INSTITUTE OF ENGINNERING AND TECHNOLOGY LUCKNOW

(An Autonomous Constituent Institute of Dr. A.P.J. Abdul Kalam Technical University, Lucknow)

Evaluation Scheme & Syllabus

For

B. Tech. Third Year

(Chemical Engineering)

AS PER

AICTE MODEL CURRICULUM

[Effective from the Session: 2020-21]

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

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

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**
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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**
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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.

B.Tech.
V & VI Semester

1	KNC501/ KNC601	CONSTITUTION OF INDIA, LAW AND ENGINEERING

CONSTITUTION OF INDIA, LAW AND ENGINEERING

L:T: P: 2: 0:0

Module 1--Introduction and Basic Information about Indian Constitution:

Meaning of the constitution law and constitutionalism, Historical Background of the Constituent Assembly, Government of India Act of 1935 and Indian Independence Act of 1947,Enforcement of the Constitution, Indian Constitution and its Salient Features, The Preamble of the Constitution, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliamentary System, Federal System, Centre-State Relations, Amendment of the Constitutional Powers and Procedure, The historical perspectives of the constitutional amendments in India, Emergency Provisions: National Emergency, President Rule, Financial Emergency, and Local Self Government – Constitutional Scheme in India.

Module 2-Union Executive and State Executive:

Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions of the President, Comparison of powers of Indian President with the United States, Powers and Functions of the Prime Minister, Judiciary – The Independence of the Supreme Court, Appointment of Judges, Judicial Review, Public Interest Litigation, Judicial Activism, LokPal, Lok Ayukta, The Lokpal and Lok ayuktas Act 2013, State Executives – Powers and Functions of the Governor, Powers and Functions of the Chief Minister, Functions of State Cabinet, Functions of State Legislature, Functions of High Court and Subordinate Courts.

Module 3- Introduction and Basic Information about Legal System:

The Legal System: Sources of Law and the Court Structure: Enacted law -Acts of Parliament are of primary legislation, Common Law or Case law, Principles taken from decisions of judges constitute binding legal rules. The Court System in India and Foreign Courtiers (District Court, District Consumer Forum, Tribunals, High Courts, Supreme Court). Arbitration: As an alternative to resolving disputes in the normal courts, parties who are in dispute can agree that this will instead be referred to arbitration. Contract law, Tort, Law at workplace.

Module 4- Intellectual Property Laws and Regulation to Information:

Intellectual Property Laws: Introduction, Legal Aspects of Patents, Filing of Patent Applications, Rights from Patents, Infringement of Patents, Copyright and its Ownership, Infringement of Copyright, Civil Remedies for Infringement, Regulation to Information-Introduction, Right to Information Act, 2005, Information Technology Act, 2000, Electronic Governance, Secure Electronic Records and Digital Signatures, Digital Signature Certificates, Cyber Regulations Appellate Tribunal, Offences, Limitations of the Information Technology Act.

Module 5 -Business Organizations and E-Governance:

Sole Traders, Partnerships: Companies: The Company's Act: Introduction, Formation of a Company, Memorandum of Association, Articles of Association, Prospectus, Shares, Directors, General Meetings and Proceedings, Auditor, Winding up.

E-Governance and role of engineers in E-Governance, Need for reformed engineering serving at the Union and State level, Role of I.T. professionals in Judiciary, Problem of Alienation and Secessionism in few states creating hurdles in Industrial development.

COURSE OBJECTIVE:

- To acquaint the students with legacies of constitutional development in India and help those to understand the most diversified legal document of India and philosophy behind it.
- To make students aware of the theoretical and functional aspects of the Indian Parliamentary System.
- To channelize students' thinking towards basic understanding of the legal concepts and its implications for engineers.
- To acquaint students with latest intellectual property rights and innovation environment with related regulatory framework.
- To make students learn about role of engineering in business organizations and e-governance.

