CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)
Kokapet (Village), Gandipet, Hyderabad, Telangana-500075. www.cbit.ac.in
ISO Certified 9001:2015
COMMITTED TO RESEARCH, INNOVATION AND EDUCATION 43 years

SCHEME OF INSTRUCTION AND SYLLABI

Of

V & VI Semesters

Of

FOUR YEAR DEGREE COURSE

in

B.Tech - CHEMICAL ENGINEERING
(AICTE Model Curriculum with effect from AY 2022-23)

R-20 Regulation

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

(Autonomous Institution under UGC), Affiliated to Osmania University,
Accredited by NBA and NAAC-UGC,
Kokapet Village, Gandipet Mandal, Hyderabad –500075. Telangana
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CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Choice Based Credit System (With effect from 2022-2023)

B.Tech (Chemical Engineering)

Semester V

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE inHours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	20MBC01	Engineering Economics & Accountancy	3	-	-	3	40	60	3
2	20CHC13	Chemical Engineering Thermodynamics II	3	-	-	3	40	60	3
3	20CHC14	Mass Transfer Operations II	3	1	-	3	40	60	4
4	20CHC15	Process Modeling and Simulation	3		-	3	40	60	3
5		Professional Elective - II	3	-	-	3	40	60	3
6		Open Elective- I	3	-	-	3	40	60	3
7	20EGM03	Universal Human Values-2	3			3	40	60	3
8	20CHI02	Internship	-	-	-	-	-	-	2
PRACTICAL									
9	20CHC16	Mass Transfer Operations Lab	-	-	3	3	50	50	1.5
10	20CHC17	Process Modeling and Simulation Lab	-	-	3	3	50	50	1.5
TOTAL			**21**	**1**	**06**	**-**	**380**	**520**	**27**

S.No	Course Code	**Professional Elective II**
1	20CHE05	Catalysis
2	20CHE06	Fertilizer Technology
3	20CHE07	Pollution Control in Process Industries
4	20CHE08	Polymer Science and Technology

S.No	Course Code	**Open Elective I**
1	20CE O02	Disaster Risk Reduction and Management
2	20ME O15	Principles of Industry 4.0
3	20ADO01	Introduction to Python Programming
4	20CS O 05	Basics of Artificial Intelligence

20MBC01 ENGINEERING ECONOMICS & ACCOUNTANCY

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: The Objectives of the Course are:

1. To demonstrate the importance of Managerial Economics in Decision Making.
2. To explain the concept of Accountancy and provide basic knowledge on preparation of Final accounts.
3. To understand the importance of Project Evaluation in a chievinga firm's Objective.

Course Outcomes: After Completion of the Course, Student will be able to:

1. Apply fundamental knowledge of Managerial Economics concepts and tools.
2. Analyze various aspects of Demand Analysis, Supply and Demand Forecasting.
3. Understand Production and Cost relationships to make best use of resources available.
4. Apply Accountancy Concepts and Conventions and preparation of Final Accounts.
5. Evaluate Capital and Capital Budgeting decision based on any technique.

CO-PO-PSO- Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	3	1	1	1	1	1	1	1	-	-	-	-	1	1
CO2	2	2	2	2	-	1	1	1	-	1	-	1	-	1	2	1
CO3	1	2	1	2	2	-	2	1	-	1	-	-	-	1	2	-
CO4	2	2	1	2	2	1	1	3	-	1	-	-	-	-	1	-
CO5	1	3	1	2	1	1	2	-	-	1	2	1	-	2	-	-

UNIT-I

IntroductiontoManagerialEconomics

Introduction to Economics and its evolution - Managerial Economics - its Nature and Scope, Importance;RelationshipwithotherSubjects.ItsusefulnesstoEngineers;BasicconceptsofManagerialeconomics- Incremental, Time perspective, Discounting Principle, Opportunity Cost, Equi marginal Principle, Contribution, Negotiation Principle.

UNIT-II

Demand and Supply Analysis

Demand Analysis-Concept of Demand, Determinants, Law of demand-Assumptions and Exceptions; Elasticity of demand - Price, Income and Cross elasticity - simple numerical problems; Concept of Supply –Determinants of Supply, Law of Supply; Demand Forecasting-Methods.

UNIT-III

Production and Cost Analysis

Theory of Production - Production function - Isoquants and Isocosts, MRTS, Input-Output Relations; Laws of returns; Internal and External Economies of Scale.

Cost Analysis: Cost concepts – Types of Costs, Cost-Output Relationship – Short Run and Long Run; Marketstructures – Types of Competition, Features, Price Output Determination under Perfect Competition, MonopolyandMonopolisticCompetition;Break-evenAnalysis– Concepts,Assumptions,Limitations,Numericalproblems.

UNIT-IV

Accountancy

Book-keeping, Principles and Significance of Double Entry Book Keeping, Accounting Concepts and Conventions, Accounting Cycle, Journalization, Subsidiary books, Ledger accounts, Trial Balance concept and preparation of Final Accounts with simple adjustments. Ratio Analysis.

UNIT-V

Capital and Capital Budgeting: Capital and its Significance, Types of Capital, Estimation of Fixed and Working capital requirements, Methods and sources of raising finance. Capital Budgeting, Methods: Traditional and Discounted Cash Flow Methods-Numerical problems.

TextBooks:

1. Mehta P.L.,"Managerial Economics: Analysis, Problems and Cases", Sultan Chand &Son's Educational publishers,2016.
2. Maheswari S.N. "IntroductiontoAccountancy",VikasPublishingHouse,11thEdition,2013.

Suggested Readings:

1. PandayI.M. "FinancialManagement",11thedition,VikasPublishingHouse,2015.
2. VarshneyandKLMaheswari,ManagerialEconomics,SultanChand,2014.
3. M. Kasi Reddy and S.Saraswathi, Managerial Economics and Financial Accounting, Prentice Hall of India Pvt Ltd, 2007.
4. A.R. Aryasri,Managerial Economics and Financial Analysis, McGraw-Hill,2013.

20CH C13 **CHEMICAL ENGINEERING THERMODYNAMICS – II**

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Chemical Engineering Thermodynamics-I

Course Objectives: This course will help the students to understand about

1. Familiarize with the theory of Solution Thermodynamics
2. The concepts of fugacity in mixtures and various methods to obtain Fugacity Coefficient in mixtures.
3. Phase Rule and Various models used to determine the activity coefficients.
4. Calculation procedure to generate Vapour- Liquid Equilibrium (VLE) in form of T-x-y or P-x-y for miscible binary mixtures.
5. Methodology adopted to determine equilibrium constant.

