DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY
LUCKNOW

Evaluation Scheme & Syllabus

For

B.Tech. 3rd Year

(Chemical Engineering)

On

AICTE MODEL CURRICULUM

(Effective from the Session: 2020-21)

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY
LUCKNOW

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR V SEMESTER CHEMICAL ENGINEERING

			SEMESTER- V										
Sl. No	**Subject Codes**	**Subject**	**Periods**			**Evaluation Scheme**				**End Semester**		**Total**	**Credit**
			L	**T**	**P**	**CT**	**TA**	**Total**	**PS**	**TE**	**PE**		
1	KCH 501	Mass Transfer -I	3	1	0	30	20	50		100		150	4
2	KCH 502	Chemical Reaction Engineering - II	3	1	0	30	20	50		100		150	4
3	KCH 503	Process Dynamics and Control	3	1	0	30	20	50		100		150	4
4	KCH 051-054	Departmental Elective-I	3	0	0	30	20	50		100		150	3
5	KCH 055-058	Departmental Elective-II	3	0	0	30	20	50		100		150	3
6	KCH551	Mass Transfer-I Lab	0	0	2				25		25	50	1
7	KCH 552	PDC Lab	0	0	2				25		25	50	1
8	KCH 553	Process Modelling and Simulation Lab	0	0	2				25		25	50	1
9		Mini Project or Internship Assessment*	0	0	2				50			50	1
10	NC	Constitution of India / Essence of Indian Traditional Knowledge	2	0	0	15	10	25		50			
11		MOOCs (Essential for Hons. Degree)											
		Total	**17**	**3**	**8**							**950**	**22**

***The Mini Project or internship (4 weeks) conducted during summer break after IV semester and will be assessed during V semester.

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR VI SEMESTER CHEMICAL ENGINEERING

SEMESTER- VI													**SESSION 2020-21**
Sl. No	**Subject Codes**	**Subject**	**Periods**			**Evaluation Scheme**				**End Semester**		**Total**	**Credit**
			L	**T**	**P**	**CT**	**TA**	**Total**	**PS**	**TE**	**PE**		
1	KCH 601	Mass Transfer -II	3	1	0	30	20	50		100		150	4
2	KCH 602	Transport Phenomenon	3	1	0	30	20	50		100		150	4
3	KCH 603	Chemical Technology	3	1	0	30	20	50		100		150	4
4	KCH 061-064	Departmental Elective-III	3	0	0	30	20	50		100		150	3
5		Open Elective-I [Annexure - B(iv)]	3	0	0	30	20	50		100		150	3
6	KCH 651	Chemical Technology Lab	0	0	2				25		25	50	1
7	KCH 652	Mass Transfer-II Lab	0	0	2				25		25	50	1
8	KCH 653	Technical Presentation	0	0	2				25		25	50	1
9	NC	Essence of Indian Traditional Knowledge/ Constitution of India	2	0	0	15	10	25		50			
10		MOOCs (Essential for Hons. Degree)											
		Total	**0**	**3**	**6**							**900**	**21**

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B.TECH III YEAR CHEMICAL ENGINEERING

(DEPARTMENT ELECTIVE SUBJECTS)

DEPARTMENT ELECTIVE – I

KCH-051	Computational Fluid Dynamics
KCH-052	Optimization Techniques
KCH-053	Numerical Methods for Chemical Engineer
KCH-054	Statistical Design of Experiments

DEPARTMENT ELECTIVE –II

KCH-055	Quality Assurance & Control
KCH-056	Process Flow Sheet Simulation
KCH-057	Process Integration
KCH-058	Intellectual Property Rights & Standardization

DEPARTMENT ELECTIVE- III

KCH-061	Fundamentals of Polymer Engineering
KCH-062	Sustainability of Environment
KCH-063	Colloid Surface & Interfacial Phenomena
KCH-064	Environment Impact Assessment

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B.TECH. III YEAR V SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 501	**COURSE TITLE: MASS TRANSFER – I**
EXAM DURATION: 3 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 3 : 1 : 0 CREDITS: 4	**PREREQUISITE: NIL**

OBJECTIVE:

- To impart knowledge on fundamentals of mass transfer phenomenon.
- To explain the principles of mass transfer and their application to separation and purification processes.
- To describe the principles and operations of mass transfer equipment.

COURSE OUTCOME:

On successful completion of the course, the student will be able to:

- Understand the principles of molecular diffusion and basic laws of mass transfer.
- Utilize mass transfer concepts to design gas absorption systems.
- Discuss the basics of humidification process and its application
- Explain the concept and mechanism of drying operations.
- Analyze the concept of crystallization process and identification of suitable crystallizer.

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS/BOOKS/PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Robert. E. Treybal. ―Mass Transfer Operation‖, 3e, Mc Graw Hill, NY,	2012
2.	Mc Cabe and J.M.Smith. ―Unit Operations in Chemical Engineering‖ , 7e, , McGraw Hill	2004
3.	Coulson and Richardson ―Heat and Mass Transfer: Fundamentals and Applications‖, Vol I-B, 7e,	2017
4.	J.D. Seader & Henley E. J., "Separation Process Principles‖ 2e, Wiley India Pvt. Ltd,	2006
5.	Geankoplis, C.J. ―Transport Processes and Unit Operations‖, 3e, Prentice Hall (I),	2003

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	**Diffusion :** Molecular and turbulent diffusion, diffusion coefficient, Fick's Law of diffusion, Dependence of diffusion coefficient on temperature, pressure and composition; measurement and estimation of diffusivity. Diffusion in multi -component gas mixtures. Diffusion in Solids: Molecular, Knudsen & surface diffusion; Inter- phase mass transfer: Mass transfer coefficients, Diffusion between phases, Equilibrium solubility of gases in liquids, Mass transfer theories, Mass transfer in fluidized beds, Flow past solids and boundary layers, Simultaneous heat and mass transfer.	**8**
II	**Absorption and Stripping:** Equipments, Gas-liquid equilibrium, Henry's law, Selection of solvent, Absorption in tray column, Graphical and analytical methods, Absorption in packed columns, simultaneous heat and mass transfer studies in packed columns, HTU, NTU &HETP concepts,Design equations for packed column, Absorption with chemical reaction and mass transfer.	**8**
III	**Humidification and Dehumidification:** Vapour liquid equilibrium and enthalpy for a pure substance, vapour pressure temperature curve, Vapour gas mixtures, Definition and derivations of relationships related with humidity Fundamental concept of humidification, Dehumidification and water cooling, Wet bulb temperature, Adiabatic and non-adiabatic operations, Evaporative cooling ,Classification and design of cooling towers.	**8**
IV	**Drying:** Solid-gas equilibrium, Different modes of drying operations, Definitions of moisture contents, Types of batch and continuous dryers, Rate of batch drying, Time of drying, Mechanism of batch drying, Continuous drying, Design of continuous dryers.	**8**
V	**Crystallisation:** Equilibrium yield of crystallization, Heat and mass transfer rates in crystallization, Theories of crystallization, Factors governing nucleation and crystal growth rates, Controlled growth of crystal, Classification and design of crystallizers.	**8**
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B.TECH III YEAR V SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 502	**COURSE TITLE: CHEMICAL REACTION ENGINEERING - II**
EXAM DURATION: 3 HOURS	**SEMESTER : V (ODD)**
L: T: P :: 3 : 1 : 0 CREDITS: 4	**PRE REQUISITES: KCH 301 (MEB), KCH 403 (CET)**

OBJECTIVE:

- To impart the basic concepts of chemical reaction engineering, reactors and contacting pattern
- To develop understanding about reactor analysis and design for heterogeneous reactions
- To impart knowledge about the Biochemical reactions and Bioprocessing

COURSE OUTCOME:

After successful completion of the course the students will be able to:

- Classify catalysts and predict physical properties of catalyst, surface area, void volume, solid density pore volume distribution.
- Understand the nature and mechanism of catalytic reactions and predict the rate controlling step reactions.
- Analyze the various contacting pattern for two phase system.
- Predict the rate equation for heterogeneous reactions and understand the effect of velocity, particle size and fluid properties on rate of reactions controlled by mass transfer
- Analyze the best kinetic regimes for mass transfer and reaction and predict the rate equation.
- Understand the nature and mechanism of Biochemical reactions.
- Understand the working of Biochemical and polymerization reactors.

REFERENCE BOOKS

S.NO	NAME OF AUTHORS/BOOKS /PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1	Smith, J, M, "Chemical Engineering Kinetics", 3rd Edition, McGraw-Hill (1990).	1990
2	Levenspiel, O., "Chemical Reaction Engineering", 3rd Edition, John Wiley, (1998).	1998
3	Fogler H.S., Elements of Chemical Reaction Engineering, 4th edition, Prentice Hall of India, (2008)	2008
4	Daizo Kunii & Octave Levenspiel, "Fluidization Engineering" 2nd Edition, Elsevier (India Print 2005) 2.	2005

5	Coulson and Richardson's Chemical Engineering Volume 3 - Chemical and Biochemical Reactors and Process Control (3rd Edition)	1994