COURSE OUTCOME: At the end of the course, learners should be able to-

1. Identify and explore the basic features and modalities about Indian constitution.
2. Differentiate and relate the functioning of Indian parliamentary system at the center and state level.
3. Differentiate different aspects of Indian Legal System and its related bodies.
4. Discover and apply different laws and regulations related to engineering practices.
5. Correlate role of engineers with different organizations and governance models

Pedagogy: Lecture, Problem based learning, Group discussions, Visual media, Films, Documentaries, Debate forums.

Suggested Readings:

- Brij Kishore Sharma: *Introduction to the Indian Constitution*, 8th Edition, PHI Learning Pvt. Ltd.
- Granville Austin: *The Indian Constitution: Cornerstone of a Nation (Classic Reissue)*, Oxford University Press.
- Subhash C. Kashyap: *Our Constitution: An Introduction to India's Constitution and constitutional Law*, NBT, 2018.
- Madhav Khosla: *The Indian Constitution*, Oxford University Press.
- PM Bakshi: *The Constitution of India*, Latest Edition, Universal Law Publishing.
- V.K. Ahuja: *Law Relating to Intellectual Property Rights* (2007)
- Suresh T. Viswanathan: *The Indian Cyber Laws, Bharat Law House*, New Delhi-88
- P. Narayan: Intellectual Property Law, Eastern Law House, New Delhi
- Prabudh Ganguli: *Gearing up for Patents: The Indian Scenario*, Orient Longman.
- BL Wadehra: Patents, Trademarks, *Designs and Geological Indications Universal Law* Publishing - LexisNexis.
- *Intellectual Property Rights: Law and Practice, Module III* by ICSI (only relevant sections)
- Executive programme study material Company Law, Module II, by ICSI (The Institute of Companies Secretaries of India) (Only relevant sections i.e., Study 1, 4 and 36).https://www.icsi.edu/media/webmodules/publications/Company%20Law.pdf
- Handbook on e-Governance Project Lifecycle, Department of Electronics & Information Technology, Government of India, https://www.meity.gov.in/writereaddata/files/e-Governance_Project_Lifecycle_Participant_Handbook-5Day_CourseV1_20412.pdf
- Companies Act, 2013 Key highlights and analysis by PWC. https://www.pwc.in/assets/pdfs/publications/2013/companies-act-2013-key-highlights-and-analysis.pdf

Referred Case Studies:

- Keshavanand Bharati V. State of Kerala, AIR 1973 SC 1461.
- Maneka Gandhi V. Union of India AIR, 1978 SC 597.
- S.R. Bammai V. Union of India, AIR 1994 SC 1918.
- Kuldip Nayyar V. Union of India, AIR 2006 SC312.
- A.D.M. Jabalpur V. ShivkantShakla, AIR 1976 SC1207.
- Remshwar Prasad V. Union of India, AIR 2006 SC980.
- Keshav Singh in re, AIR 1965 SC 745.
- Union of India V. Talsiram, AIR 1985 SC 1416.
- Atiabari Tea Estate Co.V. State of Assam, AIR 1961SC232.
- SBP & Co. Vs. Patel Engg. Ltd. 2005 (8) SCC 618.
- Krishna Bhagya Jala Nigam Ltd. Vs. G. Arischandra Reddy (2007) 2 SCC 720.
- Oil & Natural Gas Corporation Vs. Saw Pipes Ltd. 2003 (4) SCALE 92 – 185.

**** (Other relevant case studies can be consulted by the teacher as per the topic).**

Prescribed Legislations:

1. Information Technology Act, 2000 with latest amendments.
2. RTI Act 2005 with latest amendments.
3. Information Technology Rules, 2000
4. Cyber Regulation Appellate Tribunal Rules, 2000

Suggested aid for Students and Pedagogic purpose

- RSTV debates on corporate law, IPR and patent issues
- NPTEL lectures on IPR and patent rights

Episodes of 10 -part mini TV series "Samvidhan: The Making of Constitution of India" by RSTV.

