce "Principles of Unit Operations" 2nd Ed. , 1963, John Wiley and sons.
4. Incropera Frank P., De Witt David P. "Fundamentals of Heat and Mass Transfer" 3rd Ed. 1990. John Wiley and Sons.
5. Treybal Robert E. "Mass Transfer Operations" , 1953, McGraw Hill Book Company.

12. CHEMICAL PLANT DESIGN 1 Course

Introduction. Process design development. General design consideration. Health and safety; Fire and explosion hazards; Optimum design. Materials of fabrication and selection. Introduction to vessel design. Review of design of mass transfer, material transfer, material handling and heat transfer including furnaces and refrigeration units. Introduction to piping design. Introduction to computer aided design. Introduction to Product Design.

Books Recommended

1. Peters Max S., Timmerhaus Klaus D. "Plant Design and Economics for chemical Engineers" 4th Ed. 1991. McGraw Hill Inc.
2. Ludwig Ernest E. "Applied Process Design for Chemical and Petrochemical Plants" Voll 1,2 & 3, 3rd Ed.1979, Gulf Publishing Company.
3. Walas Stanley M. "Chemical Process Equipment – Selection and Design "Butterworth Heinemann" 1999.
4. Couls and Richardson Vol-VI,
5. Wells G. L. Rose L.M. "The art of Chemical Process Design" 1986. Elsevier.
6. Smith Robin "Chemical Process Design" 1995. McGraw Hill Inc.
7. Backhurst & Harker, "Chemical Process Design, John Willey
8. Evans, "Handbook of Chemical Equipment Design"

9. E.L. Cussler and G.D. Moggridge, “Chemical Product Design”, 2001, Cambridge University Press.
10. Special Issue of Chemical Engineering Research and Design, Part A 80 (A1), 2002 on “Process and Product Development”
11. James Wel, Molecular Structure and Property: Product Engineering, Ind. Engg. Chem. Res. 41(8) 1917-1919 (2002)

13. PROCESS ENGINEERING ECONOMICS 1 Course

Economics, its definition, principles and applications. Characteristics of chemical industry, Cost estimation and its techniques. Cash flow for industrial operations (cumulative cash position); factors affecting investment and production cost; Capital investments, Estimation of capital investment; Types of capital cost estimates; cost indexes; cost factors in capital investment; estimation of total product cost; interests and investment cost; types of interests; present worth and discount; Annuities; special types of Annuities; Perpetuities and capitalized cost; Taxes and insurance; types of tax; federal income tax; insurance and legal responsibilities; types of insurance; Depreciation. Types of depreciation; Cost for maintenance and repairs. Service life. Salvage value. Present value; methods of determining the depreciation; evaluation of depreciation methods ; Profitability. Alternative investments and replacements; Profitability standards; Mechanical methods of profitability evaluation (Rate of return on investment) Determining the acceptable returns; Alternative investments; Replacements; Market survey; Plant location; Cost accounting; Book keeping; financial statements.

Books Recommended

1. Peters Max S, Timmerhaus Klaus D. “Plant Design and Economics for Chemical Engineers” 4th Ed. 1991. McGraw Hill Inc.
2. Tyler Chaplin, Jr. Winter C.H. “Chemical Engineering Economics” 4th Ed., 1959, McGraw Hill Book Company Inc.
3. S.C.Sharma & T.R.Banga “Industrial Organization and Engineering Economics” Khanna Publishers, New Delhi.
4. Blank & Tarquin “Engineering Economy”
5. Gannt, Ireson & Leavernuworth “Principles of Engineering Economy”
6. Thuesen & Falirycky “Engineering Economy”
7. Donald E. Garrett. “Chemical Engineering Economics”

14. PROCESS INSTRUMENTATION AND CONTROL 1 Course

Instrumentation: Principles of measurement of temperature, pressure, level, flow, weight, pH, power, speed, position, etc. Study of common sensors, transducers, transmitters, controllers, actuators, recorders, switches, etc. Characteristics and sizing of control valves. Use of positioners and duplex action. Installation practice. Methodology for calibration.

Feedback control: Objectives of control. Terminology. Signal types and standard ranges. Interpretation of P & I diagrams: standards and conventions. Open and closed loop response to simple inputs. Servo and regulator operation. The 3-term controller. Bias and offset. Auto/manual operation and bumpless transfer. Integral windup and saturation effect of PID actions: speed of response and stability. Optimum settings. Continuous cycling and reaction curve methods. Ziegler and Nichols formulae.