Course Outcomes: At the completion of this course, students will be able to

1. Evaluate Partial molar, Residual and Excess properties.
2. Estimate Fugacity and Fugacity Coefficients for miscible binary Mixtures and also pure species.
3. Determine the activity coefficient using various models
4. Analyze Bubble and Dew point calculations for Ideal and Non Ideal solutions using VLE data
5. Predict equilibrium constant and composition of product mixture at given temperature and pressure

CO-PO-PSO Matrix

CO1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO2	3	3	3	2	2	2	2	0	1	2	0	3	3	3
CO3	3	2	1	2	2	0	1	0	1	2	0	3	3	3
CO4	3	1	1	1	1	0	0	0	1	1	0	1	3	3
CO5	3	3	2	2	3	1	2	0	1	2	0	3	3	3

UNIT I

Solution Thermodynamics theory: Fundamental property relation, Chemical potential and phase equilibria, Partial molar properties, Determination of partial molar properties, Relation between the partial molar properties, The Gibbs-Duhem equation, Ideal gas mixture, Fugacity and fugacity coefficient for pure species, Fugacity and fugacity coefficient for a species in solution,

UNIT-II

Solution Thermodynamics applications: Generalized Correlations for the Fugacity Coefficient, Ideal solution, Excess properties. Liquid phase properties from VLE data, Models for the Excess Gibbs free energy, Activity coefficient as the partial molar excess Gibbs free energy, One parameter and two parameter Margules equations, van Laar equations for activity coefficients,

UNIT-III

VLE using these activity coefficient models, Estimating the constants in the Whol's Margules and Van Laar equations from VLE data, infinite dilution data and azeotropic data, Property change of mixing, Basics of UNIFAC model, NRTL model, UNIQUAC model (Qualitative treatment only).

UNIT-IV

Phase Equilibrium: The nature of equilibrium, The phase rule and the Duhem theorem, Qualitative behaviour of VLE, P-x-y and T-x-y diagrams, Raoult's law for VLE, VLE by modified Raoult's law, Henry's Law, Azeotrope formation, Types of Azeotropes. Methodology for Bubble and dew point calculations, Flash calculations.

UNIT-V

Chemical Reaction Equilibria: The Reaction Coordinate, Application of Equilibrium Criteria to Chemical Reactions, The Standard Gibbs-Energy Change and the Equilibrium Constant, Effect of Temperature on the Equilibrium Constant, Evaluation of Equilibrium Constants, Relation of Equilibrium Constants to Composition, Equilibrium Conversions for Single Reactions, Phase Rule and Duhem's Theorem for Reacting Systems Multi reaction Equilibria.

Text Books:

1. Smith J.M., Van Ness H.C., Abbott M.M., Swihart M.T., Introduction to Chemical Engineering Thermodynamics, 8th Edition, Tata McGraw Hill, 2018.
2. Narayanan K. V., Chemical Engineering Thermodynamics, PHI, 2000.

References Books:

1. Milo D. Koretsky, Engineering and Chemical Thermodynamics, 2nd Edition, John Wiley &Sons, Inc., 2013.
2. *Introduction to Chemical Engineering Thermodynamics*. Front Cover. *Gopinath Halder*, Prentice-Hall Of India Pvt. Limited, 2009.
3. Rao Y.V. C., Chemical Engineering Thermodynamics, University Press Ltd., 2001
4. Kyle B.G., Chemical and Process Thermodynamics, 3rd Edition, Pearson, 1999.

20CHC14 **MASS TRANSFER OPERATIONS II**

Instruction	4 (3L+1T) Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Pre-requisites: Mass Transfer Operations I

Course Objectives: This course will

1. Provide students the opportunity to acquire understand the concepts of distillation.
2. Introduce students to the importance and principles of liquid-liquid extraction over distillation.
3. Provide an overall view of design concepts solid liquid extraction process.
4. Understand the concept of adsorption and its applications in industries.
5. Help students to develop an overview of major liquid-liquid and solid liquid separation process and their applications and equipment used in industry.

Course Outcomes: At the completion of this course, students will be able to about

1. Understand the principles of different separation process used in the industry.
2. Understand the Principle and application of multi component and azeotropic distillation used in the chemical industries.
3. Understand the Principle and designing of distillation column used in the chemical industries
4. List situations where liquid–liquid extraction might be preferred to distillation.
5. List the situation where solid liquid extraction might be preferred in industry
6. Explain the concept of breakthrough in fixed-bed adsorption.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	3	-	-	-	2	-	2	3	3	2
CO2	3	3	1	-	3	-	-	-	2	-	2	3	3	3
CO3	3	3	3	-	-	-	-	-	-	-	-	2	2	3
CO4	3	3	2	-	3	-	-	-	2	-	2	3	3	3
CO5	3	3	3	-	-	-	-	-	-	-	-	2	2	3
CO6	3	3	2	-	-	-	-	-	-	-	-	2	2	3

UNIT I

Distillation: VLE phase diagrams, Tie lines and mixture rule Raoult's law, Relative Volatility - Flash vaporization and differential distillation for binary mixtures- Steam distillation. Batch distillation with reflux for binary mixtures.

UNIT II

Distillation: Continuous fractionation of binary mixtures, multistage tray towers – Ponchon and Savarit method, Mc Cabe and Thiele method of determination of ideal plates for binary mixtures- enriching section, exhausting section, feed introduction, total reflux, minimum and optimum reflux ratios, use of total and partial condensers. Use of open steam. Types of Condensers and Reboilers. Packed bed distillation. Principles of azeotropic and extractive distillation.

UNIT III

Liquid-Liquid Extraction: Solubility of ternary liquid systems. Triangular and solvent free coordinate systems. Choice of solvent. Extraction with insoluble and partially soluble systems- single stage, multistage cross current and multistage counter current extraction without reflux and with reflux. Continuous contact extraction (packed beds). Equipment for liquid- liquid extraction operation.

UNIT IV

Leaching: Preparation of solid for leaching, Unsteady state operation, in-place leaching, heap leaching, percolation leaching, Shanks system, agitated vessels, Percolation vs Agitation. Steady state continuous operation equipments-methods of calculation, stage efficiency and particle equilibrium. Single stage leaching, multistage cross current leaching, multistage counter current leaching.

UNIT V

Adsorption: Principles of adsorption and their applications- Types of adsorption- Adsorbents- Adsorption equilibrium- Adsorption Isotherms for vapor and dilute solutions. Single stage and multistage adsorption- unsteady state adsorption, adsorption wave and breakthrough curve and fixed bed adsorption. Equipment for adsorption. Ion-Exchange.