B.Tech.
V & VI Semester

2	KNC502/ KNC602	INDIAN TRADITION, CULTURE AND SOCIETY

INDIAN TRADITIONS, CULTURAL AND SOCIETY

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Module 1- Society State and Polity in India

State in Ancient India: Evolutionary Theory, Force Theory, Mystical Theory Contract Theory, Stages of State Formation in Ancient India, Kingship , Council of Ministers Administration Political Ideals in Ancient India Conditions' of the Welfare of Societies, The Seven Limbs of the State, Society in Ancient India, Purusārtha, Varnāshrama System, Āshrama or the Stages of Life, Marriage, Understanding Gender as a social category, The representation of Women in Historical traditions, Challenges faced by Women. Four-class Classification, Slavery.

Module 2- Indian Literature, Culture, Tradition, and Practices

Evolution of script and languages in India: Harappan Script and Brahmi Script. The Vedas, the Upanishads, the Ramayana and the Mahabharata, Puranas, Buddhist And Jain Literature in Pali,Prakrit And Sanskrit, Kautilya's Arthashastra, Famous Sanskrit Authors, Telugu Literature, Kannada Literature,Malayalam Literature ,Sangama Literature Northern Indian Languages & Literature, Persian And Urdu ,Hindi Literature

Module 3- Indian Religion, Philosophy, and Practices

Pre-Vedic and Vedic Religion, Buddhism, Jainism, Six System Indian Philosophy, Shankaracharya, Various Philosophical Doctrines , Other Heterodox Sects, Bhakti Movement, Sufi movement, Socio religious reform movement of 19th century, Modern religious practices.

Module 4-Science, Management and Indian Knowledge System

Astronomy in India, Chemistry in India, Mathematics in India, Physics in India, Agriculture in India, Medicine in India ,Metallurgy in India, Geography, Biology, Harappan Technologies, Water Management in India, Textile Technology in India ,Writing Technology in India Pyrotechnics in India Trade in Ancient India/,India's Dominance up to Pre-colonial Times

Module 5- Cultural Heritage and Performing Arts

Indian Architect, Engineering and Architecture in Ancient India, Sculptures, Seals, coins, Pottery, Puppetry, Dance, Music, Theatre, drama, Painting, Martial Arts Traditions, Fairs and Festivals, Current developments in Arts and Cultural, Indian's Cultural Contribution to the World. Indian Cinema

COURSE OBJECTIVES:

- The course aims at imparting basic principles of thought process, reasoning and inference to identify the roots and details of some of the contemporary issues faced by our nation and try to locate possible solutions to these challenges by digging deep into our past.
- To enable the students to understand the importance of our surroundings and encourage the students to contribute towards sustainable development.
- To sensitize students towards issues related to 'Indian' culture, tradition and its composite character.

- To make students aware of holistic life styles of Yogic-science and wisdom capsules in Sanskrit literature that are important in modern society with rapid technological advancements and societal disruptions.
- To acquaint students with Indian Knowledge System, Indian perspective of modern scientific world-view and basic principles of Yoga and holistic health care system.

COURSE OUTCOMES: Ability to understand, connect up and explain basics of Indian Traditional knowledge modern scientific perspective.

Suggested Pedagogy for Teachers

- Project based learning
- Case studies
- Group discussion
- Presentations

Suggested Text & Reference Books

1. V. Sivaramakrishna (Ed.), *Cultural Heritage of India-Course Material*, Bharatiya Vidya Bhavan, Mumbai, 5th Edition, 2014
2. S. Baliyan, *Indian Art and Culture*, Oxford University Press, India
3. Swami Jitatmanand, *Modern Physics and Vedant*, Bharatiya Vidya Bhavan
4. Romila Thapar, *Readings In Early Indian History* Oxford University Press , India
5. Fritz of Capra, Tao of Physics
6. Fritz of Capra, The wave of Life
7. V N Jha (English Translation), *Tarkasangraha of Annam Bhatta,* Inernational Chinmay Foundation,Velliarnad,Amaku,am
8. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkatta
9. GN Jha (Eng. Trans.) Ed. R N Jha, *Yoga-darshanam with Vyasa Bhashya*, Vidyanidhi Prakasham, Delhi,2016
10. RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, Vidyanidhi Prakasham, Delhi, 2016
11. P R Sharma (English translation), Shodashang Hridayam
12. Basham, A.L., *The Wonder that was India* (34th impression), New Delhi, Rupa & co
13. Sharma, R.S., *Aspects of Political Ideas and Institutions in Ancient India*(fourth edition), Delhi, Motilal Banarsidass,