COURSE DETAILS

UNITS	CONTENTS	LECTURE HOURS
I	Introduction to Homogeneous and Heterogeneous reactions, catalysts and Nature of catalysis, Physical properties of catalysts, determination of surface area, void volume and solid density, pore volume distribution; Classification, preparation, testing and characterization of solid catalysts, catalyst selection, catalyst promoters and inhibitors, catalyst poisoning and catalyst deactivation (no kinetics). Adsorption, physical adsorption and chemisorption, adsorption isotherms, mechanisms of catalytic reactions, Shifting of equilibrium in chemical reactions	**8**
II	Solid catalysed reactions, the rate equations for surface kinetics, Reaction and diffusion within porous catalysts, Pore diffusion resistance combined with surface kinetics, effectiveness factor and Thiele modulus, various resistances to transfer of reactants to the catalyst site, intrinsic and global rate of reaction, kinetic regimes, heat effects during reaction, Performance equations for reactors containing porous catalyst particles, design of solid catalytic reactors.	**9**
III	Fluid-solid reactions, experimental methods for finding rates, selection of a model, shrinking core model for spherical particles of unchanging size, rate of reaction for shrinking spherical particles, determination of rate controlling step, kinetics and design, Design of packed bed and fluidized bed reactors.	**9**
IV	Fluid-Fluid Reactions, Rate equation, rate equation for straight mass transfer, kinetic regimes of mass transfer and chemical reaction, rate equation for mass transfer and chemical reactions, fluid-fluid reactor design, deciding the contactor type and contacting pattern.	**8**
V	Introduction to Biochemical reactions: Kinetics of Enzyme Fermentation and Microbial Fermentation, understanding of Biochemical Reactors and study of polymerization reactors, Bioprocessing of edible oils	**8**
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B.TECH. III YEAR V SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 503	**COURSE TITLE: PROCESS DYNAMICS & CONTROL**
EXAM DURATION: 3 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 3 : 1 : 0 CREDITS:4	**PRE-REQUISITE: KAS 302, KAS 402**

OBJECTIVE:

- To impart knowledge about basic ideas, challenges, techniques, and applications of process control for controlling various processes.
- To teach the fundamental aspects of process dynamics and control, which includes developing dynamic models of processes, control strategies for linear time-invariant systems and instrumentation aspects

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Demonstrate fundamental understanding of process control.
- Develop transfer function (input-output) and models for linear dynamical processes.
- Characterize the dynamics and stability of processes based on mathematical analysis.
- Develop the mathematical model of various chemical processes.
- Explain different control modes and their application in controlling various processes.
- Explain the working of different controllers and valves.
- Demonstrate the working and application of SCADA and DCS.

REFERENCE BOOKS:

S. NO	NAME OF AUTHORS / BOOKS / PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Coughnaowr, D. R., "Process Systems Analysis and Control", McGraw-Hill, Inc.	2017
2.	Stephanopolous, G., "Chemical Process Control", Prentice-Hall.	2008
3.	Seborg, D. E., Edgar, T., and Mellichamp, D. A., "Process Dynamics and Control", John Wiley and Sons.	2016
4.	Bequette, B. W., "Process Control: Modeling, Design, and Simulation", Prentice-Hall, Inc.	2003
5.	Chidambaram, M., "Computer Control of Processes" Narosa Publishing House Pvt. Ltd., Ind.	1994

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	Dynamic modeling of first and second-order process; Interacting and non-interacting processes; Nonlinear and integrating processes; introduction to non-minimum phase processes; Distributed parameter processes and MIMO processes; Response of first and second order processes with respect to different types of forcing functions.	**8**
II	Experimental estimation of dynamic process parameters and identification. Modes of control action: Classification of controllers and control strategy.	**7**
III	Closed loop feedback control: Servo and regulator problems; Offset; Selection of mode of control action; Closed loop response;	**7**
IV	Routh stability criterion; Controller tuning and design:, Online tuning- closed loop and open loop methods. Frequency response technique: Phase margin and gain margin; Bode stability criterion; Nyquist stability criterion; Controller design. Root locus plot and stability analysis.	**8**
V	Cascade and feed forward control: Design of controller and analysis of control system. Ratio, Adaptive, Model-based, Multivariable, Selective and Split range control. Computer process control using SCADA and DCS.	**10**
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B.TECH III YEAR V SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 051	**COURSE TITLE: COMPUTATIONAL FLUID DYNAMICS**
EXAM DURATION: 3 HOURS	**SEMESTER : V (ODD)**
L: T: P :: 3 : 0 : 0 CREDITS: 3	**PREREQUISITES: KNOWLEDGE OF A SCIENTIFIC PROGRAMMING LANGUAGE**

OBJECTIVES:

- To introduce the widely used techniques in the numerical solution of fluid equations.
- To disseminate the understanding of issues that arise in the solution of such equations, and modern trends in CFD.
- To emphasize on 'learning by doing'.

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Classify of the basic equations of fluid dynamics.
- Understand Basic space and time discretization methods. - Numerical solution of advection, diffusion and stationary problems. Numerical solution of Grid Generation, FDM.
- Analyze the accuracy and stability of finite difference methods for model equations.
- Work on programming projects.

REFERENCE BOOKS

S.NO	NAME OF AUTHORS/BOOKS /PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Fletcher C.A.J. "Computational Techniques for Fluid Dynamics, Vol. 1: Fundamental and General Techniques", Springer-Verlag.	1998
2.	Fletcher C.A.J. "Computational Techniques for Fluid Dynamics,Vol . 2: Specific Techniques for Different Flow Categories", Springer-Verlag .	1998
3.	Anderson. J.D., "Computational Fluid Dynamics", McGraw Hill.	1995
4.	Ghoshdastidar P.S., "Computer Simulation of Flow and Heat Transfer", Tata McGraw Hill	1998
5.	Patankar S.V., "Numerical Heat Transfer and Fluid Flow", Taylor and Francis	2004

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	**Basic Concepts of Fluid Flow:** Philosophy of computational fluid dynamics (CFD),review of equations governing fluid flow and heat transfer, simplified flow models such as incompressible, inviscid, potential and creeping flow, flow classification.	**5**

II	**Grid Generation:** Structured and unstructured grids, choice of suitable grid, grid transformation of equations, some modern developments in grid generation in solving the engineering problems.	**3**
III	**Finite Difference Method (FDM)**:Discretization of ODE and PDE, approximation for first, second and mixed derivatives, implementation of boundary conditions, discretization errors, applications to the engineering problems.	**15**
IV	**Finite Volume Method:** Discretization methods, approximations of surface integrals and volume integrals, interpolation and differential practices, implementation of boundary conditions, application to the engineering problems.	**9**
V	**Case studies:** Case studies using FDM and FVM: Flow and heat transfer in pipes and channels, square cavity flows, reacting flow, reactive flow, multiphase flow, Heat Transfer in Rotary Kiln Reactors, Fluid mixing, etc. Essence of Finite element method (FEM) .	**10**
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B.TECH. III YEAR V SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 052	**COURSE TITTLE: OPTIMIZATION TECHNIQUES**
EXAM DURATION: 3 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 3 : 0 : 0 CREDITS: 3	**PREREQUISITE: NIL**

OBJECTIVE:

- To provide fundamental knowledge to optimized a process plant.
- To teach the essential features of optimization problems.
- To introduce basics of linear programming and the principle of optimality.

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Understand the role of optimization in a chemical process plants.
- Formulate mathematical models for optimization problems.
- Analysis of degree of freedom and complexity of solutions to an optimization problem.
- Understand and analyze the various methods used for unconstrained one dimensional search.

REFERENCE BOOKS:

S. NO.	**Name of Authors/Books/Publishers**	**Year of Publication/ Reprint**
1.	T.F. Edgar and D.M. Himmelblau "Optimization of Chemical Process", Mc Graw Hill.	1989
2.	K.Urbanier and C. Mc Dermott "Optimal Design of Process Equipment", John Wiley.	1986
3.	Suman Dutta " Optimization Technique in Chemical Process", Cambridge University Press.	2016
4.	Chander Mohan and Kusum Deep " Optimization Technique", New Age Science.	2009
5.	S.S. Rao "Engineering Optimization", Wiley.	2009
6.	Xin She Yang " Optimization Techniques and Applications with examples", Wiley.	2018
7.	A. Ravindran, K M Ragsdell, and G V Reklaitis "Engineering Optimization: Methods And Applications", Jhon Wiley.	2006
8.	Asghar Husain and Kota Gangiah "Optimization Techniques for Chemical Engineers", Macmillan.	1976

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	**Optimization** Optimization, Degree of freedom, Optimization formulation of the Problem, Analytical Method, Necessary and sufficient conditions for optimum in single and multi-variable unconstrained and constrained problems.	**7**
II	**Constrained and unconstrained variables** Unconstrained one dimensional search, Newton, Quasi-Newton and Secant method for uni-dimensional search, Region climnation methods (Golden Section Fibonacci, Dichotomous etc), Unconstrained multivariable optimization with special focus to Powell's conjugate direction method.	**7**
III	**Optimization Techniques** Linear Programming, graphical simplex method, revised simplex method, duality and transportation problems, unconstrained multi variable search, Direct methods, Indirect method.	**7**
IV	**Finite Difference method** Forward, Backward and Divided Differences Table, Central Differences, Newton's Forward, Backward and Divided Differences Interpolation Formula, Interpolation Polynomials, Lagrange Interpolation Formula, Sensitivity analysis.	**7**
V	**Optimality** Principle of optimality, discrete and continuous dynamic programming. Algorithms & Computer Programming: Newton-Raphson Method, Gauss Elimination, Trapezoidal Rule, Simpson's $1/3^{rd}$, $3/8^{th}$ Rule, Runge-Kutta 2^{nd} Order, and R-K 4^{th} Order Methods in reference ot the Applications in Chemical Engineering.	**7**
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B.TECH. III YEAR V SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 053	**COURSE TITTLE: NUMERICAL METHODS FOR CHEMICAL ENGINEER**
EXAM DURATION: 3 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 3 : 0 : 0 CREDITS:3	**PREREQUISITE: NIL**

OBJECTIVES:

- To impart knowledge about the different type of equations in chemical engineering problems.
- To teach the solution strategy of differential algebraic, ordinary differential equation, and partial differential equations.

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Solve the equations with first order and first degree with linear coefficients.
- Understand and solve the unsteady state problems.
- Provide the solution of various types of equations.
- Apply the above mentioned strategies solving Chemical engineering problems.