Safety: Hazardous area classifications: gas groups and zones. Intrinsic safety certification. Barrier systems. Enclosures. Segregation policy. Fail-safe modes of operation. Alarm, trip and interlock systems. Alarm limits. Annunciation and acknowledgement. Common mode failure. Redundancy and diversity. Back-up systems. Emergency shut-down systems. Fire and gas detection. Pressure relief & venting systems passive and active.

Control strategy: Formulation P&I diagrams. Translation into block diagrams. Degrees of freedom and determination. Control objectives. Inventory constraints. Selection of variables for measurement and control. Non-linearity and saturation effects. Control schemes for a variety of items of plant. Use of feedback, cascade, ratio, feed forward, and other conventional strategies. Use of analyzers and chromatographs.

Control theory: Use of Laplace transforms. Heavy side's approach to partial fractions. Transfer functions and superposition. First order systems: lags and leads. Time delays. Second order systems: damping factor and natural frequency. Critical damping. Under damped systems: response time, overshoot, decay ratio, etc. Block diagram algebra: OLTF and CLTF. Characteristic equation. Use of final value theorem. Higher order systems: approximation by lag plus delay.

Modeling: Lumped parameter models of plant, e.g. jacketed vessel. Classical assumptions. Accumulation equals input minus output. Linearisation and deviation variables. Scope for approximation. Modelling of control loop elements. Integrated systems models. Analogies with electrical and mechanical systems. Validation of models.

Books Recommended

1. Stephanopoulos George "Chemical Process Control An Introduction to Theory and Practice" 1993. Prentice-Hall (Pvt) Limited.
2. Coughanowr Donald R., Koppel Lowell B. "Process Systems Analysis and control" , 1965, McGraw Hill Book Company.
3. Seaborg, Mellicamp " Process Dynamic and Control"
4. Benedict Robert P., "Fundamentals of Temperature, Pressure and Flow Measurements" 3rd Ed. 1984. John Wiley and Sons.
5. Considine Douglas M. "Process Industrial Instruments and Controls Handbook" 4th Ed., 1993, McGraw Hill Inc.

15. CHEMICAL PLANT DESIGN PROJECT 1 Course

The students to undertake a complete design of chemical process plant based on the application of basic principles of Chemical Engineering using an integrated approach to produce design of the project.

Books Recommended

1. Perry, "Chemical Engineers" Handbook, 1992.
2. Kirk Othmer, "Encyclopedia of Chemical Technology", 1996, McGraw Hill.
3. Mcketta, "Encyclopedia of Chemical Process Design"
4. McGraw Hill Encyclopedia of Science and Technology
5. All recommended books listed above.

16. ENVIRONMENTAL ENGINEERING 1 Course

Scope of environmental pollution; present state of the environment and measures for air and water pollution; features of air and water pollution control measures in the Chemical/Petrochemical industry; Solid waste treatment; Environmental central legislation; Introduction to environmental impact assessment.

Books Recommended

1. Davis Mackenzie L., Cornwell David A. "Introduction to Environmental Engineering" 2nd Ed. 1991. McGraw Hill Inc.
2. Pandey G.N., Garney G.C. "Environmental Engineering" , 2001, Tata McGraw Hill Publishing Company Limited.

DETAILS OF ALLIED COURSES
FOR
B.Sc/B.E. CHEMICAL ENGINEERING

1. ENGINEERING DRAWING AND GRAPHICS 1 Course

Computer aided Drawing & drafting covering the following topics. Geometrical drawing. Orthographic projections, First angle and third angle projection, Projection of points. Projection of lines and simple positions and inclined to both the planes. Projection of solids in simple positions. And inclined to both the planes. Sections of solids and auxiliary views. Development of surfaces. Pictorial projections such as isometricand oblique view. Conic section. Cycloidal curves. Spirals and insulates. Planning and drawing. Lettering and dimensioning. Rivets, riveted joints. Screws and screwed fastenings. Keys, cotters. Pulleys. Assembly machine drawing, preparation of details and assembly drawing in pencils of subjects selected from the following bearings. Wall-brackets, shaft coupling, engine pistons, engine rods, connecting rods, stuffing boxes etc.

Books Recommended

1. Parkinson A.C. 'First Year Engineering Drawing",1961.
2. Warren J. Luzzadder & John M. Duff. "Fundamentals of Engineering Drawing" National Book Foundation.

2. ENGINEERING MATERIALS 1 Course

Introduction to the concept of stress and strain as applied to chemical engineering design. Physical, Mechanical and thermal properties. Classification and application of the following materials of construction. Iron and steel, stainless steel, Nickle, Hastaloy, Copper alloys, Aluminum and its alloys, Lead Titanium and tantalum, PVC, Teflon, polyolefins, polytetra flouro ethylene (PTFE) glass, stone ware, acid resistant bricks and tiles. Special materials of construction.