B.Tech. VI Semester

OPEN ELECTIVE-I

KOE-061	REAL TIME SYSTEMS
KOE-062	EMBEDDED SYSTEM
KOE-063	INTRODUCTION TO MEMS
KOE-064	OBJECT ORIENTED PROGRAMMING
KOE-065	NUMERICAL TECHNIQUES
KOE066	GIS & REMOTE SENSING
KOE-067	UNDERSTANDING THE HUMAN BEING COMPREHENSIVELY-HUMAN ASPIRATIONS AND ITS FULFILLMENT

KOE-061 REAL TIME SYSTEMS

Unit	Topics	Lectures
I	**Introduction** Definition, Typical Real Time Applications: Digital Control, High Level Controls, Signal Processing etc., Release Times, Dead-lines, and Timing Constraints, Hard Real Time Systems and Soft Real Time Systems, Reference Models for Real Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency.	8
II	**Real Time Scheduling** Common Approaches to Real Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems, Optimality of Effective-Deadline-First (EDF) and Least-Slack-Time-First (LST) Algorithms, Rate Monotonic Algorithm, Offline Versus Online Scheduling, Scheduling Aperiodic and Sporadic jobs in Priority Driven and Clock Driven Systems.	8
III	**Resources Sharing** Effect of Resource Contention and Resource Access Control (RAC), Non-preemptive Critical Sections, Basic Priority-Inheritance and Priority-Ceiling Protocols, Stack Based Priority- Ceiling Protocol, Use of Priority-Ceiling Protocol in Dynamic Priority Systems, Preemption Ceiling Protocol, Access Control in Multiple-Module Resources, Controlling Concurrent Accesses to Data Objects.	8
IV	**Real Time Communication** Basic Concepts in Real time Communication, Soft and Hard RT Communication systems, Model of Real Time Communication, Priority-Based Service and Weighted Round-Robin Service Disciplines for Switched Networks, Medium Access Control Protocols for Broadcast Networks, Internet and Resource Reservation Protocols.	
V	**Real Time Operating Systems and Databases** Features of RTOS, Time Services, UNIX as RTOS, POSIX Issues, Characteristic of Temporal data, Temporal Consistency, Con-currency Control, Overview of Commercial Real Time databases.	8

Text Books:

1. Real Time Systems – Jane W. S. Liu, Pearson Education Publication.

Reference Books:

1. Real Time Systems – Mall Rajib, Pearson Education
2. Real-Time Systems: Scheduling, Analysis, and Verification – Albert M. K. Cheng, Wiley.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Describe concepts of Real-Time systems and modeling.
2. Recognize the characteristics of a real-time system in context with real time scheduling.
3. Classify various resource sharing mechanisms and their related protocols.
4. Interpret the basics of real time communication by the knowledge of real time models and protocols.
5. Apply the basics of RTOS in interpretation of real time systems.

KOE-062 EMBEDDED SYSTEM

COURSE OBJECTIVE: *After completion of the course student will be able to:*

1. Attain the knowledge of embedded system and its development environment.
2. Gain the knowledge of RTOS based embedded system design and its applications.

COURSE OUTCOME: *After completion of the course student will be able to:*

CO1: Understand the basics of embedded system and its structural units.
CO3: Analyze the embedded system specification and develop software programs.
CO3: Evaluate the requirements of the programming embedded systems, related software architecture.
CO3: Understand the RTOS based embedded system design.
CO3: Understand all the applications of the embedded system and designing issues.