TEXTBOOK:

1. Mass Transfer Operations, 3rd ed., R. E. Treybal, McGraw-Hill, New York, 1980.

REFERENCES:

1. Transport Processes and Separation Process Principles 4th ed., C. J. Geankoplis, PHI, Learning Pvt. Ltd., New Delhi, 2009.
2. Principles of Mass Transfer and Separation Processes, B.K. Dutta, PHI Learning Pvt. Ltd., New Delhi, 2007.

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CBIT(A) **with effect from 2022-23**

20CHC15 PROCESS MODELING AND SIMULATION

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Some background of Fluid Flow operations, CRE-I, and Mathematics

Course Objectives:

1. This course is helpful to learn the formulation of a mathematical process model
2. Students are introduced toframe the concerned equations of a chemical process models leading to ODE.
3. Understanding and Framing a chemical process models using fundamental principles of conservation.
4. Understanding lumped parameter model and distributed parameter model
5. Students get familiar with the solution techniques of the developed model equations.
6. Application this knowledge of for entire chemical plant design.

Course Outcomes: After completing the course students will be able to

1. Understand the concepts modeling and simulation
2. Familiarize with conservation laws, continuity equation, equation of motion and its application in mathematical model building
3. Understand mathematical models of Reactors and Separation equipment
4. Understand the basic concept for solving the developed model equations
5. Familiarize with flow sheet for chemical process simulation with the software packages.

CO-PO-PSO Matrix

CO	PO1	PO2	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO1	PSO
1	1	2	1	2	2	2	1	1	1	0	0	1	2	1
2	1	2	2	2	2	2	1	1	1	0	0	1	2	1
3	3	3	3	3	2	2	3	1	1	0	0	1	3	2
4	3	3	3	3	3	3	3	1	1	0	0	2	3	2
5	3	3	3	3	3	3	2	1	2	1	0	3	3	1

UNIT-I

Introduction: Modelling and simulation, definition, concept and uses of mathematical models, Classification of mathematical models- steady state Vs dynamic models, lumped Vs distributed parameter models, deterministic Vs stochastic models.

Fundamental laws: Principles of formulation,Continuity Equation, Component Continuity Equation, Energy equation, and Equation of motion.

UNIT – II

Examples of mathematical models of reactor systems: Series of isothermal constant hold-up Continuous Stirred Tank Reactors (CSTRs), CSTRs with variable hold-ups, batch reactor, and gas phase pressurized CSTR, Non-isothermal CSTR.

UNIT – III

Examples of mathematical models of separation and other important systems: Gas absorber,Single component vaporizer, ideal binary distillation column, batch distillation with hold-up, Laminar flow of liquid in pipe, gravity flow tank.

UNIT – IV

Empirical model building- Method of least squares, linear, polynomial

Solution of non-linear algebraic equations- Bisection, False position, Newton- Raphson method

Numerical solution of ordinary differential equations- Euler's method, Modified Euler's method, Runge- Kutta 4^{th} order method

UNIT – V

Process simulation using modular and equation based solving approaches: Modular approaches to process simulation: Analysis Vs Design mode, sequential modular approach, Simultaneous modular approach, Equation solving approach.

Simulation of Chemical Processes: Introduction to various simulation software packages in chemical engineering, Simulation of models such as isothermal CSTR, non-isothermal CSTR, and batch reactor.

Textbooks:

1. William L Luyben, "Process Modeling, Simulation and Control for Chemical Engineers", McGraw Hill Publishing Company, 2^{nd} edition, 1990
2. S.K. Gupta, Numerical Methods for Engineers, Wiley Eastern, New Delhi, 1995
3. B.V.Babu, Process Plant Simulation, Oxford University Press, 2004

Suggested Reading:

1. Steven C. Chapra and Raymond P Canale, "Numerical methods for Engineers", McGraw Hill International, 2nd edition, 1988

20EGM03 **UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY**
(**B.E/B.Tech II/III Year** -Common to all Branches)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60Marks
CIE	40 Marks
Credits	3

Pre-requisites: Universal Human Values - I

Introduction

This course discusses the role of human values in one's family, in society and in nature. In the Induction Program, students would get an initial exposure to human values through Universal Human Values–I. This exposure is to be augmented by this compulsory full semester foundation course.

Course Objectives

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in human being, family, society and nature/existence.
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Course Outcomes

By the end of the course,

1. Students are expected to become more aware of themselves, and their surroundings (family, society, nature)
2. They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. They would have better critical ability.
4. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

The course has 28 lectures and 14 practice sessions:

Unit I

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

- Purpose and motivation for the course, recapitulation from Universal Human Values-I
- Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration
- Continuous Happiness and Prosperity- A look at basic Human Aspirations
- Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
- Understanding Happiness and Prosperity correctly- A critical appraisal of the current Scenario
- Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking- disliking.

Unit II

Understanding Harmony in the Human Being - Harmony in Myself

- Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
- Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
- Understanding the characteristics and activities of 'I' and harmony in'I'
- Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of

- Physical needs, meaning of Prosperity in detail
- Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

Unit III

Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship

- Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
- Understanding the meaning of Trust; Difference between intention and competence
- Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
- Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co -existence as comprehensive Human Goals
- Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

Unit IV

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

- Understanding the harmony in the Nature
- Interconnectedness and mutual fulfilment among the four orders of nature - recyclability and self- regulation in nature
- Understanding Existence as Co-existence of mutually interacting units in all – pervasive space
- Holistic perception of harmony at all levels of existence.

Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Unit V

Implications of the above Holistic Understanding of Harmony on Professional Ethics

- Natural acceptance of human values
- Definitiveness of Ethical Human Conduct
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of
- people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
- Case studies of typical holistic technologies, management models and production systems
- Strategy for transition from the present state to Universal Human Order:
  a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers
  b. At the level of society: as mutually enriching institutions and organizations

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

Mode of Conduct (L-T-P-C 2-1-0-3)

- Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them. Tutorial hours are to be used for practice sessions.
- While analysing and discussing the topic, the faculty mentor's role is in pointing to essential

elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

- In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration.
- Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.
- Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practicals are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignments and/or activities are included.
- The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

Assessment:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self- assessment, peer assessment etc. will be used in evaluation.
Example:
Assessment by faculty mentor: 10 marks
Self assessment/Assessment by peers: 10 M
Socially relevant project/Group Activities/Assignments: 20 marks
Semester End Examination: 60 marks
The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

Textbooks

The Text Book

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Valuesand Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1 The teacher's manual
2. R R Gaur, R Asthana, G P Bagaria, "Teachers' Manual for A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN978-93-87034-53-2