REFERENCE BOOKS:

S. NO.	Name of Authors/Books/Publishers	Year of Publication/Reprint
1.	Mickley, Reid and Sherwood, "Applied Mathematics in Chemical Engineering", Tata McGraw Hill, New Delhi.	1981
2.	S.C. Chapra and R.P. Canale, "Numerical Methods for Engineers", McGraw Hill International Edition	2010
3.	S.S. Shastry, "Introductory Methods of Numerical Analysis", Prentice Hall of India.	2005
4.	B.S. Grewal, "Numerical Methods in Engineering & Science", Khanna Publishing house.	2013
5.	M.K. Jain, S.R.K. Iyengar and R.K. Jain, "Numerical Methods for Scientific and Engineering Computation", Wiley Eastern.	1985
6.	Pradeep Ahuja, " Introduction to Numerical Method in Chemical Engineering", PHI Learning Pvt Ltd.	2010
7.	Kenneth J. Beers "Numerical Method for Chemical Engineer: Application in MATLAB", Cambridge University Press.	2007
8.	S Elnashaie and F Uligh "Numerical Techniques for Chemical and Biochemical Engineers using MATLAB", Springer.	2007

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	Approximations and Errors: Types of Errors, Significant figures, Accuracy of Numbers, Precision, Error Propagation, Applications in Chemical Engineering. Solution of Algebraic and Transcendental Equations: Basic Properties of Equations, Relations between Roots and Coefficients, Descartes Rule of Sign, Synthetic Division of a Polynomial by a Linear Expression, Bisection, Secant, Method of False Position or Regula Falsi etc., Convergence of Iterative Methods, Newton Raphson Method, Newton-Raphson Method for Non Linear Equations in Two Variables, Algorithms & Computer Programming for all these Methods in Applications of Chemical Engineering.	**9**
II	Solution of Linear Equations: Mathematical Background, Matrix inversion, Gauss Elimination, Gauss Jordan Method, Gauss-Seidel Iteration Method, Jacobi's Method, Gauss Seidel Method, Eigen Value Problem, Algorithms & Computer Programming for all these Methods in Applications of Chemical Engineering.	**6**
III	Curve Fitting Method of Least Squares, Fitting a Straight Line and a Polynomial, Fitting a Non-linear Function, Fitting Geometric and Exponential Curves, Fitting a Hyperbola, a Trigonometric Function, etc., Algorithms & Computer Programming of Curve Fitting Methods. Finite Differences & Interpolation: Finite Differences: Forward, Backward and Divided Differences Table, Central Differences, Newton's Forward, Backward and Divided Differences Interpolation Formula, Interpolation Polynomials, Lagrange Interpolation Formula, Inverse Interpolation, Algorithms & Computer Programming for all these Methods in Applications of Chemical Engineering	**7**
IV	Numerical Differentiation & Integration: Differentiation Formula based on Tabulator at Equal and Unequal Intervals, Newton-Cotes Integration Formulas, Trapezoidal Rule and Simpson's $1/3^{rd}$ and $3/8^{th}$ Rule, Algorithms & Computer Programming for all these Methods in Applications of Chemical Engineering.	**6**

V	Ordinary Differential Equations: Taylor's Series and Euler's Method, Modifications and Improvements in Euler's Method, Runge-Kutta 2^{nd} Order & 4^{th} Order Methods, Milne's Predictor-Corrector Methods, Boundary Value Problems, Algorithms & Computer Programming for all these Methods in Applications of Chemical Engineering. Partial Differential Equations: Parabolic, Hyperbolic, Elliptic (Explicit method-finite difference), Applications in Chemical Engineering.	**7**
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SUBJECT CODE: KCH 054	**COURSE TITLE: STATISTICAL DESIGN OF EXPERIMENTS**
EXAM DURATION: 3 HOURS	**SEMESTER : V (ODD)**
L : T : P :: 3 : 0 : 0 CREDITS: 3	**PRE REQUISITES:** NIL

OBJECTIVES:

- To provide advance concepts of statistical modeling
- To introduce and emphasize on experimental designs for scientific investigations.

COURSE OUTCOME:

Upon completion of this course, the students will be able to:

- Familiarize with basic concepts such as random errors, random variables, random sampling and hypothesis testing
- Distinguish between determinate and indeterminate errors and quantify them
- Compare variability due to random errors with variability from controlled process factors
- Choose appropriate design of experiments
- Estimate pure error in the experiments
- Interpret ANOVA results and identify significant factors that influence the experiments
- Fit empirical models to experimental data using linear regression concepts
- Optimize processes using response surface methodology

REFERENCE BOOKS

S.NO	NAME OF AUTHORS/BOOKS /PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Montgomery, D. C., G.C. Runger, Applied Statistics and Probability for Engineers. 5th ed. New Delhi: Wiley-India. .	2011
2.	Montgomery, D. C., Design and Analysis of Experiments. 8th ed. New Delhi: Wiley-India, 2011	2011
3.	Myers, R. H., D. C. Montgomery and C. M. Anderson-Cook, Response Surface Methodology. 3rd ed. New Jersey: Wiley.	2009

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	**Introduction** Overview of the subject, random errors, random variables, random sampling, determinate and indeterminate errors and their analyses	**6**

II	**Probability distribution:** Presentation of experimental data, discrete, continuous and normal probability density functions, standard probability distribution functions: Normal, Student's T, chi-square and F distributions	**8**
III	**Design of experiments:** Systematic planning of experiments, methods for analysis of experimental results. General linear model ANOVA, and model checking **Factorial Designs** : The 2k Factorial Design, blocking and confounding in the 2k factorial design, introduction to two and three-level fractional factorial design.	**12**
IV	**Fitting regression Models:** linear and nonlinear regression, general Linear Models and methods for fitting, validating and testing	**7**
V	**Response surface methods:** Introduction to response surface methods and experiments with random factors Strategies for experimental design with examples	**9**
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B.TECH. III YEAR V SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 055	**COURSE TITTLE: QUALITY ASSURANCE & CONTROL**
EXAM DURATION: 3 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 3 : 0 : 0 CREDITS:3	**PREREQUISITE: NIL**

OBJECTIVE:

- To impart knowledge about the quality control and quality assurance in chemical industries.
- To teach control charts and total quality management.
- To provide conceptual knowledge of the aspects like QC tests, documentation, quality certifications, ISO and SQC.

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Appreciate the importance of quality assurance and control in chemical industry.
- Understand the role of ISO for process plants.
- Learn the manufacturing operations and controls of process plants.
- Understand the importance of documentation and the scope of quality certifications applicable to industries.
- Understand the responsibilities of QA & QC departments.

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS/BOOKS/PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Weinberg S., Good Laboratory Practice Regulations, Vol. 69, Marcel Dekker Series.	2003
2.	ICH guidelines.	1990
3.	ISO 9000 and Total Quality Management.	2015
4.	Piotr Konieczka and Jacek Namiesnik “Quality Assurance and Quality Control in the Analytical Chemical Laboratory”, CRC Press.	2009
5.	P.L. Jain “ Quality Control and Total quality Management”, McGraw Hill.	2006
6.	Ram Babu Sao “ Perfect: Quality Assurance and Quality Control”, Create Space Independent Publishing Platform.	2016

7.	Amitava Mitra " Fundamentals of Quality Control and Improvement", Wiley.	2016
8.	Quality Assurance for the Chemical and Process Industries: A Manual of Good Practices. ASQ Quality Press.	1999

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	**Quality:**Definition, History, Importance, Cost of Quality, Approaches of Quality Management, Hierarchy of Quality management: Inspection & Test, Quality Control. **Total Quality Management:** Definition, Models of TQM, Elements of TQM, Principles of TQM. Deming's approach, PDCA cycle, Training for Quality management. **Quality Circle:** Quality Circle structure, Its operation, Characteristics of Quality Circle, Basic problem solving techniques. Introduction to Six Sigma and Taguchi concepts.	**9**
II	**Quality Assurance (QA):** Introduction, Definition, Management principles in QA, Forms of QA, QA in different stages. Quality in material management, Vendor selection & development. **ISO:** Introduction, ISO 9000 series of standard, ISO:9001 clauses, ISO:17025, Registration process, Benefits of ISO.	**6**
III	**Statistical Quality Control :** SQC tools, Benefits of SQC, Concept of variation, Assignable & Chance causes, Attributes & variables, Frequency distribution curve & its types. Normal Distribution curve, Problems on FD curve & ND curve. **Control chart for variable:** Definition, Formulae & its problems. Control chart patterns, Process capability. Problems on x & R chart and Process capability.	**7**
IV	**Quality Improvement Programme:** Histogram, Charts, Brain-storming, Cause & Effect diagram, Pareto analysis. **Quality survey:** Scope, Types of audit, inspection methods, Quality budget, Vendor Quality Rating. **Control chart for attribute :** Definition, Formulae & its problems. Problems on p, c charts. Sampling: Definition, types of sampling, importance, benefits and limitations of sampling.	**7**

V	**Manufacturing operations and controls** Sanitation of manufacturing premises, processing of intermediates and bulk products, packaging operations, release of finished product, time limitations on production, expiry date calculation, calculation of yields, production record review, packaging, salvaging, handling of waste and scrap disposal.	**6**
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DR. A.P. J ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW

B.TECH. III YEAR V SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 056	**COURSE TITLE: PROCESS FLOW SHEET SIMULATION**
EXAM DURATION: 3 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 3 : 0 : 0 CREDITS:3	**PREREQUISITE: NIL**

OBJECTIVE:

- To introduce about flowsheet simulation.
- To teach solution strategy of steady state and unsteady state systems.