KOE-062 EMBEDDED SYSTEM		
Unit	**Topic**	**Lectures**
1	Introduction to Embedded Systems: Introduction to Embedded Systems – The build process for embedded systems- Structural units in Embedded processor , selection of processor & memory devices- DMA – Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging.	**8**
2	Embedded Networking: Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols – RS232 standard – RS422 – RS485 – CAN Bus -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) –need for device drivers.	**8**
3	Embedded Firmware Development Environment: Embedded Product Development Life Cycle objectives, different phases of EDLC, Modelling of EDLC; issues in Hardware-software Co-design, Data Flow Graph, state machine model, Sequential Program Model, concurrent Model, object oriented Model.	**8**
4	RTOS Based Embedded System Design: Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non preemptive scheduling, Task communication shared memory, message passing-, Inter process Communication – synchronization between processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance, comparison of Real time Operating systems: Vx Works, чC/OS-II, RT Linux.	**8**
5	Embedded System Application Development: Design issues and techniques Case Study of Washing Machine- Automotive Application- Smart card System Application.	**8**

Text Books:

1. Wayne Wolf, "Computers as Components: Principles of Embedded Computer System Design", Elsevier, 2006.
2. Michael J. Pont, "Embedded C", Pearson Education , 2007.
3. Steve Heath, "Embedded System Design", Elsevier, 2005.
4. Muhammed Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay, "The 8051
5. Microcontroller and Embedded Systems", Pearson Education, Second edition, 2007.

KOE-063 INTRODUCTION TO MEMS

COURSE OBJECTIVE: *After completion of the course student will be able to:*

1. Understand the Basic concept of MEMS, Mechanics of Beam and Diaphragm Structures, Air Damping and Electrostatic Actuation.
2. Know the knowledge of Thermal Effects and the Applications of MEMS in RF.

COURSE OUTCOME: *After completion of the course student will be able to:*

CO1: Understand the Basic concept of MEMS Fabrication Technologies, Piezoresistance Effect, Piezoelectricity, Piezoresistive Sensor.
CO2: Explain Mechanics of Beam and Diaphragm Structures.
CO3: Understand the Basic concept of Air Damping and Basic Equations for Slide-film Air Damping, Couette-flow Model, Stokes-flow Model.
CO4: Know the concept of Electrostatic Actuation.
CO5: Understand the applications of MEMS in RF

KOE-063 INTRODUCTION TO MEMS		
Unit	**Topic**	**Lectures**
1	**Introduction to MEMS:** MEMS Fabrication Technologies, Materials and Substrates for MEMS, Processes for Micromachining, Characteristics, Sensors/Transducers, Piezoresistance Effect, Piezoelectricity, Piezoresistive Sensor.	**8**
2	**Mechanics of Beam and Diaphragm Structures:** Stress and Strain, Hooke's Law. Stress and Strain of Beam Structures: Stress, Strain in a Bent Beam, Bending Moment and the Moment of Inertia, Displacement of Beam Structures Under Weight, Bending of Cantilever Beam Under Weight.	**8**
3	**Air Damping:** Drag Effect of a Fluid: Viscosity of a Fluid, Viscous Flow of a Fluid, Drag Force Damping, The Effects of Air Damping on Micro-Dynamics. Squeeze-film Air Damping: Reynolds' Equations for Squeeze-film Air Damping, Damping of Perforated Thick Plates. Slide-film Air Damping: Basic Equations for Slide-film Air Damping, Couette-flow Model, Stokes-flow Model.	**8**
4	**Electrostatic Actuation:** Electrostatic Forces, Normal Force, Tangential Force, Fringe Effects, Electrostatic Driving of Mechanical Actuators: Parallel-plate Actuator, Capacitive sensors. Step and Alternative Voltage Driving: Step Voltage Driving, Negative Spring Effect and Vibration Frequency.	**8**
5	**Thermal Effects:** Temperature coefficient of resistance, Thermo-electricity, Thermocouples, Thermal and temperature sensors. **Applications of MEMS in RF** MEMS Resonator Design Considerations, One-Port Micromechanical Resonator Modeling Vertical Displacement Two-Port Microresonator Modeling, Micromechanical Resonator Limitations.	**8**

Text & Reference Books:

1. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalakrishnan, K. N. Bhat and V. K. Atre, "Micro and smart systems", Wiley India, 2010.
2. S.M. Sze, "Semiconductor Sensors", John Wiley & Sons Inc., Wiley Interscience Pub.
3. M.J. Usher, "Sensors and Transducers", McMillian Hampshire.
4. RS Muller, Howe, Senturia and Smith, "Micro sensors", IEEE Press.