Reference Books

1. A Nagaraj Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amar kantak,1999.
2. N. Tripathi, "Human Values", New Age Intl. Publishers, New Delhi,2004.
3. Cecile Andrews, Slow isBeautiful
4. Gandhi - Romain Rolland (English)
5. Dharampal, "Rediscovering India"
6. E. FSchumacher. "Small isBeautiful"
7. J. C. Kumarappa "Economy ofPermanence"
8. Pandit Sunderlal "Bharat Mein AngrejiRaj"
9. Mohandas Karamchand Gandhi "The Story of My Experiments withTruth"
10. 10.Mohandas K. Gandhi, "Hind Swaraj or Indian Home Rule"
11. Maulana Abdul Kalam Azad, India Wins Freedom-
12. Vivekananda - Romain Rolland(English)
13. The Story of Stuff (Book)

CBIT(A) **with effect from 2022-23**

20CH E05 **CATALYSIS**
(Professional Elective II)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60Marks
CIE	40Marks
Credits	3

Pre-requsites : Chemical Reaction Engg- I

Course objectives: This course helps the students to understand
1. Different types of catalysts, their structures and synthesis processes
2. Mechanism and kinetics of heterogeneous catalysts
3. Physical and chemical catalytic properties
4. Applications of catalysis in processes
5. Catalytic reactions and reactor design

Course Outcomes: At the end of the course, student will be able to
1. Explain the basic concepts of catalysis
2. Summarize the methods of preparation and characterization o f catalysts
3. Analyze the role of heat and mass transfer in the catalytic reactor design
4. Distinguish the performance of catalytic reactors
5. Identify the role of catalysts in the environmental protection
6. Explain the commercial aspects of catalytic reactors

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	-	-	-	-	-	-	-	2	2	2
CO2	3	2	1	1	1	-	-	-	-	-	-	2	2	2
CO3	3	2	2	1	1	1	1	-	-	-	-	2	2	2
CO4	3	2	1	1	1	1	1	-	-	-	-	1	2	2
CO5	3	2	2	1	1	1	1	-	-	-	-	1	2	2
CO6	3	2	2	1	1	1	-	-	-	-	-	1	2	2

UNIT – I
Catalysis: Introduction to Catalysis, Comparison of Catalyst Types, Basics of Heterogeneous and Homogeneous Catalysis.

UNIT – II
Basic concepts in heterogeneous catalysis: Catalyst characterization for physical and Chemical properties, Optimal distribution of catalyst in a pellet. Surface reactivity and kinetics of reaction on surfaces, poisoning and regeneration.

UNIT – III
Heat and mass transfer and its role in heterogeneous catalysis. Calculations of effective diffusivity and thermal conductivity of porous catalysts

UNIT – IV
Industrially important catalysts and processes such as oxidation, processing of petroleum and hydrocarbons, synthesis gas and related processes, Environmental catalysis. Zeolite catalysts, preparation, characterization and applications

UNIT – V
Commercial Catalytic Reactors (Adiabatic, fluidized bed, trickle bed, slurry etc.).Selection and design and preparation of catalysts

Textbooks:

1. John MeurigThomas, W. J. Thomas, Principles and Practice of HeterogeneousCatalysis,WileyVCH;2nd Edition,2014
2. James John Carberry, Chemical and Catalytic Reaction Engineering, Dover Publications, INC,2001

Suggested Readings:

1. L K Doraiswamy, M M Sharma, Heterogeneous Reactions: Fluid-fluid- solid Reactions, Wiley,1984
2. B Viswanathan, S Sivasanker, and A V Ramaswamy, Catalysis: Principles and Applications, Narosa Publishing House, 2002

CBIT(A) **with effect from 2022-23**

20CH E06 **FERTILIZER TECHNOLOGY**
(Professional Elective II)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: MEBC, MUO, Chemical Technology

Course objectives: This course helps the students to understand the:

1. Use of fertilizers in improving soil productivity and crop yield.
2. Different types of the nitrogenous, phosphoric and potash fertilizers.
3. Various fertilizer application methods.
4. Different organic fertilizer production methods.

Course outcomes: At the end of the course, the students will be able to:
1. Identify the different nutrients and significance of feed stocks for the production of fertilizers.
2. Identify methods for the production of various nitrogenous fertilizers.
3. Apply different manufacture methods for various phosphorous fertilizers.
4. Production methods for potassium and mixed complex fertilizers
5. Differentiate the need, application techniques and uses of new variety of fertilizers.
6. Design effluent treatment methods and impact of fertilizers on environment.

CO-PO-PSO Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	-	-	-	-	-	-	-	-	-	2	2
2	2	2	2	-	-	-	-	-	-	-	-	-	2	2
3	3	2	2	-	-	-	-	-	-	-	-	-	2	-
4	2	3	3	3	3	-	-	-	-	-	2	-	-	2
5	2	2	-	-	-	2	2	-	-	-	2	-	2	2

UNIT – I
Introduction: Fertilizer Technology, Plant Nutrients, Role of essential elements for plant growth, macro & micro elements.. Availability of feed stocks. Secondary nutrients; feedstock and raw materials for nitrogenous fertilizer. Secondary nutrients; phosphatic & potassic fertilizer.

UNIT –II
Nitrogen fertilizers: Introduction, Manufacture of Nitric acid and other nitrogenous fertilizers such as ammonium sulphate, ammonium nitrate, calcium ammonium nitrate, ammonium chloride, Sodium Nitrate.

UNIT – III
Phosphatic fertilizers: Phosphatic fertilizers - raw materials, phosphate rock, process for the production of sulphuric and phosphoric acids, ground phosphate rock,single super phosphate, triple super phosphate – methods of production, characteristics and specifications.

UNIT –IV
Potassium fertilizers: Introduction, Potassium Sulphate and Potassium Nitrate, Mixed and Compound fertilizers. Liquid fertilizers. Bio fertilizers – Introduction, advantages over chemical fertilizers, types and uses.

UNIT –V
Fertilizer application techniques: different soil controlled release fertilizers. Effluent treatment methods for various fertilizer plants. Environmental impact of fertilizer plants on Ecosystem. Indian Fertilizer industry – production Economics and future plans.

Text Books:

1. Brahma Mishra, "Fertilizer Technology and Management", IK International Publishing House Pvt. Ltd., New Delhi, 2012.
2. Dr. Shalini Suri, "Bio Fertilizers and Bio pesticides", 1st Ed., APH publishing Corporation, New Delhi, 2011.

Suggested Reference Books :

1. Fertilizer Association of India, "Fertilizer Handbook", 2nd Ed., Scientific Publisher, New Delhi, 2009.
2. UNIDO, "Fertilizer Manual", 3rd edition, Kluwer Academic Publishers, New Delhi,1998.