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Synthesize a flowsheet for the process on paper and implement this in a simulation program.
- Deal with ASPEN PLUS/HYSIS/PRO II/Design II/UniSim/OLI Pro/Aspen Custom Modeler/TK-Solver.
- Use process flowsheet simulations to solve problems in the chemical industry.
- Estimate the thermo-physical properties for the chemical species and identify the correct models to use.
- Design a distillation column, feed height and number of trays in a column.

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS/BOOKS/PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Dimian A. C., "Integrated Design and Simulation of Chemical Processes", Elsevier.	2003
2.	Westerberg, A. W., Hutchison, H. P., Motard, R. L. & Winter, P., "Process Flowsheeting", Cambridge University Press.	1979
3.	K.M. Hangos and I. T. Cameron, "Process Modelling and Model Analysis", Academic Press.	2001
4.	Kumar, A., "Chemical Process Synthesis and Engineering Design", Tata McGraw Hill.	1981

5.	W. F. Ramirez, "Computational Methods for Process Simulation", 2nd ed., Butterworths.	1997
6.	A.W. Westerberg, et al, "Process Flow Sheeting", Cambridge University Press.	1990
7.	A.K. Jana " Process Simulation and Control using ASPEN", PHI Learning Pvt Ltd.	2012
8.	Sakari Kaijaluoto "Process Optimization by Flowsheet Simulation", Technical Research Centre of Finland.	1984

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	**Introduction to Process Simulation:** Background and history of process simulation; Steady State and Dynamic Simulation; Different approaches to process simulation; modules and components in a process simulation package, integration of simulation tools, structure and functionality of commercial simulation tools, selection of flowsheet and simulation software. **Process Flow sheeting:** Approaches to flowsheeting, collection and estimation of thermo-physical properties for the chemical species of the system, thermo-physical properties banks, computer aided flow-sheeting, manual calculations with recycle streams, partitioning and tearing a flowsheet.	**8**
II	**Fundamentals of systems engineering:** System definition, system properties, aggregation/decomposition, hierarchies of systems; Introduction of canonical modeling concepts: devices, connections, equations, variables. **Formalizing the modeling process :** Methods of structuring complex chemical processes, procedures for process modeling; degrees of freedom in a flow sheet. Numerical properties of the model equations. **Numerical methods for steady-state and dynamic systems:** Differential Algebraic Equations; Synthesis of reaction systems and synthesis of azeotropic separation systems.	**9**
III	**Processing Simulation with software:** ASPEN PLUS/HYSIS/PRO II/Design II/UniSim/OLI Pro/Aspen Custom Modeler/TK-Solver: Introduction to the Simulation Package; Features of simulation packages; Introduction to the simulation package Graphical User Interface; Example-	**6**

	1: Flashing of Light Hydrocarbons; Survey of unit operation models; Example-2: Vinyl chloride monomer (VCM) flow sheet.	
IV	**Flow sheet Calculations and Model Analysis Tools:** Sensitivity and case-study runs; Design specifications and calculator blocks; Example-3: VCM flow sheet sensitivity run / design-spec run. Inorganic chemicals and electrolyte modeling; Example-4: sour water systems (CO_2 and H_2S removal for example)	**6**
V	**Physical Properties:** Overview of physical property system; Property model specifications; Property data requirements and input; Physical property analysis; Example-1: Introducing a non-databank component. Multistage Separation: RADFRAC: Rigorous rating and design fractionation model; Example-2: Using RADFRAC in the VCM flow sheet. Introduction to ICARUS (an economic evaluation package inside ASPEN PLUS), Flow sheet Convergence: Example-3: VCM flow sheet convergence.	**6**
		35

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR V SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 057	**COURSE TITLE: PROCESS INTEGRATION**
EXAM DURATION: 3 HOURS	**SEMESTER : V (ODD)**
L: T: P :: 3 : 0 : 0 CREDITS: 3	**PRE REQUISITES: NIL**

OBJECTIVES:

- To disseminate the understanding of the energy and mass targets in design of processes
- To teach the basics of process integration and its application.

COURSE OUTCOME:

Upon completion of this course, the students will be able to:

- Understand of the fundamentals of process integration.
- Perform pinch analysis.
- Analyze and design heat exchanger networks.
- Minimize the water consumption and waste generation.

REFERENCE BOOKS

S.NO	NAME OF AUTHORS/BOOKS /PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Kemp I. C., "Pinch Analysis and Process Integration: A user Guide on Process Integration for the Efficient Use of Energy", 2nd Ed., Butterworth-Heinemann.	2007
2.	Smith R.., "Chemical Process Design and Integration", 2nd Ed., Wiley.	2005
3.	Shenoy U. V., "Heat Exchanger Network Synthesis", Gulf Publishing Company.	1995
4.	El Halwagi M. M., "Process Integration", 7th Ed., Academic Press.	2006

Course details

UNITS	CONTENTS	LECTURE HOURS
I	**Process Integration and its Building Blocks:** Definition of process integration (pi), school of thoughts, areas of application and techniques available for pi, onion diagram.	**8**
II	**Pinch Technology:** Basic concept, comparison with energy auditing, role of thermodynamic laws, problem addressed by pinch technology. **Key Steps of Pinch Technology:** Data extraction, targeting, designing, optimization and supertargeting.	**12**

III	**Basic Elements of Pinch Technology:** Grid diagram, composite curve, problem table algorithm, grand composite curve. **Targeting of Heat Exchanger Network (HEN):** Energy targeting, area targeting, number of units targeting, shell targeting, cost targeting.	**8**
IV	**Designing of HEN:** Pinch design methods, heuristic rules, stream splitting, design of maximum energy recovery (MER), design of multiple utilities and pinches, design for threshold problem, loops and paths.	**8**
V	**Heat Integration of Equipments:** Heat engine, heat pump, distillation column, reactor, evaporator, drier, refrigeration systems. **Heat and Power Integration:** Co-generation, steam turbine, gas turbine.	**6**
		42

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR V SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 058	**COURSE TITLE: INTELLECTUAL PROPERTY & STANDARDIZATION**
EXAM DURATION: 3 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 3 : 0 : 0 CREDITS: 3	**PRE-REQUISITE: KAS 302, KAS 402**

OBJECTIVE:

- To introduce fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects inindustries.
- To disseminate knowledge on patents, patent regime in India and abroad and registration aspects
- To disseminate knowledge on copyrights and trademarks& registration
- To aware about current trends in IPR and Govt. steps in fostering IPR

COURSE OUTCOME:

Upon completion of this course, the students will be able to:

- The students once they complete their academic projects, shall get an adequate knowledge on patent and copyright for their innovative research works
- During their research career, information in patent documents provide useful insight on novelty of their idea from state-of-the art search. This provide further way for developing their idea or innovations
- Pave the way for the students to catch up Intellectual Property(IP) as an careeroption
- Gives awareness of international standards to students

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS / BOOKS / PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Nithyananda, K V. Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.	2019
2.	Neeraj, P., & Khusdeep, D.. Intellectual Property Rights. India, IN: PHI learning PrivateLimited..	2014
3.	Ahuja, V K.. Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.	2017
.	**E-resources:** • Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf • World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf **Reference Journal:** • Journal of Intellectual Property Rights (JIPR): NISCAIR	

	Useful Websites: • Cell for IPR Promotion and Management(http://cipam.gov.in/) • World Intellectual Property Organisation(https://www.wipo.int/about-ip/en/) • Office of the Controller General of Patents, Designs &Trademarks(http://www.ipindia.nic.in/)

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	**Overview of Intellectual Property:** Introduction to intellectual property right(IPR), intellectual property and its protection, Forms of Protection depending on product; Patent, copyright, trademark, design knowhow, trade secrets etc.	**6**
II	**Patents:** Concept of quality mark and standardization, development in quality mark, bureau of Indian standards (BIS)and its role, IS, Ag Mark, BIS Hallmark, ECO mark, FPO mark , geographical indication mark under WTO /TRIPS, Bharat stage emissions,Toxicity labels; and vegetarian and non-vegetarian mark	**8**
III	**Copyrights:** Quality council of India and its role, National accreditation body NABCB (National accreditation board for certification bodies),benefits of accreditation, Important legislations; National and International	**8**
IV	**Trademarks:** Patenting systems in India, requirements of filing a patent application, patents in R&D, opposition to grant of patent under Indian Patent act 1970, protection of chemical pharmaceutical and biotechnological inventions	**6**
V	**Other forms of IP Design:** Management of intellectual property right (IPR's), quality management systems(QMS), ISO-9000 for manufacturing, ISO-14000 for environment, ISO -5000 for energy management systems, ISO - 22000 for Food safety management systems(FSMS), Information security management system(ISMS), Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition IP Laws	**8**
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DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR V SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 551	**COURSE TITLE: MASS TRANSFER-1 LAB**
EXAM DURATION: 2 HOURS	**SEMESTER: V**
L: T: P :: 0 : 0 : 2 CREDIT: 1	**PRE-REQUISITE: MASS TRANSFER-1**

OBJECTIVE:

- To impart knowledge about the basic fundamental principles of mass transfer by performing different experiments
- To make them correlate theory and practical process by experimentation.

COURSE OUTCOME:

On successful completion of the course, the student will be able to

- Analyze the data on diffusion coefficient and mass transfer coefficient.
- Study the characteristic of Packed bed absorption column
- Discuss the working of a cooling tower and temperature drop in a fluid inside it.
- Understand the working mechanism of crystallizer and dryer

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS/BOOKS/PUBLISHERS	YEAR OF PUBLICATION/REPRINT
1.	Robert. E. Treybal. ―Mass Transfer Operation‖, 3e, Mc Graw Hill, NY,	2012
2.	Mc Cabe and J.M.Smith. ―Unit Operations in Chemical Engineering‖ , 7e, , McGraw Hill	2004
3.	Coulson and Richardson ―Heat and Mass Transfer: Fundamentals and Applications‖, Vol I-B, 7e,	2017
4.	J.D. Seader & Henley E. J., "Separation Process Principles‖ 2e, Wiley India Pvt. Ltd,	2006
5.	Geankoplis, C.J. ―Transport Processes and Unit Operations‖, 3e, Prentice Hall (I),	2003

COURSE DETAILS:

S. NO.	LIST OF EXPERIMENT
1	To Determine the Gas-phase mass-transfer coefficient in wetted wall column
2	To Determine the diffusion co-efficient of an organic vapor (naphthalene) in air.
3	To estimate the Solid liquid mass-transfer coefficient for dissolution of benzoic acid in water.