KOE-064 OBJECT ORIENTED PROGRAMMING

COURSE OBJECTIVE: After completion of the course student will be able to:

1. Understand the Basic concept of Object Orientation, object identity and Encapsulation.
2. Know the knowledge of Basic Structural Modeling, Object Oriented Analysis and C++ Basics.

COURSE OUTCOME: After completion of the course student will be able to:

CO1: Understand the Basic concept of Object Orientation, object identity and Encapsulation.
CO2: Understand the Basic concept of Basic Structural Modeling.
CO3: Know the knowledge of Object oriented design, Object design.
CO4: Know the knowledge of C++ Basics.
CO5: Understand the Basics of object and class in C++.

KOE-064 OBJECT ORIENTED PROGRAMMING		
Unit	**Topic**	**Lectures**
1	Introduction: The meaning of Object Orientation, object identity, Encapsulation, information hiding, polymorphism, generosity, importance of modelling, principles of modelling, object oriented modelling, Introduction to UML, conceptual model of the UML, Architecture.	**8**
2	Basic Structural Modeling: Classes, Relationships, common Mechanisms, and diagrams. Class &Object Diagrams: Terms, concepts, modelling techniques for Class & Object Diagrams. Collaboration Diagrams: Terms, Concepts, depicting a message, polymorphism in collaboration Diagrams, iterated messages, use of self in messages. Sequence Diagrams: Terms, concepts, depicting asynchronous messages with/without priority, call-back mechanism, broadcast messages. Basic Behavioural Modeling: Use cases, Use case Diagrams, Activity Diagrams, State Machine , Process and thread, Event and signals, Time diagram, interaction diagram, Package diagram. Architectural Modeling: Component, Deployment, Component diagrams and Deployment diagrams	**8**
3	Object Oriented Analysis: Object oriented design, Object design, Combining three models, Designing algorithms, design optimization, Implementation of control, Adjustment of inheritance, Object representation, Physical packaging, Documenting design considerations. Structured analysis and structured design (SA/SD), Jackson Structured Development (JSD).Mapping object oriented concepts using non-object oriented language, Translating classes into data structures, Passing arguments to methods, Implementing inheritance, associations encapsulation. Object oriented programming style: reusability, extensibility, robustness, programming in the large. Procedural v/s OOP, Object oriented language features. Abstraction and Encapsulation.	**8**
4	C++ Basics : Overview, Program structure, namespace, identifiers, variables, constants, enum, operators, typecasting, control structures C++ Functions : Simple functions, Call and Return by reference, Inline functions, Macro Vs. Inline functions, Overloading of functions, default arguments, friend functions, virtual functions	**8**
5	Objects and Classes : Basics of object and class in C++, Private and public members, static data and function members, constructors and their types, destructors, operator overloading, type conversion. Inheritance : Concept of Inheritance, types of inheritance: single, multiple, multilevel, hierarchical, hybrid, protected members, overriding, virtual base class Polymorphism : Pointers in C++, Pointes and Objects, this pointer, virtual and pure virtual functions, Implementing polymorphism	**8**

Text Books:

1. James Rumbaugh et. al, “Object Oriented Modeling and Design”, PHI
2. Grady Booch, James Rumbaugh, Ivar Jacobson, “The Unified Modeling Language User Guide”, Pearson Education
3. Object Oriented Programming with C++, E Balagurusamy, TMH

Reference Books:

1. R. S. Salaria, Mastering Object Oriented Programming with C++, Khanna Publishing House
2. C++ Programming, Black Book, Steven Holzner, dreamtech
3. Object Oriented Programming in Turbo C++, Robert Lafore, Galgotia
4. Object Oriented Programming with ANSI and Turbo C++, Ashok Kamthane, Pearson
5. The Compete Reference C++, Herbert Schlitz, TMH
6. C++ and Object Oriented Programming Paradigm, PHI
7. C++ : How to Program, 9th Edition, Deitel and Deitel, PHI

KOE 065 NUMERICAL TECHNIQUES

COURSE OBJECTIVE: Students undergoing this course are expected to-

1. Understand about the basics of numerical techniques and its applications to Engineering Problems.

COURSE OUTCOME: After completion of the course student will be able to-

CO1: Understand about the basics of Ordinary Differential Equations, Separable equations, Equations made separable by change of variables.
CO2: Retrieve the information content of Power series method.
CO3: Apply problem specific Bessel's equation, Bessel Functions to engineering applications.
CO4: Understand about the basics of matrix, Eigen values and eigen vectors.
CO5: Analysis of Stage wise Processes by the Calculus of Finite Differences, Countercurrent Liquid- Liquid Extraction.

KOE 065 NUMERICAL TECHNIQUES		
Unit	**Topic**	**Lectures**
1	Ordinary Differential Equations, Separable equations, Equations made separable by change of variables, Homogeneous Equations, Equations with first order and first degree with linear coefficients, Exact equations, Linear equation of first order, Bernoulli's equation, Other integrating factors, Integration of Exact equations, Equations of first order and higher degree, Clairaut's equation, Singular solutions, Equations with missing terms, General properties of Linear equations, Linear equations with constant coefficients, Determination of the complementary function, exponential functions, Determination of the particular integral, the Euler equation, Simultaneous Linear Differential equations.	**8**
2	Power series method, theory of the power series method, Legendre's equation, Legendre's Polynomials, Frobenius Method.	**8**
3	Bessel's equation, Bessel Functions Jv(x), Bessel Functions Jv(x) for any $v \geq 0$. Gamma Function, Solution J-v(x) of the Bessel Equation, Backbones of Bessel's Theory, Jv(x) with $v = \pm 1/2, \pm 3/2, \pm 5/2$.	**8**
4	Definition of matrix, Some special definitions and operations involving matrices, Determinants, Theorems on determinants, Inverse of a matrix, Orthogonal and unitary matrix. Orthogonal vectors, System of linear equations, Systems on n equations with n unknowns, Cramer's Rule, Eigen values and eigen vectors.	**8**
5	Analysis of Stage wise Processes by the Calculus of Finite Differences, Countercurrent Liquid- Liquid Extraction, Solution of Difference Equations, Stirred-Tank Reactor System, Distillation in a Plate Column, Unsteady-state Operation, Starting a Stirred-tank Reactor, Rate at which a Plate Absorber Approaches Steady State.	**8**

Text & Reference books:

1. Mickley, Reid and Sherwood, "Applied Mathematics in Chemical Engineering", Tata McGraw Hill, New Delhi (1981).
2. E. Kreyszig, "Advanced Engineering Mathematics", 8th edition, John Wiley and Sons (1999).
3. M. R. Spiegel, "Advanced Mathematics for Engineers and Scientists", Schaum Outline Series, McGraw Hill, (1971).
4. Chandrika Prasad, Reena Garg, "Advanced Engineering Mathematics", Khanna Publishing house

KOE 066 GIS & REMOTE SENSING

COURSE OBJECTIVE: *Students undergoing this course are expected to-*

1. Understand about the principles of GIS, Remote Sensing, Spatial Systems, and its applications to Engineering Problems.