20CH E 07 **POLLUTION CONTROL IN PROCESS INDUSTRIES**
(Professional Elective II)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Environmental Studies, MUO

Course Objectives: This course will help the students to understand the:
1. Effects of pollution on environment and ecosystems
2. Types and sources of pollution from process industries
3. Measurement of air and water pollution in process industries
4. Different methods and equipment used in industrial pollution abatement
5. Pollution control practices in process industries

Course Outcomes: At the completion of this course, students will be able:
1. Differentiate the types of wastes generated in an industry, their effects on living and non-living things
2. Understand the effect of climate changes, atmospheric dispersion of air pollutants, and operating principles.
3. Working principles of particulate control devices.
4. Quantify industrial wastewater and its treatment.
5. Analyze the hazardous and non-hazardous solid wastes and select the treatment and disposal methods.
6. Apply environmental management systems (EMS) to an industrial activity

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	1	1	2	1	1	1	1	1	2	2	2
CO2	2	2	2	2	1	1	2	1	1	1	1	2	2	2
CO3	2	2	1	1	1	2	2	1	1	1	1	2	3	2
CO4	2	1	2	1	1	2	3	1	1	1	1	2	2	3
CO5	2	2	2	2	1	1	3	1	1	1	1	2	3	3
CO6	2	1	1	1	1	2	1	2	1	1	2	2	2	2

UNIT- I
Introduction: Definition and types of pollution from chemical industries. Effects of pollution on environment and ecosystems - global warming - greenhouse effect. Laws and standards for pollution. Sources, types, characteristics and effects of air pollutants, liquid effluents, solid wastes in process industries.

UNIT- II
Air Pollution: Meteorological aspects of pollution dispersion, adiabatic and environmental lapse rate, Turbulence and stability of atmosphere. Indoor air pollution - smoke and hydrocarbons. Richardson Number, Plume raise, plume behavior and characteristics, effective stack height.
General Control Methods and Equipment: removal of sulphur dioxide, oxides of nitrogen and carbon, organic vapors from gaseous effluents. Removal of particulate matter - principle and working of settling chambers cyclone separators solid traps, fabric and fiber filters, electro-static precipitators.

UNIT- III
Water Pollution: Concepts and estimation of oxygen demands - DO, BOD, COD, and TOD. Oxygen sag curve, BOD curves and modeling. Wastewater Treatment – Concept, significance and classification as Primary, Secondary, Tertiary methods. Principle, working mechanism and applications of biological treatment techniques like stabilization ponds, Aerated lagoons, conventional activated sludge process, aerobic and anaerobic methods, suspended and attached growth processes, fluidized bed contractors. Trickling filters.

UNIT- IV
Industrial Solid Waste Management: Industrial solid wastes “Types, classification, properties, management and general disposal methods. Industrial solid wastes – environmental effects and disposal methods commonly practiced. Methods practiced in paper and textile industries.

UNIT- V

Pollution control practices in Process Industries: Principle, working mechanism and application of tertiary treatment methods like carbon adsorption, Ion-exchange, Reverse Osmosis, Ultra Filtration in process industries. Sludge treatment and disposal methods like Incineration and land filling. Pollution control in petroleum and fertilizer industries

Text Books

1. C.S.Rao, "Environmental Pollution Control Engineering", 2nd Ed, New Age International, 2007.
2. S.P.Mahajan, "Pollution control in process industries", 27th Ed, McGraw Hill Pub, 2002.

Suggested Reading:

1. Metcalf and Eddy, "Wastewater Engineering: Treatment and Reuse", 4th Ed, MGH publishing, 2004.
2. M.N Rao and H.V.N Rao, "Air Pollution", Tata McGraw- Hill Publishing Company Limited, New Delhi, 2000.
3. Peavy, H.S., Rowe, D.R. and Technobanolous, G., "Environmental Engineering", McGraw Hill, 1985.

20 CHE08 **POLYMER SCIENCE AND TECHNOLOGY**
(Professional Elective II)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60Marks
CIE	40Marks
Credits	3

Pre-requisites: MEBC, MUO, Chemical Technology

Course objectives: This course helps the students to

1. Understand the fundamental- chemical, physical and mechanical behavior of polymers.
2. Understand the structure-processing-property relationship of polymers.
3. Estimate the processing techniques, along with the production of polymers.
4. Evaluate the synthesis, manufacture, processing and characterization of different polymers
5. Understand the basic concepts involved in polymer blends, composites and nano composites.

Course Outcomes: At the end of the course students will be able to

1. Explain the basic concepts of polymers, polymerization techniques and behavior in polymers
2. Distinguish different types of polymerizations
3. Determine the molecular weight of polymers by different techniques
4. Interpret the various processing techniques used for polymers, rubbers and fibers
5. Summarize the manufacturing and characterization of various industrially important polymers
6. Explain the concepts of polymer blends, composites and nanocomposites

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	-	2	2	-	-	-	1	2	3	2
CO2	3	3	3	-	-	2	2	-	-	-	1	2	3	3
CO3	3	3	3	-	-	2	2	-	-	-	1	2	3	3
CO4	3	3	3	-	-	2	2	-	-	-	1	2	3	2
CO5	3	3	3	-	-	2	2	-	-	-	1	2	3	2
CO6	3	3	3	-	-	2	2	-	-	-	1	2	3	2

UNIT-I
Definitions and concepts of terms used in polymer engineering, Classification of polymers; Polymer structures, functionality; polymerization reactions–mechanism of polymerization; stereo specific polymerization, copolymerization. Polymer material structure and Properties: Deformation, flow and melt characteristics. Morphology and order in crystalline polymers. Rheology and the mechanical properties of polymers. Polymers tructure and physical properties

UNIT-II
Polymerization reactors, polymerization processes, characterization of polymers, analysis of polymerization reactions, polymer degradation, Condensation polymerization, Addition polymerization, Ionic and coordination polymerization.

UNIT- III
Molecular weight and molecular weight distribution in polymers, Experimental methods for molecular weight determination: cryoscopy, ebulliometry, membrane osmometry, light scattering method, viscometry, intrinsic viscosity measurement, gel permeation chromatography. Structure and Properties: Thermal transitions, Crystallinity, Molecular weight characterization, Nuclear Magnetic Resonance (NMR) and Fourier Transform Infrared (FTIR) techniques.

UNIT–IV
Polymer processing: modeling– compression & transfer, injection & jet; casting; extrusion, calendaring, lamination, spinning & finishing. Processing methods , effect of additives used, plasticizers, colourants, heat stabilizers, antioxidants, ultraviolet absorbers, antistatic agents, flame retardants, blowing agents, fillers etc.

Molding techniques for plastics, injection molding, compression molding, calendaring, blow moulding, extrusion, thermoforming, spinning methods for fibres, compounding methods for elastomers, general study of elastomer processing methods.