4	To study the absorption of a gas in a packed column and calculation of NTU and HTU
5	To study flooding and loading characteristic of Packed bed absorption column
6	To study working and operation of the cooling tower
7	To study the fluidized bed drying
8	To Study drying characteristics of solids in a batch tray dryer under constant drying conditions
9	To find out crystal yield in batch crystallizer
10	To study crystallization operation using open pan Crystallizer

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR V SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 552	**COURSE TITLE: PROCESS DYNAMICS & CONTROL LAB**
EXAM DURATION: 2 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 0 : 0 : 2 CREDIT:1	**PRE-REQUISITE: NIL**

OBJECTIVE:

- To provide knowledge to apply fundamental principles of chemical process dynamics and control.
- To teach dynamics of typical chemical engineering processes and experiments involving control loop design.
- To inculcate the hands on practice attitude in students to operate different types of controllers and valves when they work in these fields.

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Operate and handle the interacting and non-interacting systems in industries.
- Understand the various input behaviours.
- Understand the working of various valves in industries and understand the function of each small unit attached to it.
- Select and operate different types of controllers used in industries.

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS / BOOKS / PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Coughnaowr, D. R., "Process Systems Analysis and Control", McGraw-Hill, Inc.	2017
2.	Stephanopolous, G., "Chemical Process Control", Prentice-Hall.	2008
3.	Seborg, D. E., Edgar, T., and Mellichamp, D. A., "Process Dynamics and Control", John Wiley and Sons.	2016
4.	Bequette, B. W., "Process Control: Modeling, Design, and Simulation", Prentice-Hall, Inc.	2003
5.	Chidambaram, M., "Computer Control of Processes" Narosa Publishing House Pvt. Ltd., Ind.	1994

COURSE DETAILS:

S. No.	LIST OF EXPERIMENTS
1.	Transient response to single tank system with storage & Flow to (a) step change (b) Impulse change input.
2.	Transient response of non-interacting system in series.
3.	Transient response of interacting system in series.
4.	Study the operation of ON-OFF electronic temperature controller & determination of its performance to control the temperature of a system having capacity to store thermal energy.
5.	Study the principle of operation & working of pneumatic servo system with various input functions.
6.	Transient response of a CSTR System to step change.
7.	Controlling a batch reactor using digital PID controller.
8.	Study the dynamics of parallel & counter flow shell & tube heat exchanger.
9.	Controlling of Parallel Flow & counter flow STHE using digital PI controller to have desired output.
10.	Dynamics characteristics of mercury & water manometers.
11.	Study of control value characteristics

DR. A.P. J ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH. III YEAR V SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 553	**COURSE TITTLE: PROCESS MODELING & SIMULATION LAB**
EXAM DURATION: 2 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 0 : 0 : 2 CREDIT: 1	**PREREQUISITE: NIL**

OBJECTIVE:

- To impart conceptual knowledge about the modelling & simulation techniques of chemical processes.
- To teach various simulation approaches and basic knowledge of simulators.
- To provide knowledge about skills in using process simulators for solving chemical engineering processes problem.

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Analyze steady-state and unsteady state material and energy balance on a system
- Analyze physical and chemical phenomena involved in various chemical processes.
- Develop mathematical models for various chemical engineering plant based processes.
- Use various simulation approaches such as sequential, simultaneous, and equation oriented.
- Simulate a chemical process using process simulators (ASPEN Plus/ ASPEN Hysys/ MATLAB/ PRO-II/ CHEMCAD/ FlowTran/ Fluent/ MATLAB etc.).

REFERENCE BOOKS:

S. No.	NAME OF AUTHORS/BOOKS/PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Luyben W.L., Process Modeling, Simulation and Control for Chemical Engineering, McGraw-Hill.	1998
2.	Babu, B.V., Process Plant Simulation, Oxford University Press.	2004
3.	Denn, M. M., Process Modeling, Longman Sc & Tech.	1987
4.	Holland, C. D., Fundamentals and Modeling of Separation Processes: Absorption, Distillation, Evaporation and Extraction, Englewood Cliffs, Prentice-Hall.	1974
5.	Finlayson, Bruce A. Introduction to chemical engineering computing. John Wiley & Sons	2012
6.	Jana, Amiya K. Process modelling and control using ASPEN. PHI Learning Pvt. Ltd.	2009
7.	Kamal,I. M. AL-Malah, Aspen plus: chemical engineering applications, Wiley	2017
8.	Juma Haydary, Chemical Process Design and Simulation: Aspen Plus and Aspen HYSYS Applications, Wiley	2019
9.	Alkis Gonstantinides and Navid Mostoufi, Numerical Methods for Chemical Engineers with MATIAB Applications, Prentice Hall PTR	1999

10.	Michael B. Cutlip, Problem Solving in Chemical and Biochemical Engineering with POLYMATH, Excel, and MATLAB, Prentice Hall PTR	2008
11.	Yeong Koo Yeo, Chemical Engineering Computation with MATLAB, CRC Press	2018

COURSE DETAILS:

S.NO.	**LIST OF EXPERIMENTS**
1.	Introduction to Process Modeling & Simulation.
2.	Practice examples of process Modeling & simulation and solution of problems using MATLAB
3.	Introduction to Aspen Plus and Simulation of individual equipment using ASPEN Plus.
4.	To calculate the VLE data for ideal mixture and various activity coefficient models by using ASPEN Plus.
5.	To determine the Composition of vapor and liquid streams in a flash distillation still using VLE data.
6.	To apply material balance/enthalpy balance in the plate columns.
7.	To study the absorption, reaction and diffusion processes in a contact reactor/bubble absorber/packed tower/plate column through a two film model.
8.	To simulate liquid –liquid extraction column.
9.	To design and optimize a single effect and multiple effect evaporator.
10.	To design of a shell and tube heat exchanger.
11.	To simulate the CSTR/PFR model and compute the component mole fractions in the product stream.
12.	To simulate the laminar flow of water through a constant diameter circular pipe.
13.	To apply complete material and energy balance for a given reactor-separator system.

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY
B.TECH III YEAR V SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE:	**COURSE TITLE: MINI PROJECT OR INTERNSHIP ASSESSMENT***
EXAM DURATION: 20 MINUTES PRESENTATION	**SEMESTER: V (ODD)**
L: T: P :: 0 : 0 : 2 CREDIT:1	**PRE-REQUISITE: NIL**

OBJECTIVE:

- To inculcate research attitude amongst students.
- To develop presentation skills.
- To teach how to study and solve practical problems

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Understand and workout the project problem.
- Gain experience to make a project report.
- Acquire the necessary confidence to carry out main project in the final year.

COURSE DETAILS:

- The student jointly or individually is required to prepare a project report based on experimental or theoretical research work The key features such as literature survey, Problem formulation, solving methodologies and future aspects of industries are the major necessities of the report under the supervision of a guide.
- The project report is to be submitted by the end of the semester and the work will be assessed based on the report and the presentation of the work.
- The assessment of all the mini projects should be done by a committee consisting of three or four faculty members - the students will present their project work before the committee - the relative grading and group average marks for the various projects will be fixed by the committee - the guides will award the marks for the individual students in the project maintaining the group average.
- Each group will submit the project report to the department through the guide - the head of the department will certify the copies and keep one copy in the departmental library.

DR. A.P. J ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH. III YEAR VI SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 601	**COURSE TITLE: MASS TRANSFER –II**
EXAM DURATION: 3 HOURS	**SEMESTER: VI (EVEN)**
L: T: P :: 3 : 1 : 0 CREDITS: 4	**PREREQUISITE: MASS TRANSFER -I**

OBJECTIVE:

- To impart knowledge on fundamentals of mass transfer phenomena and to apply those concepts to real engineering problems.
- To explain the principles of mass transfer and their application to separation and purification processes.
- To describe the principles and operations of mass transfer equipment.