Corrosion: Electrochemical series and corrosion potential. Nature, types and rate of corrosion. Passivity. Crevice and pitting corrosion. Stress corrosion: cracking and fatigue. Cathodic and anodic protection. Coatings. Corrosion resistance of steels, alloys, etc.

Books Recommended

1. Srivastava C.M., Srinivasan C. "Science of Engineering Materials" 2nd Ed.2000, New Age International (PRACTICALS) Limited, Publishers.
2. Varnon John. "Introduction of Engineering Materials" MacMillan.
3. William F. Smith. "Principles of Materials Science and Engineering" McGraw Hill.
4. R.A. Flinn and P.K. Trjan "Engineering Materials and Their Applications"Jaico.
5. Ijaz Hussain Khan. "Corrosion Technology", Vol-I and 2, Institute of Chemical Engineering, University of the Punjab, Lahore Pakistan.

3. COMMUNICATION SKILLS 1 Course

Importance of effective communication, the process and principles of communication. Planning organizing, editing before communication. Letters and memos, like direct requests, persuasive requests favourable/unfavourable replies etc. Special messages like job presentation, job application, goodwill messages etc., Types, preparation and presentation of reports, analytical reports, informational reports, monthly/annual reports, conference reports, progress proposals reports, formal reports, project reports. Oral communication, business meetings, interpersonal and non-written communication. Modern office technology for communication. Social and intercultural communication.

Books Recommended

1. Bough L. Sue. "How to Write First Class Letters" ,1999, Nte Publishing Group USA.
2. Pauley S.E. "Technical Report Writing Today"
3. Day Robert A. "How to Write and Publish a Scientific Paper", 1997.
4. Murphy, "Business Communication" National Book Foundation..

4. INDUSTRIAL MANAGEMENT 1 Course

Personnel management: Introduction, Job description and personnel specifications. Recruitment. Training and Career development. Appraisal. Motivation. Employment Law. Disciplinary procedures and appeals. Payment systems. Shift scheduling. Personal & Industrial safety. Health & Insurance. Superannuation, Holidays and Medical coverage.

Labour and Engineering Laws; A study of national/international laws in practice.

Works & plant management: General principles, growth of Management Thought and Functions. Management and Organization Structures. Liaison & coordination of departments. Delivery and despatch of goods. Productivity Improvement. Production Management. Project Management. PERT/CPM. Purchase, Sale and Inventory Management Systems. Budget and Budgetary controls. Inspection and Quality Control Systems. ISO certification. Total Quality Management and New Trends.

Books Recommended

1. Freeman-Bell Gail, Blakwill James "Management in Engineering Principles and Practice" 2nd Ed., 1996, Prentice-Hall (Pvt) Limited.
2. Buffa, "Production and Operations Management".
3. Saiyadian Mirza S. "Human Resources Management" 2nd Ed., 2000, Tata McGraw –Hill Publishing Company Limited
4. Beach, "Personal Management"

5. ELECTRICAL/MECHANICAL TECHNOLOGY 1 Course

Introduction to electrical technology; A.C/D.C. motors, their types and control; Generators; Transformers; Single and three phase A.C. circuits; Power factor; Introduction to industrial electronics. Introduction to machines and power transmission systems; Prime movers; Pullies; Gears and governors etc.

Books Recommended

1. Chappman "Workshop Technology"
2. R. Keith Mobley "Maintenance Fundamentals" Newnes (Butterworth-Heinmann).

6. MAINTENANCE ENGINEERING 1 Course

Forms of maintenance, Scheduling of maintenance. Organization of maintenance force. Design considerations; Layout and construction; maintenance of rotary and stationery equipment, inspection techniques. Computerized Maintenance. Non-destructive testing techniques, basics of rigging and lifting. Overall safety of plant and personnel; Accident prevention; Forms of corrosion, prevention and inhibition; Preparation for startup and shut down. Preventive and predictive maintenance; Lubrication and lubricants. Maintenance of safety equipment.

Books Recommended

1. A. Kelly & M.J. Harris, Management of Industrial Maintenance, Butter Worth, London, Boston.
2. Salih O. Tuffuaa, A. Rauf & John Dixon Compbell “Planning & Control of Maintenance Systems: Modeling & Analysis” John Willey and Sons.
3. Mobley, R. “Maintenance fundamentals”, 1999. ISBN.0-7506-7151-3.