COURSE OUTCOME: *After completion of the course student will be able to-*

CO1: Understand about the principles of Remote Sensing and its advantages and limitations.
CO2: Retrieve the information content of remotely sensed data.
CO3: Apply problem specific remote sensing data for engineering applications.
CO4: Analyze spatial and attribute data for solving spatial problems.
CO5: Create GIS and cartographic outputs for presentation

KOE-066 GIS & REMOTE SENSING		
Unit	**Topic**	**Lectures**
1	Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; major atmospheric windows; principal applications of different wavelength regions; typical spectral reflectance curve for vegetation, soil and water, spectral signatures.	**8**
2	Different types of sensors and platforms; contrast ratio and possible causes of low contrast; aerial photography; types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap; stereoscopic vision, requirements of stereoscopic photographs; air-photo interpretation- interpretation elements;	**8**
3	Photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurements by the parallax method; ground control for aerial photography; satellite remote sensing, multispectral scanner- whiskbroom and push-broom scanner; different types of resolutions; analysis of digital data- image restoration; image enhancement; information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices.	**8**
4	Microwave remote sensing. GI Sand basic components, different sources of spatial data, basic spatial entities, major components of spatial data, Basic classes of map projections and their properties. .	**8**
5	Methods of data input into GIS, Data editing, spatial data models and structures, Attribute data management, integrating data (map overlay) in GIS, Application of remote sensing and GIS for the management of land and water resources.	**8**

Text & Reference Books:

1. Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.
2. Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.
3. George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.
4. Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK.
5. Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
6. Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.

KOE-067 UNDERSTANDING THE HUMAN BEING COMPREHENSIVELY – HUMAN ASPIRATIONS AND ITS FULFILLMENT

Course Objectives:

1. To help the students having the clarity about human aspirations, goal, activities and purpose of life.
2. To facilitate the competence to understand the harmony in nature/existence and participation of human being in the nature/existence.
3. To help the students to develop the understanding of human tradition and its various components.

Course Methodology:

1. The methodology of this course is exploration and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.
2. It is free from any dogma or set of do's and don'ts related to values.
3. It is a process of self-investigation and self-exploration, and not of giving sermons. Whatever is found as truth or reality is stated as a proposal and the students are facilitated and encouraged to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation.
4. This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student leading to continuous self-evolution.
5. This self-exploration also enables them to critically evaluate their preconditioning and present beliefs.

KOE-067 UNDERSTANDING THE HUMAN BEING COMPREHENSIVELY- HUMAN ASPIRATIONS AND ITS FULFILLMENT		
Unit	**Topic**	**Lectures**
1	**Introduction:** The basic human aspirations and their fulfillment through Right understanding and Resolution; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution.	**8**
2	**Understanding Human being and its expansion:** The domain of right understanding starts from understanding the human being (the knower, the experience and the doer); and extends up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).	**8**
3	**Activities of the Self:** Understanding the human being comprehensively is the first step and the core theme of this course; human being as co-existence of the self and the body; the activities and potentialities of the self; Reasons for harmony/contradiction in the self.	**8**
4	**Understanding Co-existence with other orders:** The need and the process of inner evolution (through self-exploration, selfawareness and self-evaluation)- particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence).	**8**
5	**Expansion of harmony from self to entire existence:** Understanding different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All-encompassing Resolution covering all four dimensions of human endeavour viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from self to Nature and entire Existence.	**8**

Reference Books:

1. A Foundation Course in Human Values and Profession Ethics (Text Book and Teachers' Manual), R. R. Gaur, R. Sangal, G. P. Bagaria (2010), Excel Books, New Delhi [ISBN 978-8-174-46781-2]
2. Avartansheel Arthshastra, A. Nagraj, Divya Path Sansthan, Amarkantak, India
3. Economy of Permanence – (a quest for social order based on non-violence), J. C. Kumarappa (2010), Sarva-Seva-Sangh-Prakashan, Varansi, India
4. Energy and Equity, Ivan Illich (1974), The Trinity Press, Worcester & Harper Collins, USA
5. Ishandi Nau Upnishad, Shankaracharya, Geeta press, Gorakhpur,
6. Manav Vyavahar Darshan, A. Nagraj, Divya Path Sansthan, Amarkantak, India
7. Manaviya Sanvidhan, A. Nagraj, Divya Path Sansthan, Amarkantak, India