COURSE OUTCOME:

Students completing the course will be able to

- Understand the basics of distillation process for separation.
- Analyze the distillation process for binary and multicomponent mixtures
- Determine the number of stages required for separation of liquid-liquid and solid-liquid extraction process.
- Understand the adsorption mechanism and adsorption equilibrium

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS/BOOKS/PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Robert. E. Treybal. ―Mass Transfer Operation‖, 3e, Mc Graw Hill, NY,	2012
2.	Mc Cabe and J.M.Smith. ―Unit Operations in Chemical Engineering‖ , 7e, McGraw Hill	2004
3.	Coulson and Richardson ―Heat and Mass Transfer: Fundamentals and Applications‖, Vol I-B, 7e,	2017
4.	J.D. Seader & Henley E. J., "Separation Process Principles‖ 2e, Wiley India Pvt. Ltd,	2006,
5.	Geankoplis, C.J. ―Transport Processes and Unit Operations‖, 3e, Prentice Hall (I),	2003

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	**Distillation** Pressure-composition, Temperature-concentration, Enthalpy-concentration diagrams for ideal and non-ideal solutions, Raoults law and its application,	**8**

	Maximum and minimum boiling mixtures, concept of relative volatility, Single Stage Distillation, Differential distillation, Flash vaporization, Vacuum, molecular and steam distillation.	
II	**Continuous Distillation of Binary Mixtures**: Multistage contact operations, Characteristics of multistage tower, McCabe Thiele method, Ponchon Savarit method, Reflux, maximum, min. and optimum reflux, Use of open steam, Tray efficiency, Determination of height and column diameter, Multistage batch distillation; Principles of azeotropic and extractive distillation, Introduction to multi component distillation system.	**8**
III	**Liquid-Liquid Extraction:** Ternary liquid equilibrium, Triangular graphical representation concept of theoretical or ideal stage, Equipment used for single stage and multistage continuous operation; Analytical and graphical solution of single and multistage operation Super critical fluid extraction.	**8**
IV	**Solid /Liquid Extraction:** Leaching, Solid liquid equilibrium, Equipment used in solid-liquid extraction, Single and multistage cross current contact and counter current operations. Concept of an ideal stage, Overall stage efficiency, Determination of number of stages.	**8**
V	**Adsorption:**Description of adsorption processes and their application, Types of adsorption, Nature of adsorbents adsorption equilibrium and adsorption hysteresis, Freundlich and Langmuir adsorption isotherm , Chemisorption Stage wise and continuous contact adsorption operations, Determination of number of stages, Equipments; Ion exchange, Equilibrium relationship, Principle of ion-exchange, techniques and applications, Principles and application of dialysis, osmosis reverse osmosis, thermal diffusion, sweep diffusion.	**8**
		40

DR. A.P. J ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH. III YEAR VI SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 602	**COURSE TITLE: TRANSPORT PHENOMENON**
EXAM DURATION: 3 HOURS	**SEMESTER: VI (EVEN)**
L: T: P :: 3 : 1 : 0 CREDITS: 4	**PRE-REQUISITE: KCH 302, KCH 303, KCH 501**

OBJECTIVE

- To provide knowledge to analyze various transport processes.
- To teach the solution approximation methods and their limitations.

COURSE OUTCOME:

On completion of this course, the students will be able to

- Understand the chemical and physical transport processes and their mechanism
- Do heat, mass and momentum transfer analysis samultaneously.
- Analyze industrial problems along with appropriate approximations and boundary conditions
- Develop steady and time dependent solutions along with their limitations

REFERENCE BOOKS:

S. NO	NAME OF AUTHORS / BOOKS / PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Bird, R. B., Stewart, W. E. and Lightfoot, E. W., Transport Phenomena, 2nd Edition, John Wiley & Sons, London, ISBN: 978-0-470-11539-8.	2006
2.	Brodkey, R. S., Hershey, H. C., Transport Phenomena, Bertrams Print On Demand, Swindon, U.K., ISBN: 978-0-972-66359-5.	2003
3.	Welty, J. R., Wilson, R. W., and Wicks, C. W., Gregory L. R., Fundamentals of Momentum Heat and Mass Transfer, 6th Edition. John Wiley& Sons, New Jersey, ISBN:978-0-470-50481-9.	2014

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	**Momentum Transport** Viscosity - Temperature effect on viscosity of gases and liquids - Newton's law - Mechanism of momentum transport - Shell balance method - Pressure and velocity distributions in falling film - Circular tube - Annulus.	**8**

II	**Equations of Change and Turbulent Flow:** Equation of continuity- Motion - Use of equations of change to solve flow problems - Dimensional analysis of equations of change - Comparison of laminar and turbulent flows - Time-smoothed equation of change.	**7**
III	**Energy Transport:** Thermal conductivity - Temperature and pressure effect on thermal conductivity of gases and liquids - Fourier's law - Mechanism of energy transport - Shell energy balance - Temperature distribution in solids and laminar flow - with electrical - Nuclear - Viscous, Chemical heat source - Heat conduction through composite walls, cylinders – Spheres	**8**
IV	**Temperature Distribution in Turbulent Flows:** Energy equations - Use of equations of change - Dimensional analysis of equations of change - Time-smoothed equations of change - Empirical expressions - Temperature distribution for turbulent flow in tubes	**7**
V	**Mass Transport:** Diffusivity - Temperature and pressure effect - Fick's law - Mechanism of mass transport - Theory of diffusion in gases and liquids - Shell mass balances - Concentration distribution in solids and in laminar flow: stagnant gas film - Heterogeneous and homogeneous chemical reaction systems- Falling film - Porous catalyst. The equation of continuity - Summary of equations of change and fluxes. Momentum, heat and mass transfer analogies: Chilton–Colburn analogy and Reynold's Analogy	**10**
		40

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR VI SEMESTER CHEMICAL ENGINEERING

SUBJE CT CODE: KCH 603	**COURSE TITLE: CHEMICAL TECHNOLOGY**
EXAM DURATION: 3 HOURS	**SEMESTER : VI (EVEN)**
L: T: P :: 3 : 1 : 0 CREDITS: 4	**PRE REQUISITES: NIL**

OBJECTIVE:

- To provide knowledge of the various processes involved in chemical industries for the production of inorganic and organic chemicals.
- To disseminate knowledge of the Production and Consumption Pattern, Manufacturing process and flow sheet.
- To make students aware of the latest technological developments and Engineering problems.

COURSE OUTCOME:

After successful completion of the course the students will be able to:

- Understand the plant process and flow sheet.
- Keep up the productivity while maintaining all safety norms stipulated, during their job.
- Solve Engineering problems that are likely to come across during the operation of plants.
- Suggest alternative manufacturing process in terms of Economic viability of the product.
- Have enhanced employability.

REFERENCE BOOKS

S.NO	**NAME OF AUTHORS/BOOKS /PUBLISHERS**	**YEAR OF PUBLICATION/ REPRINT**
1	Dryden, C. E. "Outlines of Chemical Technology" (Edited and Revised by M. Gopala Rao and M. Sittig)East West Press. Pvt. Ltd, New Delhi, 3rd Edition	1997
2	Austin G. T. Shreve's Chemical Process Industries", 5th Edition, McGraw Hill	1984
3	"Chemtech" Volume I - IV, Chemical Engineering Education Development Centre, I.I.T., Madras.	1975-1978.
4	O P Gupta, "Chemical Process Technology", Khanna Publishing House.	2018

COURSE DETAILS:

UNITS	**CONTENTS**	**LECTURE HOURS**
I	Introduction: Importance and Overview of Chemical Process Industries Starch, glucose and starch Fermentation products : Alcohol, Acetic acid, Citric acid and antibiotics	**10**

	Cellulose -Derivatives of Cellulose- Carboxyl Methyl Cellulose and gun cotton, Structural aspects of cellulose. Oil, fats and waxes industry: properties of oils and fats, Saturated, mono-, di-, and polyunsaturated fatty acids, hydrogenation of edible oils, hydrogenolysis, esterification and randomization, refining, waxes, Fat Splitting, Soap, Surfactants, Emulsifiers, Glycerin,.	
II	Chlor-alkali industry: Common salt, Caustic soda and Chlorine, Soda Ash, Hydrochloric acid. Sulfur Industry: Sulfur and sulfuric acid, Oleum Phosphorus Industry: Phosphorus, Phosphoric acid and super phosphates, Nitrogen and Fertilizer Industry: Ammonia, Nitric acid, Urea and other nitrogen fertilizers, Mixed fertilizers (SSP, TSP, NPK, KAP, DAP, Nitro phosphate), Effect of changing feed raw material on fertilizer products, Bio-fertilizers, Agrochemical industries: Manufacturing process of some important pesticides, insecticides, fungicides, fumigants, herbicides and their uses.	**9**
III	Paper industry: pulping; Recovery of chemicals from cooking liquors; Paper making. Wood Chemicals industry: Composite wood, plywood etc.; Manufacture of oleoresin, turpentine, menthol, Ethanol production; Essential oils, perfumes, flavors and cosmetics, Pharmaceutical industries: Classification and production of drugs Leather industry: Tanning processes; Leather making; Embossing; Leather chemicals.	**8**
IV	Surface coating industries: Types of surface coating; Paints, varnishes, distempers and enamels. Dyes industry: Classification of dyes and dye intermediates; production of some important dyes, lacquers and toners. Synthetic and natural fibers: Nylon, Dacron, Terylyne, Polyester, Viscose rayon, acetate rayon , Natural and synthetic rubber, vulcanization and reclaiming of rubber, SBR, Nano fibers Plastics; Thermosetting and Thermo Plastics (PVC, Polyethylene, Polyurethane, Teflon) .	**8**
V	Crude oil distillation, Thermal conversion processes (vis-breaking, coking), Catalytic conversion processes (fluid catalytic cracking, catalytic reforming, hydro cracking, alkylation, isomerization, polymerization),Finishing processes, Sulphur removal process, lube oil manufacture; Petrochemicals: ethylene, propylene, formaldehyde, methanol, ethylene oxide, ethanolamine, cumin, ethylene glycol, ethyl benzene, BTX; Separation of xylenes	**10**
	TOTAL	**50**

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR VI SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 061	**COURSE TITTLE: FUNDAMENTALS OF POLYMER SCIENCE AND ENGINEERING**
EXAM DURATION: 3 HOURS	**SEMESTER: VI (EVEN)**
L: T: P :: 3 : 0 : 0 CREDITS: 3	**PREREQUISITE: NIL**

OBJECTIVE:

- To provide a broad and fundamental knowledge of the polymers and their chemical, physical and mechanical behaviour.
- To emphasize on polymer synthesis, reaction engineering, and various processing techniques like moulding and extrusion.
- To equip the students with the knowledge necessary for deciding which characterization technique(s) would be appropriate for determining properties of interest.

COURSE OUTCOME:

On successful completion of the course, the student will be able to:

- Evaluate the different molecular weight and size of the polymers. Identify the various polymers.
- Understand the structure-properties relationship of polymeric materials. Decide which test methods are suitable for the measurement of various properties such as rheology and mechanical properties of polymers.
- Understand the various mechanism of polymerization and choose suitable techniques for polymer synthesis.
- Understand and analyze the various methods used for manufacturing polymers.
- Identify various polymer processing techniques used for the fabrication of polymer-based products.