DETAILS OF SPECIALIZED COURSES
FOR
B.Sc./B.E. CHEMICAL ENGINEERING

1. BIOCHEMICAL ENGINEERING

Introduction to Bio chemical and Fermentation technology. Basic Microbiological (Enzyme) reaction kinetics and energy patterns in biological system; Isolation of enzymes and immobilized enzyme technology; Cellular genetics and control systems; Transport phenomenon in microbial system; Design and analysis of biochemical reactors (fermentators); Anaerobic and aerobic metabolism photosynthesis and bio synthesis; Bio mass production and utilization; Application of biotechnology to energy conversion, solid waster and water treatment etc.

Books Recommended

1. Clark Blanch "Bio-Chemical Engineering"
2. Coulson J.M., Richardson J.F. "Chemical Engineering" Vol-VI, , 1985, The English Book Society and Pergamon Press.

2. COMPUTER AIDED DESIGN

Use of Computer and Software for the design and analysis of process equipment and process plant.

Books Recommended

1. Krishnamoorthy C.S., Rajeev S. "Computer Aided" Design – Software and Analytical Tools" 5th Ed. 2001, Narosa Publishing House.
2. Nambiar K.R. "Computer Aided Design, Production and Inspection", 1999, Narosa Publishing Co.

3. NUCLEAR ENGINEERING

Radioactive decay; Nuclear reactions and artificial radioactivity; General properties; Neutrons; Neutrons flux; Fusion; Fission; and Chain reaction; Separation of isotopes and uses of stable isotopes; Nuclear reactor principles; Reactor start up and operations; Material of construction; Design of gas cooled enriched Uranium Reactors; Processing methods of nuclear materials; Radiation hazards; Shielding; Detection and control instruments; Waste management.

4. POLYMER ENGINEERING

Detailed account of raw materials used; advanced treatment of methods of polymerization and co-polymerization; principles of polymers formation; thermal cleavage of covalent bonds; radical production by photochemical; high energy radiation and oxidation – reduction processes; structure and properties of polymer; analysis and testing of polymers; production and properties of commercially important polymers; detailed account of polymer processing; design of equipment and machinery used; recent advances in polymer technology.

Books Recommended

1. Fried Joel R. "Polymer Science and Technology", 1995, Prentice Hall (Pvt) Limited.
2. Painter Paul C., Coleman Michael M. "Fundamentals of Polymer Science-An Introductory Text" , 1994, Technomic Publishing Co. Inc.

5. PETROLEUM REFINERY ENGINEERING

Introduction; origin; formation and composition of petroleum; indigenous and world resource potential of Pakistan. Refinery products; properties; significant tests and standard test methods; characterization and evaluation of crude oil stocks; generation of crude processing data; crude pre heating and preliminary treatment; pipestill heaters; desalting; chemical treatment of refinery distillation; atmospheric and vacuum distillation; steam stripping; various arrangements of distillation towers. Number of trays calculation by various methods; various types of reflux employed; Packie's approach; processing plans, schemes and product patterns of refineries. Modern separation, conversion and treatment processes; auxiliary processes and operations; refinery corrosion and metals; blending plants, product design and marketing. Use of linear programming techniques to solve refinery blending and production problems; overview of petroleum act.

Books Recommended

1. Nelson W. L. "Petroleum Refinery Engineering" 4th Ed., 1958, McGraw Hill Book Company Inc.
2. Shell, "Handbook of Petroleum Technology"

6. MINERALS PROCESSING TECHNOLOGY

Introduction; Economic justification and scope of Mineral Processing; Flocculation and Dispersion; Electrical double layer theory; Flocculation, Coagulation and dispersion phenomena; Mechanism and application; Introduction to the surface Chemistry of Minerals; Flotation; Chemical and physical aspects; process uses with examples; flotation reagents; absorption mechanism; classification, types and applications; Differential floatation of complex ores; Flotation Machines, Pneumatic and mechanical types; Magnetic and Electrostatic separation; Basic principles, Equipment and applications; Auxiliary operations and flow sheets.

7. GAS ENGINEERING

Introduction to natural gas industry application of phase rule to gaseous flow and compression calculation low pressure gas flow measurements, gas purification by low temperature process sweetening and dehydration of crude gas distribution of gas in city gas appliances and their design corrosion protection of gas pipelines.

Books Recommended

1. Katz Donald L., Lee Robert L. “Natural Gas Engineering, Production and Storage” , 1990, McGraw Hill Inc.
2. Melvin A. “Natural Gas-Basic Science and Technology” , 1988, British Gas.

8. PROCESS ANALYSIS AND OPTIMATION 1 Course

Use of models in process engineering: Model as a working description of a system. Levels of detail. Types and function of model: mechanistic, empirical, stochastic, procedural and qualitative. Reasoning using models.