UNIT-V

Industrial polymers: Manufacturing processes, properties and uses of Polyethylene, Polypropylene, Polyvinylchloride, Polystyrene, Nylon, Polyethylene terephthalate. Hydrocarbon plastics and elastomers. Other carbon chain polymers. Hetero chain thermoplastics. Thermo setting resins. Polymer Blends: Types, Compatibility, Thermal and Mechanical Properties. Polymer Composites: Types, Properties, Preparation, Fibre-reinforced composites, In-situ composites. Polymer Nano composites: Basic concepts, Processing, Characterization.

TextBooks:

1. Text Book of Polymer Science, F.W. Billmeyer, JohnWiley,NewYork,1962
2. Polymer Science & Technology, P.Ghosh, TMC,2001

Suggested Reading:

1. The elements of Polymer Science & Engineering, Alfred Rudin, Academic Press, 2nd Edition,1998
2. Introduction to Polymers, R.J.Young, Chapman & Hall, London,1991

20CE O02 **DISASTER RISK REDUCTION AND MANAGEMENT**
(Open Elective-I)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CEE	40 Marks
Credits	3

Course Outcomes: Upon completion of this course, the student will be able to,

1. Identify and understand the concepts of hazards, causes and impacts of disasters.
2. Develop a critical capacity to evaluate the principles and practices of disaster risk reduction and management;
3. Develop a deep awareness of disaster resilience, risk mitigation, and recovery policies as they arise from natural hazards around the globe
4. Apply knowledge about existing global frameworks and existing agreements and role of community in successful Disaster Risk Reduction.
5. Evaluate DM study including data search, analysis and presentation as a case study.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	2	2	2	1	2	2	2	1	1	1	1
CO2	1	1	2	2	2	3	3	1	2	1	1	1	1	1	
CO3	2	2	2	2	2	2	3	2	1	1	2	1	1		
CO4	2	2	2	2	3	2	1	1	1	1	1	1			
CO5	2	1	2	1	2	3	1	2	2	2	2	1	1	1	1

UNIT I

- Hazard and disaster-concepts, vulnerability and risk
- Hazard and disaster type – Natural, Water- related, Pandemic and Human induced hazards disasters
- Causes and Impacts of disasters – Impacts on natural eco systems: physical, psychological and social impact
- Disaster and financial resilience
- GIS and remote sensing
- Disaster vulnerability profile of India –Specific to geographical regions and states (as per regional significance)

UNIT II

- Disaster Management Cycle –Rescue, Relief, Rehabilitation, Prevention, Mitigation and Preparedness
- Disaster risk reduction {DRR) –Community based DRR, institutions concerned with safety, disaster mitigation and construction techniques as per Indian standards
- Early warning systems

UNIT III

- Trauma and stress management
- First aid and emergency procedures
- Awareness generation strategies for the community on safe practises in disaster (as per regional significance)

UNIT IV

- Components of disaster management –preparedness of rescue and relief, mitigation, rehabilitation &reconstruction
- Institutional frame work of disaster management in India (NDMA-SDMA, NDRF, Civic volunteers, NIDM)
- Phases of disaster/risk management and post-disaster responses
- Compensation and insurance
- Applications of remote sensing &GIS in disaster management

UNIT V

- Capacity building for disaster/damage mitigation (structural and non structural measures).
- Disaster risk reduction strategies and national disaster management guidelines

- Disaster management Act -2005
- Regional issues as per regional requirement/university can take minimum two topics as per high powered committee

Books:

1. Singh, R. (2017), "Disaster management Guidelines for Earth quakes, Landslides, Avalanches and Tsunami". Horizon Press publications.
2. Taimpo (2016), "Disaster management and preparedness". CRC Press Publications
3. Nidhi, G.D. (2014), "Disaster management preparedness". CBS Publications Pvt. Ltd.
4. Gupta, A.K.,Nair, S.S., Shiraz, A. and Dey, S. (2013), "Flood Disaster Risk Management-CBS Publications Pvt Ltd.
5. Singh, R. (2016), "Disaster management Guidelines for Natural Disasters" Oxford University Press Pvt. Ltd.

20ME O15 **PRINCIPLES OF INDUSTRY 4.0**
(Open Elective I)

Instruction	3L	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. Understand the concept and applications of Digital Manufacturing and Industry 4.0.
2. Relate different Additive manufacturing processes as a part of Digital Manufacturing
3. Understand the concept of Virtual prototyping, digital design and Importance of reverse engineering in Digital Manufacturing
4. To understand the concept of Industry 4.0 and allied technologies.
5. To Provide an understanding on the challenges faced and relevant industrial applications of Industry 4.0

Outcomes: At the end of the course, the students will be able to:

1. Understand the Basics and applications of Digital Manufacturing and Industry 4.0.
2. Understand the role of Additive Manufacturing, Virtual prototyping and Reverse Engineering processes and their adaptability to Digital Manufacturing.
3. Understand the concepts of digital manufacturing based product life cycle and its management.
4. Understand the concept of Industry 4.0 and allied technologies.
5. Understand the basics of Internet of things and cloud computing pertaining the fourth industrial revolution.

UNIT-I

Introduction to digital manufacturing: Definition of digital manufacturing, Operation Mode and Architecture of Digital Manufacturing System, Impact on manufacturing careers, Advantages of digital manufacturing and design, Information sharing in the digital thread, Digital twins and Files format (STL, AMF, 3MF), Multiple organizations in the manufacturing process. Introduction of Industry 4.0, case study on car manufacturing by Bosch.

UNIT-II

Additive Manufacturing Processes: Additive Manufacturing processes – Engineering polymers, metals and ceramics. Stereo lithography, Selective Laser Sintering, Fused Deposition Modeling, Layered object manufacturing. Electronic Materials, Bio-printing, Food Printing. Preprocessing and Post processing in AM

Virtual Prototyping & Reverse Engineering: Virtual Prototyping, Applications, Virtual Prototyping and Virtual Manufacturing.Reverse Engineering, Application of Reverse Engineering in Digital Manufacturing. Self-Learning of Manufacturing System and Intelligent Manufacturing System.

UNIT-III:

Key Technology of Digital Manufacturing: Various Digital Technologies in Product Lifecycle, Digital Equipment and Digital Processing Technology, Technology of Digital Maintenance and Diagnosis.

Product life cycle management: Introduction, Types of Product Data, Product life cycle management (PLM) systems. Features of PLM System, System architecture, Product information models, Functionality of the PLM Systems.

UNIT-IV

Industry 4.0: Various Industrial Revolutions, Compelling Forces and Challenges for Industry 4.0, Comparison of Industry 4.0 Factory and Today's Factory, automation, data exchanges, cloud, cyber-physical systems, mobile robots, Big Data, deep machine learning, Production Systems, IoT, Challenges of implementing Industry 4.0, Impact of implementing Industry 4.0 in various sectors, Applications domains and the way forward.