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS/BOOKS/PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	F.W. Billmeyer, "Text Book of Polymer Science", 3rd Edn., Wiley Inter-Science	1984
2.	F. Rodriguez, "Principles of polymer systems",4th Edn., Taylor, and Francis, Washington	2003
3.	Herman F. Mark (Editor) "Encyclopaedia of Polymers Science and Technology", John Wiley-Inter Science. 4thEdn.	2014
4.	J. R. Fried, "Polymer Science and Technology", Prentice-Hall, Inc	1995

5.	A. Kumar, "Fundamentals of Polymer Engineering", 2nd Edn.	2003
6.	A.Rudin, "Elements of Polymer Science and Engineering", 2nd Edn.Academic Press, San Diego London Boston New York Sydney Tokyo Toronto.	1999

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	**Introductory Concepts And Definitions:** Some definitions: Polymer, Monomer, Oligomer, Repeating Unit, Representation of Polymer Structures, End groups, Degree of Polymerization: Polymerization and Functionality, Copolymers: Random copolymers, Alternate copolymers, graft copolymers, block copolymers. Molecular Architecture, Thermoplastics, and Thermosets, Elastomers. Fibers, and Plastics, Polymer molecular weights, and molecular weight distribution, the practical aspect of molecular weight measurement. Configuration and crystallinity of polymers, Effect of polymer isomerism, and conformational changes.	**6**
II	**Polymer Synthesis And Reaction Engineering:** Polymerization techniques: Addition polymerization: Bulk polymerization, solution polymerization, suspension polymerization, emulsion polymerization, Condensation polymerization: melt poly-condensation, solution poly-condensation Polymerization reaction mechanism: Step growth polymerization, Free radical polymerization, Copolymerization, Ionic and coordination polymerization Polymer reaction engineering: Homogeneous and Heterogeneous Polymerization Processes, Batch, Semibatch, and Continuous Processes, Polymerization Reactors.	**8**
III	**Polymer Material Structure And Properties:** Polymer structure and physical properties, Thermal transitions, Crystallization of polymers, Glass transition temperature, Viscoelastic behavior of polymers, Dynamic mechanical behavior at thermal transitions, Strain-stress tests, crazing in glassy polymers, Fracture mechanics, toughness and brittleness, polymer rheology, the effect of fabrication processes **Characterization Of Polymers:** Some important techniques and instruments used for characterization of polymers such as Viscometers, Rheometers, Surface properties (Contact angle) measurement, Fourier-Transform Infrared Spectroscopy (FT-IR), Raman spectroscopy, X-ray diffractometers (XRD), X-ray photoelectron spectroscopy (XPS), Scanning Electron Microscopy (SEM), Trasmission Electron (TEM) Microscopy, Atomic force microscopy (AFM) Thermogravimeric Analysis (TGA),	**8**

	Differential Scanning calorimetry (DSC), Dymanic mechanical thermal analysis (DMTA) etc.	
IV	**Manufacturing Of Polymers:** Polyethylene, polypropylene, polyvinylchloride and copolymers, polystyrene, polyamides, polyesters, Acrylics, Phenol-formaldehyde, Melamine-formaldehyde, Polyurethane, Epoxides, Rubbers and elastomers **Polymer Mixtures: Blends, Alloys, Reinforced Plastics And Composites:** Polymer compatibilization, Thermodynamic theories for polymers solutions, solubility parameter, Flory-Huggins theory, modified solubility parameter model, solvents and plasticizers, Polymer blending, reinforced plastics and elastomers, additives for polymers, polymer composites	**8**
V	**Processing Of Polymers :** Plastics-extrusion, injection molding, blow molding, compression, and transfer molding, Recycling of polymers	**6**
		36

DR. A.P. J ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW

B.TECH. III YEAR VI SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 062	**COURSE TITLE: SUSTAINABILITY OF ENVIRONMENT**
EXAM DURATION: 3 HOURS	**SEMESTER: VI (EVEN)**
L: T: P :: 3 : 0 : 0 CREDITS: 3	**PREREQUISITE: NIL**

OBJECTIVES:

- To create awareness in every engineering graduate about the significance of sustainability of environment.
- To teach about the effect of technology on the environment and ecological balance.
- To make students sensitive to the sustainable utilization of natural resources.

COURSE OUTCOME:

On successful completion of the course, the student will be able to:

- Understand the impact of environmental pollution and concept of sustainable development
- Analyze various resource conservation methodologies.
- Design of various air pollution and water pollution control equipments.
- Apply the basic scientific and sustainability principles behind waste management for solving practical waste management challenges
- Discuss the ethical and moral issues involved in seeking the sustainable use of resources

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS/BOOKS/PUBLISHERS	YEAR OF PUBLICATION/REPRINT
1.	Howard S. Peavy, D. R. Rowe & C. Tchobonoglous "Environmental Engineering", McGraw Hill	1984
2.	Metcalf & Eddy, "Waste Water Engineering Treatment, Disposal & Reuse", Tata McGraw Hill	2003

3.	Pandey G. N. and Carney G. C., "Environmental Engineering ". Tata McGraw Hill	1991
4.	Kreith F. and Tchobanoglous G., "Handbook of Solid Waste Management", 2nd Ed., Mc Graw Hill	2002
5.	Werner Strauss, 'Air Pollution Control: Measuring and monitoring air pollutant' Wiley	1978
6	Pichtel J., "Waste Management Practices: Municipal, Hazardous and Industrial", CRC	2005

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	**Introduction:** Interaction of man and environment,, Ecology & Environment, components of the biosphere, biodiversity, Food chain, Environmental pollution from chemical process industries, characterization of emission and effluents, environmental Laws and rules (CPCB ,UPPCB), standards for ambient air, noise emission and effluents, concept of sustainable development	**8**
II	**Resource Conservation:** Process modification, alternative raw material, recovery of by co-product from industrial emission effluents, recycle and reuse of waste, energy recovery and waste utilization, Water use minimization,	**6**
III	**Air quality Control:** Particulate emission control by mechanical separation and electrostatic precipitation, wet gas scrubbing, gaseous emission control by adsorption and adsorption, Design of cyclones, ESP, fabric filters and absorbers. **Water Pollution Control:** Physical treatment, pre-treatment, solids removal by settling and sedimentation, filtration centrifugation, coagulation and flocculation. Anaerobic and aerobic treatment biochemical kinetics, trickling filter, activated sludge and lagoons, aeration systems, sludge separation and drying and design of CETP, use of low waste technology.	**10**
IV	**Solid Waste management:** Industrial and Municipal, Characterization of wastes-hazardous and non-hazardous wastes. Waste disposal and management laws and guidelines. Non-hazardous industrial wastes-treatment, disposal, utilization and management. Value-extraction from the wastes. Handling, storage and disposal of hazardous wastes.	**7**
	Environment and Sustainable development: Economic development and social welfare consideration in socio economic developmental policies and planning. Impact of energy sources on environment, Approaches to mitigate environmental emissions from energy sector. Cleaner development mechanisms and their applications, Case studies on techno-economics of	**7**

V	energy conservation and renewable energy technologies for making non renewable energy sources available over longer periods.	
	TOTAL	**38**

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR VI SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 063	**COURSE TITLE: COLLOID SURFACE & INTERFACIAL PHENOMENA**
EXAM DURATION: 3 HOURS	**SEMESTER : VI (EVEN)**
L: T: P :: 3 : 0 : 0 CREDITS: 3	**PRE REQUISITES: NIL**

OBJECTIVES:

- To introduce students to the fundamentals of colloidal and interfacial phenomena
- Exposing them to a broad selection of topics, including colloidal suspensions, Intermolecular, nanoscale and interfacial forces systems
- To provide knowledge about Mesoscale thermodynamics and Mesoscale phenomena in soft matter and Nano fluids and Advanced & Functional Interfaces.

COURSE OUTCOME:

On successful completion of the course, the student will be able to:

- Quantitatively understand the constraints on the nature of intermolecular attraction to lead to system size independent intrinsic properties of materials
- Develop knowledge on interfacial phenomena to solve the practical chemical engineering problems.
- Understand the different forces involved in interfacial phenomena.
- Understand the importance of the surface properties.

REFERENCE BOOKS

S.NO	NAME OF AUTHORS/BOOKS /PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Surfactants and interfacial phenomena, Milton J. Rosen, 3rd edition	2004
2.	Principles of Colloid and Surface Chemistry, Paul C. Hiemenz, Marcel DEker, 2nd edition	1986
3.	Physical Chemistry of Surfaces, Arthur W. Adamson, 5th edition, Wiley,.	1990
4.	Foundations of Colloid Science, Robert J. Hunter, Clarendons, Oxford, Volume 1,	1989
5.	Colloidal Dispersions, W. B. Russel, D. A. Saville, and W, R. Schowalter, Cambridge University Press	1989
6.	Intermolecular and Surface forces, Jacon N. Israelachvili, Academic Press,	1992 or later
7.	interfacial Forces in Aqueous Media, Carel J. van Oss, Marcel Dekker or Taylor Francis	1994

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	Introduction of colloidal systems and their classification, origin of charge on colloidal particles, stabilization of different colloidal system by surfactants, solubilisation, emulsions, microemulsions, HLB, micelle formation by surfactants, thermodynamic parameters of micellization, emulsification by surfactants, micellar catalysis, synergism in mixture of two surfactants.	**8**
II	Fundamental aspects of colloidal suspensions, surface tension, wetting, surfactant adsorption, self-assembly, and inter particle interactions, as well as the importance of these phenomena to consumer, industrial, and biomedical applications.	**8**
III	Intermolecular, nanoscale and interfacial forces in organic, polymeric, biological and aqueous systems. Van der waals, electrostatic double layer, acid-base interactions including hydrophobic attraction and hydration pressure.	**8**
IV	Mesoscale thermodynamics and Mesoscale phenomena in soft matter & applications Gibb's treatment of interfaces, concept of excess concentration, variation of interfacial tension with surface concentration, Adhesion, wetting, nucleation, flotation, patterning of soft material by self organization and other techniques.	**10**
V	Nanofluidics and Advanced & Functional Interfaces: Stability of thin (< 100 nm) film, self-organization in confined systems, mesoscale patterning. Superhydrophobicity, functionsl coatings, structural colours, nano-adhesives, nanocomposites.	**8**
		42

DR. A.P. J ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH. III YEAR VI SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 064	**COURSE TITLE: ENVIRONMENTAL IMPACT ASSESMENT**
EXAM DURATION: 3 HOURS	**SEMESTER: VI (EVEN)**
L: T: P :: 3 : 0 : 0 CREDITS: 3	**PRE-REQUISITE: NIL**

OBJECTIVE:

- To provide a broad understanding of environmental auditing and environmental impact assessment.
- To impart knowledge about the increasing importance of corporate social responsibility.