Strategy for model building: Relationship between engineering and mathematical approximations. Example of dynamic delay of air heater. Conceptual models. Formulation of functional – mechanistic models based on conservation equations. Coordinate free methods based on vector/matrix notation. Models for complex and irregular geometry.

Case study examples for heat exchanger and tubular reactor definition of system parameters consistent with the model. Averaging and model reduction techniques. Numerical procedures based on weighted residuals.

Adaptive models: Empirical models based on non-linear regressive adaptive refinement of models. State variables models and matrix differential equations. Filtering and continuous up-dating of models. State estimation and adaptive control.

Population balance models: Description of process in terms of distribution functions based on principal attributes. Age distribution. Process vessel characteristics in terms or residence time distribution functions. Standard models based on plug flow, CSTR and dead space. Mixing and age distribution. Application to reaction systems and liquid-liquid extraction.

Quantitative models: Diagnostics procedures. Signal flow graphs. Reasoning with qualitative models.

Models for process simulation: Analysis of systems behavior for process optimization, flexibility and safety. Stability and multiple states. Optimization methods; Analytical/numerical techniques for single variable and multi variable (constraint and unconstrained) functions; linear programming; PERT and CPM project and its organization.

Books Recommended

1. Taha Hamdy A. “Operation Research-An Introduction” Prentice Hall (Pvt) Limited.
2. Edgar T.F., Himmelblau D.M. “Optimization of Chemical Processes” McGraw-Hill Inc.

9. PETROCHEMICALS

Introduction

- Introduction to the History of Petrochemical Industries & Their Development In Pakistan and the World.

Petrochemicals Raw Materials

- Hydrocarbon Sources and Raw materials; their characterization, availability and Pricing

Processes for the production of Olefins, Monomers, Polymers and Product of Industrial Importance

Books Recommended

1. Austin George T. “Shreve’s Chemical Processes Industries” 5th Ed. McGraw Hill International Edition.
2. Sami Matar, “From Hydrocarbons to Petrochemicals”, Gulf Publishing Co.
3. Nelson, “Petroleum Refinery Engineering” McGraw Hill Co.

OBJECTIVES FOR M.Sc./M.E. CHEMICAL ENGINEERING

Programs leading to M.Sc./M.E. Chemical Engineering are offered with class work and research emphasis particularly in the areas of reaction engineering, process control and dynamics, biochemical engineering environmental engineering separation processes, plant design, loss prevention and safety.

B. POST-GRADUATE CURRICULUM

1. The M.Sc./M.E degree in Chemical Engineering course shall comprise a minimum of:
   I. one academic year for Full-time students and
   II. two academic years for Part-time students.

2. The minimum number of teaching weeks per term shall be 16.

3. The minimum number of contact hours should be determined so as to make a total of 30 credit hours. For this purpose, one theory hour should be one credit hour:2-3 practical hours should be one credit hour and tutorial is zero credit hours.

4. There shall be two terms of sixteen (16) weeks each in which at least eight (8) courses shall be taken. The third term shall be devoted to research work and report presentation.

5. The student should be evaluated during the session through tests, quizzes and assignments followed by a comprehensive examination at the end of each term.

6. Each student shall be required to complete a research project (minimum of 6 credit hour rating) for the partial fulfillment of the degree. The degree shall be awarded on the satisfactory recommendation of a panel of examiners, who shall examine the candidate and evaluate his report.

7. A minimum of 75% attendance should be compulsory in all course work.

8. The Committee recommended that B.Sc/B.E. Chemical Engineering from a recognized university should be the minimum requirement for eligibility of a candidate seeking admission to the degree of M.Sc./M.E. Chemical Engineering.

SCHEME OF STUDIES
FOR
M.SC./M.E. CHEMICAL ENGINEERING

The committee proposed that at least eight courses be covered for M.Sc./M.E Chemical Engineering degree apart from the research project. The respective departments may allow a student to choose these courses so as to make up a total credit hours rating as proposed above. It is also recommended that at least four courses be made compulsory and the remaining may be chosen from a list of Electives and/or specializations. For this purpose the department may draw a list of Compulsory, Elective and Specialization courses depending upon the market demand and expertise/specializations available in the department. A list of proposed courses, objective and outlines of courses is given below:

LIST OF COURSES:

1. Advanced Mathematics
2. Numerical Methods in Chemical Engineering
3. Advanced Chemical Engineering Thermodynamics
4. Advanced Chemical Reactor Design
5. Advance Transport Phenomena
6. Advanced Fluid Mechanics
7. Advanced Heat Transfer
8. Advanced Mass Transfer
9. Process Dynamics & Control
10. Particle Dynamics
11. Separation Processes
12. Transport Processes
13. Process Design and Optimization
14. Project Management
15. Environmental Engineering
16. Biochemical Engineering
17. Process Modeling & Simulation
18. Energy Engineering
19. Process Safety & Loss Prevention
20. Advanced Computer Aided Design
21. Polymer Engineering