UNIT –V

Internet of Things (IoT) - IoT design methods, physical devices and enabling technologies, Industrial Internet of Things (IIoT), Smart Manufacturing.**Cloud Computingand Manufacturing**- Cloud models, cloud manufacturing examples, cloud based manufacturing, Cloud service and platforms for manufacturing.

Augmented Reality and Virtual Reality in Manufacturing.

Text Books:

1 Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of DigitalManufacturing Science, Springer-Verlag London Limited,2012
2 Brent Stucker, David Rosen, and Ian Gibson, Additive Manufacturing Technologies, ISBN 978-1-4419-1120-9, Springer, 2010
3 Chee Kai Chua, Kah Fai Leong, 3D printing and additive manufacturing: principles and Application, 4th edition of rapid prototyping
4 Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things.

Suggested reading:

1. Lihui Wang and Andrew Yeh Ching Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009
2. Venuvinod, PK; Ma, W; Rapid prototyping – Laser based and other technologies, Kluwer,2004

20ADO01 **INTRODUCTION TO PYTHON PROGRAMMING**
(Open Elective I)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
1. To introduce the python programming environment.
2. To impart knowledge basics data types and operation.
3. To familiarize with function, tuple, dictionary to process the data.
4. To introduce various packages in python
5. To familiarize class, object, exception handling and working with files.

Course Outcomes:
Upon successful completion of this course, students will be able to:
1. Explore data operations on list, tuple and dictionary in python.
2. Understand deployment of models on different datasets.
3. Apply supervised, unsupervised, resembling and NLP models on different datasets.
4. Perform data analysis using python packages.
5. Build and evaluate the models using python programming.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	1	1	-	-	-	1	1	1	1			
CO2	2	1	2	1	2	-	-	-	-	-	1	-			
CO3	2	1	2	2	1	-	-	-	-	-	-	-			
CO4	2	1	1	1	1	-	-	-	-	-	-	1			
CO5	2	1	1	1	1	-	-	-	-	-	-	1			

UNIT-I:
Introduction: Historical introduction to python, Installing Python, python interpreter and its environment: Argument passing and interactive mode, source encoding; Informal introduction to python: Python as calculator: Numbers, Strings, Lists, Programming steps.

UNIT - II
Control Statements and functions: control flow tools: if statement**,** for statements, range function, break and continue statements, else clauses on loops, pass and match statements; Defining function: default and keywords argument values, special parameters: positional-or-keywords arguments, positional parameters, keywords arguments, function examples, Arbitrary and Unpacking argument lists, lambda expression, documentation strings, function annotations, coding style, Input and output, reading and writing files.

UNIT - III
Data structures and Modules: More on lists: Lists as stack and queues, list comprehensions, nested list comprehensions, del statement, Tuples and sequences, sets and operations, Dictionaries, looping and conditional statements on dictionary; Modules: Executing modules as scripts, module search path, compiled python files, standards modules, dir() function, packages: Importing * from packages, intra packages references, packages in multiple directories, error and exception handling.

UNIT - IV
Design with Classes: Classes and Objects, python scopes and namespaces, class defining syntax: class objects, instances, method objects, instances variables, Inheritance, private variables, odds and ends, Iterators, generators and

their expressions, standards library: OS interfaces and string pattern matching, virtual environment and packages, pip, floating point arithmetics: issue and limitations, error representation.

UNIT - V

Graphical User Interfaces: GUI Programming: Graphical User Interfaces, Using the tkinter Module, Display text with Label Widgets, Organizing Widgets with Frames, Button Widgets and Info Dialog Boxes, Getting Input with Entry Widget, Using Labels as Output Fields, Radio Buttons, Check Buttons. Simple Graphics and Image Processing: Overview of Turtle Graphics, Two dimensional Shapes, Colors and RBG System, Image Processing, GUI case studies.

Text Book:

1. Kenneth A. Lambert, The Fundamentals of Python: First Programs, 2011, Cengage Learning. 2. Think Python First Edition, by Allen B. Downey, O'reilly publishing

Suggested Reading:

1. Introduction to Computation and Programming Using Python. John V. Guttag, The MIT Press.
2. James Payne, Beginning Python using Python 2.6 and Python 3, Wrox publishing
3. Paul Gries, Practical Programming: An Introduction to Computer Science using Python 3,The Pragmatic Bookshelf, 2nd edition (4 Oct. 2013)

Web Resources:

1. https://python.org/tutorial/
2. Joy of computing Nptel course by prof. Sudersan Iyengar, IIT Roper
3. https://www.udemy.com/course/python-programming-beginner-to-advanced/

20CSO05

BASICS OF ARTIFICIAL INTELLIGENCE
(Open Elective)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	60 Marks
Continuous Internal Evaluation	40 Marks
Credits	3

Course Objectives: The objectives of this course are,

1. To learn fundamental concepts in Artificial Intelligence.
2. To explore various paradigms involved in solving AI problems involving perception, reasoning and learning.
3. To apply AI concepts for building an expert system to solve the real-world problems.

Course Outcomes: On Successful completion of this course, student will be able to,

1. Differentiate between a rudimentary Problem and an AI problem, its Characteristics and problem-solving Techniques.
2. Compare and contrast the various knowledge representation schemes of AI.
3. Appraise knowledge in Uncertainty and Probabilistic reasoning approaches.
4. Understand the different learning techniques.
5. Apply the AI techniques to solve the real-world problems.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO 4
CO 1	3	3	3	1	3	-	-	-	-	-	-	-	3	3	1	-
CO 2	3	3	3	1	3	-	-	-	-	-	-	-	3	3	3	1
CO 3	3	3	3	1	3	-	-	-	-	-	-	-	3	3	3	1
CO 4	3	3	3	1	3	-	-	-	-	-	-	-	3	3	3	1
CO 5	3	3	3	1	3	3	-	-	-	-	-	-	3	3	3	1

UNIT - I

Introduction: History Intelligent Systems, Foundations of Artificial Intelligence, Sub areas of Al, Applications. **Problem Solving - State - Space Search and Control Strategies:** Introduction, General Problem Solving Characteristics of problem, Exhaustive Searches, Heuristic Search Techniques, Iterative - Deepening A*, Constraint Satisfaction.

UNIT - II

Logic Concepts and Logic Programming: Introduction, Propositional Calculus Propositional Logic, Natural Deduction System, Axiomatic System, Semantic Table, A System in Propositional Logic, Resolution, Refutation in Propositional Logic, Predicate Logic, Logic Programming.

Knowledge Representation: Introduction, Approaches to knowledge Representation, Knowledge Representation using Semantic Network, Extended Semantic Networks for KR, Knowledge Representation using Frames.