COURSE OUTCOME:

On completion of this course, the students will be able to

- Understand the different steps within environmental impact assessment.
- Imply current jurisdictional and institutional arrangements in relation to environmental impact assessment.
- Understand environmental auditing and describe the main components of the environmental auditing process.
- Identify methods for auditing specific environmental issues associated with the activities of an organisation and product/service.
- Assess critically the use and application of environmental auditing.

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS / BOOKS / PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	A K Srivastava, Environment impact Assessment, APH Publishing	2014
2.	John Glasson, Riki Therivel & S Andrew Chadwick "Introduction to EIA" University College London Press Limited	2011
3.	Larry W Canter, "Environmental Impact Assessment", McGraw Hill Inc. , New York,	1995
4.	Ministry of Environment & Forests, Govt. of India 2006 EIA Notification	2006
5.	Rau G J and Wooten C.D "EIA Analysis Hand Book" Mc Graw Hill	
6.	Robert A Corbett "Standard Handbook of Environmental Engineering" McGraw Hill.	1999
7.	O P Gupta, "Elements of Environmental pollution & Control" Khanna Publisïng house.	

8.	Stanley E. Manahan, "Environmental Chemistry ", VIth Ed. Lewis Publishers, London	
9.	Anil Agarwal & Sunita Narayan, "Dying Wisdom Rise, Fall, and potential of India's Traditional rain water harvesting systems", CSE Publication. New Delhi.	
10.	Peter Wathern, Routledge, "Environmental Impact Assessment (Theory and Practice)", (Taylor and Frances Group), London and New York.	
	Brady, J., Ebbage, A. & Lunn, R., "Environmental Management in Organizations: The IEMA Handbook" 2nd edition. London, Earthscan.	2011

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	Introduction to EIA & Audit, Environment & Industries, Input information, Plant Operation, Environmental Management planning, Waste Streams impact on water bodies.	**5**
II	Environmental Impact Assessment planning. Activities, Methodology for Environmental Impact Assessment, Role of Environmental Engineering firm, Role of Regulatory agencies & control boards, Requirement of environment audit statement, Role of the Public. Study of environment protection rules 1986 and its amendment in 1993	**10**
III	Environmental Audit: Introduction, Environmental information Purpose & advantage of studies, General approach of environmental Auditing Environmental Audit, Types of Environmental Audit, Auditing Procedures and Methods, Audit programs in India, Auditing program in major polluting Industries, Reports of the Environmental audit studies.	**7**
IV	Pollution prevention and control laws & acts: Constitution of India & environment, Constitution protection to Environment laws, Administrative & legislative arrangement for Environmental production, Indian Standards, Pollution control acts in India, critical appraisal, fiscal incentives for environmental protection. Environmental Clearance process in India - Key Elements in 2006 EIA(Govt. of India) Notification	**10**
V	Guidelines of preparation of project report and its evaluation, methods of clearance from the concern authorities at various labels. Standards for Water, Air and Noise Quality - Environmental Management Plan-EIA- Case studies of EIA	**10**
		42

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR VI SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 651	**COURSE TITLE: CHEMICAL TECHNOLOGY LAB**
EXAM DURATION: 2 HOURS	**SEMESTER: VI (EVEN)**
L: T: P :: 0 : 0 : 2 CREDIT: 1	**PRE-REQUISITE: NIL**

OBJECTIVE:

- To introduce the fundamental principles of chemical lab experiments.
- To make them correlate theory and practical processes in industry, through experimentation.

COURSE OUTCOME:

After successful completion of this course, the students will be able to:

- Understand the basic concepts of production processes
- Conduct experimental procedure for manufacture of soap, organic chemicals etc and analyze them
- Make the students aware of basic safety considerations during handling of chemicals, glass ware usage, instruments used in analysis and production activities.
- Enhance their practical knowledge and thus their employability

REFERENCE BOOKS

S.NO	NAME OF AUTHORS/BOOKS /PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1	Dryden, C. E. "Outlines of Chemical Technology" (Edited and Revised by M. Gopala Rao and M. Sittig)East West Press. Pvt. Ltd, New Delhi, 3rd Edition	1997
2	Austin G. T. Shreve's Chemical Process Industries", 5th Edition, McGraw Hill	1984
3	"Chemtech" Volume I - IV, Chemical Engineering Education Development Centre, I.I.T., Madras.	1975-1978.
4	O P Gupta, "Chemical Process Technology", Khanna Publishing House.	2018

COURSE DETAILS:

LIST OF EXPERIMENTS:

Preparation and Quality evaluation of any ten experiments of the following:

1. Preparation of Turkey Red Oil for leather industry from castor oil.
2. Preparation of dry/oil bound distemper.
3. Preparation of cement Paint.
4. Preparation of Liquid soap.
5. Preparation of alkyd resin.
6. Preparation of Transparent Soaps.
7. Preparation of Detergent Powder.
8. Preparation of Margarine.
9. Soxhlet Extraction of oil bearing materials.
10. Splitting of Oils for fatty acid preparation.
11. Preparation of bio-fertilizer.
12. Preparation of Sanitizer.
13. Distillation of essential oil from aromatic plant materials such as leaves, flowers, fruits, fruit peals etc., using Cleavenger's Apparatus.

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR VI SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 652	**COURSE TITLE: MASS TRANSFER-II LAB**
EXAM DURATION: 2 HOURS	**SEMESTER: VI (EVEN)**
L: T: P :: 0 : 0 : 2 CREDIT: 1	**PRE-REQUISITE: NIL**

OBJECTIVE:

- To impart knowledge of the basic fundamental principles of mass transfer by performing different experiments
- To make them correlate theory and practical process by experimentation.

LAB OUTCOME:

On successful completion of the lab, the student will be able to:

- Analyze the data on Analyze vapor-liquid equilibrium and Boiling point diagram
- Discuss the performance of distillation column
- Explain the adsorption kinetics and isotherm at solid-liquid interface
- Understand the separation process by Liquid- Liquid Extraction and solid liquid extraction.

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS/BOOKS/PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Robert. E. Treybal. ―Mass Transfer Operation‖, 3e, Mc Graw Hill, NY,	2012
2.	Mc Cabe and J.M.Smith. ―Unit Operations in Chemical Engineering‖ , 7e, , McGraw Hill	2004
3.	Coulson and Richardson ―Heat and Mass Transfer: Fundamentals and Applications‖, Vol I-B, 7e,	2017
4.	J.D. Seader & Henley E. J., "Separation Process Principles‖ 2e, Wiley India Pvt. Ltd,	2006
5.	Geankoplis, C.J. ―Transport Processes and Unit Operations‖, 3e, Prentice Hall (I),	2003

COURSE DETAILS:

S. No.	LIST OF EXPERIMENTS
1	To study vapor-liquid equilibrium and prepare Boiling point diagram for a binary liquid mixture.
2	To study the performance of Bubble cap distillation column.

3	To verify Rayleigh equation for differential distillation of binary system.
4	To study the performance of sieve plate distillation unit.
5	To determine Overall efficiency for a three-stage counter-current and cross current system.
6	To determine the ternary curve for the system acetic acid-water-carbon tetrachloride.
7	To study the solid –liquid extraction system- Soxhlet's experiment.
8	To study the operation on extraction of oil from seed.
9	To determine the adsorption kinetics and isotherm at solid-liquid interface.
10	To obtain the breakthrough curve for the given adsorption system.

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR VI SEMESTER CHEMICAL ENGINEERING

SUBJECT CODE: KCH 653	**COURSE TITLE: TECHNICAL PRESENTATION**
EXAM DURATION: 2 HOURS	**SEMESTER: VI (EVEN)**
L: T: P :: 0 : 0 : 2 CREDIT: 1	**PREREQUISITE: NIL**

OBJECTIVE: The purpose of this course is to prepare our students for:

- To provide them better learning and understanding through presentations.
- To develop better communication skill and confidence.
- To provide a platform for sound discussions of technical & challenging areas.

COURSE OUTCOME:

On successful completion of the lab, the student will be able to:

- Improve their communication skill.
- How to write refined report of any technical topics.
- To learn new challenging area of their domain.
- Knowledge of the application of Artificial Intelligence in Chemical Engineering.
- Knowledge of automation through on ERP module training.

COURSE DETAILS:

- Presentation on Chemical Engineering topics.
- Presentation on ERP module training.
- Presentation on the application of Artificial Intelligence in Chemical Engineering.
- Presentation on some project taken up.
- Presentation on simulation and simulators.
- Presentation on certification process.
- Presentation on Chemical analysis and measuring techniques.
- Presentation on any other innovative idea.