DETAILS OF COURSES
FOR
M.Sc./M.E. IN CHEMICAL ENGINEERING

1. ADVANCED MATHEMATICS

Application of advanced mathematical techniques to chemical engineering analysis. Mathematical modeling, scaling, regular and singular perturbation, multiple scales and asymptotic analysis. An introduction to modeling of Chemical Engineering problems. Formulation and classification of partial differential equations. Finite difference approximation. Method of characteristics. Formulation of boundary conditions and treatment of nolinearities. Coupled equations. Application of the above principles, chemical engineering problems including linear and nonlinear ordinary differential equations and partial differential equations.

2. NUMERICAL METHODS IN CHEMICAL ENGINEERING

Numerical treatment of ordinary differential equations and partial differential equations, with Chemical Engineering option.
Sampling theory, Inference and estimation. Tests of Hypotheses, THEORY-test, chi-square test, F-Test and analysis of variance. Regression analysis and correction. Random walk and poison processes, Application of simulation to the solution of engineering problems. Linear programming (Simplex Methods).

3. ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS

Advanced topics in thermodynamics, with emphasis on chemical and physical equilibria and the estimation of thermodynamic properties. Methods of treating chemical and phase equilibria in multicomponent systems through the application of thermodynamics and molecular theory.

4. ADVANCED CHEMICAL REACTOR DESIGN

Design, scale-up and optimization of chemical reactors with allowance for heat and mass transfer and non-ideal flow patterns. Analysis of rate data for gas-solid, gas-liquid, and three-phase reaction systems. Transport processes in heterogeneous catalytic systems. Nonlinear boundary value problems arising in chemical reactor theory. Chemical reactor stability and sensitivity.

5. ADVANCE TRANSPORT PHENOMENA

Advanced treatment of conductive heat transfer and convective heat and mass transfer. Use of boundary conditions to obtain solutions in particular situation. Interfacial phenomena. Simultaneous heat and mass transfer. Turbulence and its measurements. Statistical approach to turbulent flow. Mathematical model of turbulence. Applications of continuity and Navier-Stokes equations of particular situations. Solutions of boundary layer equations. Application to equipment design. Transfer through membranes and transpiration cooling.

6. ADVANCED FLUID MECHANICS

Solutions of the Navier-strokes equation, Percolation in porous media. Low Reynolds number flow. Creeping flow around a sphere. Laminar boundary layer. Free surface flows. Bubble dynamics at low, intermediate and large Reynold's number. Boundary conditions in the presence of surface active agents. Interphase transport in isothermal systems. Fluid dynamics of two phase flow. Purely viscous non-newtonian constitutive equations. Fluidization.

7. ADVANCED HEAT TRANSFER

Optimal design of shell and tube heat exchangers. Pinchtechnology. Flow arrangements of increased heat recovery. Condensation of single vapours, Condensation of single and mixed vapours. Vaporizers, evaporators and reboilers. Extended surfaces heat transfer. Cooling towers. Furnace design and operation. Process design of equipment for heat transfer operation based on performance and economic optima.

8. ADVANCED MASS TRANSFER

Uses and characteristics of separation processes. Simple equilibrium processes. Additional factors influencing product purities. Multi-stage separation processes. Patterns of change and computational approaches. Limiting flows and stage requirements. Emprical correlation, stage to stage methods. Successive approximation methods. Capacity and efficiency of contacting devices. Energy requirements of separation processes. Selection of separation processes. Optimal design and operation of separation processes.

9. PROCESS DYNAMIC & CONTROL

Fundamentals of mathematical modeling. Modeling and simulation of chemical processes. Transient response of control systems. Frequency response analysis. Root locus method of analysis. Frequency response

of controllers. Frequency response of closed loop systems. Complex control scheme. Optimum controller settings. Dynamics and control of heat exchangers, distillation columns and chemical reactors. An introduction to modern control theory and computer control.
Enhancement of single loop control, digital control systems. Multiloop and multivariable control. Design of control systems.

10. PARTICLE DYNAMICS

Flow around particles. Drag force, Motion of particles and bubbles, Sedimentation. Settling. Fluidization. Centrifugation. Filtration. Gas cleaning. Theory of cyclones. Atomization. Power storage. Solid conveying. Aerodynamics instability of liquids and mechanics of drop formation. Agglomeration mechanics.

11. SEPARATION PROCESSES

Solvent extraction. Industrial processes & reagents, Equilibrium. Extraction kinetics. Extraction processes for metals including copper and uranium. Laboratory data collection. Column equipment and design principles. Mixer-settler performance. Coalescence.
Adsorbtion. Ion exchange, principles, application and equipment. Fundamentals of membrane separation processes. Operating principles and equipment for dialysis. Reverse osmosis. Gas separation. Leaching and sorption.

12. TRANSPORT PROCESSES

Development of differential and integral forms of Momentum and Energy conservation equations, The analogy between heat and momentum transfer, Solution of laminar flow and inviscid flow problem, Boundary layer theory, Turbulent flow, conductive and convective heat transfer problems, Heat transfer during laminar and turbulent flow. Solution of steady and transient beat and mass diffusion problems, Convective heat and mass transfer in laminar and turbulent flow. Interphase heat and mass transport.

13. PROCESS DESIGN AND OPTIMIZATION

A co-ordinating course consisting of Chemical Engineering problems of considerable complexity which require for their solutions to the application of thermodynamics. Transport processes. Reaction engineering. The selection of materials of construction. The organization for optimization. Optimization techniques. Function of a single veriable. Analytical & numerical methods. Multivariable functions,

analytical and numerical methods. Function of continuous variable, analytical and numerical methods. Optimization in practice.

14. PROJECT MANAGEMENT

Project identification and formulation. Project selection models. Feasibility preparation including market evaluation, Demand forecasting. Site selection and survey. Plant capacity decisions. Project engineering including selection of technology. Industrial proprietary rights. Procurement operations. Contracts and contractors. Project implementation, PERT/CPM. Resource allocation. Cost estimates. Progress reporting. Industrial hazards and safety consideration. Quality Management in Projects. Project Audit, Use of computer software packages in project management.

15. ENVIRONMENTAL ENGINEERING

Introduction to environmental engineering and basic terminology. Environmental issues at global, regional and national levels. Types of environmental pollution and their control. Land pollution. Water pollution. Air pollution and noise pollution. Plastic materials. Recyeling.

Effects of pollutants on living systems. Effluent Guidelines and standards; Monitoring of pollution, Conservation of Material Resources and Energy through recycling. Water pollution, Waste water and its treatment. Industrial waste treatment and disposal. Air pollution and its abatement. Solid waste management. Noise pollution and its abatement, Radioactivity and its monitoring. Pollution control of selected industry. Mathematical modeling of environmental pollution control.

Environmental Management and Auditing system (EMAS). Sustainbale development. Environment friendly technologies and cleaner production. Polution prevention. Life cycle analysis.

16. BIOCHEMICAL ENGINEERING

Characteristics of industrial microorganism. Growth of microorganism. Basic metabolic processes. Biodegradation. Bio mass productivity & activity. Aerobic & anaerobic processes, Nitrification & Denitrification processes.

Stirred tank bioreactor. Jet bioreactor. Reciprocating jet bioreactor. Hallow fiber bioreactor. Fuidized bed bioreactor. Application of various bio processes for the treatment of industrial wastes and production of chemical.

Theory of Bio-chemical processes involved in the production of food products, beverages, organic acids, industrial solvents, various pharmaceutical products and commercial enzymes.

17. PROCESS MODELING & SIMULATION

Basic techniques of numerical computation and analytical methods shall be used to develop modeling methodology. Numerical methods for integration. Solution of non-linear equations. Matrix manipulation. Systems of equations. Regression and differential equations as applied to thermodynamic kinetic and transport processes. Mathematical models of equipment, process and their interconnection.

Economic evaluation of processes. Strategies for decision making, trouble shooting to faults, safety and failure analysis. The selection and specification of engineering materials using computer methods. Process synthesis and design case studies.

18. ENERGY ENGINEERING

Chemical fuels, Characteristics of chemical fuels, Chemical fuels reserves and production in Pakistan, Combustion chamber design. Clean coal technology. Fluidized bed combustion. Atmospheric pressure FBC boiler. Atmospheric pressure FBC furnaces. Fast fluidized bed systems. Pressurized fluidized bed combustion. Pollutant emissions in combustion processes.

Primary and secondary fuels, Energy conversion with combustain. Wind power. Water power. Solar power. Geo thermal power. Nuclear power. Calculations in fuel and energy, energy economics. Energy conservation methodologies of selected systems, Renewable energy technologies.

19. PROCESS SAFETY AND LOSS PREVENTION

Introduction to hazard, accident and loss. Legislation and law. Major hazard control and management systems. Hazard identification and safety audit. Hazard assessment. Plant siting and layout. Process and pressure system design. Safety in plant operation. Maintenance and modification. Control system design. Human factors in control system design. Emission and dispersion. Fire, explosion and toxic release and storage. Transport. Emergency planning, Personal safety and safety systems.

20. ADVANCED COMPUTER AIDED DESIGN

Selection and design of chemical, biochemical or petrochemical processes, equipment and control systems, case studies, Comparison and optimization, Equipment evaluation and estimating procedures using computer methods. Process oriented Languages, data banks, decompositional methods related to process systems arrangement. Heuristic synthesis of equipment sequences. Application in chemical and petro-chemical processes.

21. POLYMER ENGINEERING

Structure and properties of polymers. Analysis and testing of polymers. Methods of polymerization and copolymerisation. Preparation and properties of commercially important polymers. Polymers processing, equipments and machinery. Polymer blends, formulation and performances.

Syntheses of high polymers, properties, thermodynamics and molecular weight. Polymer additives, blends and composites. Commodity thermoplastics and specializing polymers. Polymer processing and rheology. Application of polymers.

RECOMMENDATIONS

1. Four Academic years should be the duration of the Curriculum.
2. The minimum number of teaching weeks per academic year should be 24.
3. The minimum number of contact hours for the theory, practical and tutorial should be so determined as to make a total of 124 credit hours. For this purpose one theory hour should be one credit hours; two to three practical hours should be one credit hour and tutorial is zero credit hours.
4. The Practical/Lab work should comprise at least one third of the total credit hours.
5. All the Universities/Institutions should make arrangements for practical training of their students in industrial organizations during summer vacations specially in the Third Year.
9. The students should be evaluated during the session through tests, quizzes and assignments followed by a comprehensive examination at the end of the year.

10. A minimum of 75% attendance should be made compulsory for all years.

8. The committee recommended that the title of the degree in Chemical Engineering shall be B.Sc./B.E. Chemical Engineering.

9. The committee was intimated that “Feed Back Questionnaire” prepared by the committee for getting evaluation / opinion of Industrial Sector regarding graduates in Chemical Engineering was sent to various offices of the Chamber of Commerce and Industries in Pakistan. However, none of these offices gave any response despite personal contacts. The committee reviewed the situation and felt that Chamber of Commerce and Industries was not a relevant body for graduate of Chemical Engineering as they were not direct employer of those graduates.

10. The committee, therefore, felt that “Feed Back Questionnaire” should be sent directly to the manufacturers/companies/units in various sectors of chemical industry. For this purpose, a comprehensive list of the chemical industries in Pakistan has been provided to the office of the HEC with the advice that “Feed Back Questionnaire” be sent to the companies to solicit their response. Once the response is received, the office should record data in computer and prepare a statistical analysis. The observations and findings of the response so obtained shall be presented to Curriculum Revision Committee in a special one-day meeting.

11. The students should be encouraged to use computers and the necessary facilities may be made available for the purpose.

12. Efforts be made to provide appropriate and latest equipment for the Laboratories of the teaching departments and the process should be continued so that latest/state of the art equipment is added replacing obsolete equipment. Special attention be given to the provision of adequate funding for recurring expenditure to operate and maintain the Laboratory equipment.

13. Opportunities may be provided to the teachers of Universities for In-service training to update their knowledge in the advanced topics recently introduced in the proposed curriculum.

14. Fresh graduates who join the faculty should be provided opportunity to undertake industrial training, for short periods varying for one to six months with the leading industries of the country.

15. Lectures by subject experts may be facilitated by HEC.

16 University teachers may be provided proper incentives for encouraging them to write books/monographs in the field of their expertise. It may be made mandatory for University Libraries to obtain these books through market/HEC in reasonable number for the benefit of teachers and students.

17. The HEC may provide funds/facilities for the establishment of Departmental Libraries which will stock books related to that particular subject. Special emphasis should be given to the provision of research journals. For this purpose the department should be provided with facilities to have E-mail, internet connection to major library services in Pakistan and abroad where they can have access to be literature available in digital form. There should also be a national library, which should hold a comprehensive stock of books on the subjects and should serve as lending library for the departments.

18. Industrial training of Engineering students is highly desirable and as such efforts should be made to provide training to all students. In order to create adequate training opportunities, the HEC may take up the matter with the Government of Pakistan to enforce legislation making it mandatory for industry to provide training to engineering students in proportion to their capital investment and / or number of engineers employed. For legislation purpose guidance may be obtained from the Apprenticeship Act 1984, and the practice in the neighboring countries. The industrial training should be for senior students and preferably held during summer vacation, so that the academic activities are not disturbed.