UNIT - III

Uncertainty Measure - Probability Theory: Introduction, Probability Theory, Bayesian Belief Networks, Certainty Factor Theory, Dempster - Shafer Theory.

UNIT - IV

Intelligent Agents: Agents vs Software programs, classification of agents, Multi- agent systems, Architecture of intelligent agents, Multi-agent application.

Expert System and Applications: Introduction, Phases in Building Expert Systems Expert System Architecture, Expert Systems Vs Traditional Systems, Truth Maintenance Systems, Application of Expert Systems, List of Shells and tools.

UNIT - V

Machine - Learning Paradigms: Introduction, Machine learning System, Supervised and Unsupervised Learning, Inductive Learning, Learning Decision Trees, Deductive Learning, Clustering, Support Vector Machines

Text Books:

1. Saroj Kaushik, "Artificial Intelligence", Cengage Learning India, First Edition, 2011.
2. Russell, Norvig, "Artificial Intelligence: A Modern Approach", Pearson Education, 3rd Edition, Prentice Hall.

Suggested Reading:

1. Rich, Knight, Nair, "Artificial Intelligence", Tata McGraw Hill, 3rd Edition, 2009.
2. Trivedi, M.C., "A Classical Approach to Artificial Intelligence", Khanna Publishing House, Delhi.

Online Resources:

1. https://nptel.ac.in/courses/106105077
2. https://nptel.ac.in/courses/106106126

20CHI02 **INTERNSHIP-II INDUSTRIAL / RURAL INTERNSHIP**

Instruction	3 to 4 weeks/90 hours
Duration of End Examination	-
Semester End Examination	-
Continuous Internal Evaluation	50 Marks
Credits	2

20CHC16 **MASS TRANSFER OPERATIONS LAB**

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Pre-requisites: MTO I and MTO II

Course objectives: This course will help the students to understand about

1. Estimate the efficiency of simple and steam distillation
2. Plotting the drying curve and estimating total drying time
3. Estimate diffusion co-efficient and mass transfer coefficients
4. Estimate the height of packed bed column.
5. Estimate separation efficiency of VLE, LLE, and leaching.
6. Determine the relationship between vapor and liquid at different temperatures

Course Outcomes: The students able to know

1. Calculate diffusivity coefficient
2. Separation of components by simple and steam distillation
3. Separation components by drying
4. Separation components by liquid- Liquid Extraction and solid-liquid extraction
5. Calculate mass transfer coefficient in wetted wall column.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	3	1	1	0	0	1	3	1
CO2	3	3	3	2	2	2	3	1	1	0	0	1	3	1
CO3	3	3	3	2	2	2	3	1	1	0	0	1	3	1
CO4	2	2	3	2	2	2	3	1	1	0	0	1	3	1
CO5	2	2	3	2	2	2	3	1	1	0	0	1	3	1

List of Experiments:
(Any 10 experiments to be conducted)

1. Estimation of diffusivity coefficient for the gaseous system (CCl_4 - Air).
2. Perform the simple distillation of methanol- water system.
3. Measure the purity of distillate by carrying out Steam Distillation.
4. Calculation of height equivalent to theoretical plate in packed column.
5. Experiment on Liquid - Liquid Extraction.
6. Experiment on Solid-Liquid Extraction (Leaching).
7. Determine Mass transfer coefficient using wetted wall column.
8. .Batch Drying
9. Determination of vapor - liquid equilibrium data for the given system.
10. Determine the PVT behavior of pure fluids by using Equation of state Liquid- Liquid Equilibrium Equipment
11. Calculate the property change of mixing
12. To determine the relationship between vapor and liquid at different temperatures
13. To determine the solubility characteristics of given solution at different temperatures
14. Determine distribution coefficient for toluene- acetic acid and chloroform- acetic acid mixture.
15. Construct Ternary Diagram for system of three liquid, one pair partially soluble i.e.acetic acid-Benzene-Water system.

Textbooks

1. R.E.Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983
2. Introduction to Chemical Engineering Thermodynamics (in SI units) by J M Smith and H C Van Ness and M M Abbott, 7th edition, Mc-Graw Hill International Edition, 2005

20CHC17 **PROCESS MODELING AND SIMULATION LAB**

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Pre-requisites: C or C++ or MATLAB and basic knowledge of chemical processes

Course Objectives: This practical course helps the students to understand the:

1. Application of their MATLAB coding and skills learnt in previous semesters, as a prerequisite for problem solving.
2. Formulation of a process models leading to ODE.
3. Formulation of a process models leading to non linear equations.
4. Open-loop simulation through MATLAB coding for simple chemical processes.
5. Steady state simulation of the process models using ASPEN
6. Application this knowledge of aspen for entire plant design.

Course Outcomes: At the end of the course, students will be able to

1. Develop chemical engineering process models based on fundamental laws of mass and energy transfer
2. Dynamically simulate and interpret two heated tanks, using MATLAB
3. Dynamically simulate and analyze continuous reactors in Series using MATLAB
4. Adapt ASPEN software to perform steady state simulation of valves
5. Apply ASPEN software for simulation of batch Distillation
6. Utilize ASPEN software to design Plug flow reactor

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	3	-	-	-	1	-	2	2	2
CO2	3	3	2	3	3	1	-	-	-	1	-	3	3	2
CO3	3	3	3	3	3	3	-	-	-	1	-	2	3	3
CO4	3	2	2	3	3	2	-	-	-	2	-	2	3	2
CO5	3	3	3	3	3	2	-	-	-	1	-	2	3	3
CO6	3	3	3	3	3	3	-	-	-	1	-	2	3	3

Introduction: Software Packages. Understanding the basic concepts and steps involved for developing process flow sheet. Setting up models for simulation

List of Experiments (Minimum of 10 experiments in the list are to be performed)

Part I: Dynamic simulation using MATLAB

1. Two-heated Tanks in series.
2. Three CSTRs in series at isothermal constant holdup condition.
3. Batch Reactor.
4. Vapor Liquid Equilibrium.
5. Ideal Binary distillation.
6. Gas-Phase Pressurized CSTR

Part II: Steady State simulation using ASPEN

1. Simulation of simple units like valves, pumps, flash columns
2. Estimation of thermodynamics properties of the system through simulation

3. Simulation of reactor systems
4. Simulation of Distillation columns
5. Simulation of Heat exchangers
6. Flow-sheeting of chemical process.

Textbooks:

1. Chemical Process Modeling And Computer Simulation by Amiya K. Jana .2018
2. Manjeet KaurBedi, Prof. Vikram Singh, A Textbook Of Simulation And Modeling, Laxmi Publications, 2011.
3. Aspen Plus (R) - Chemical Engineering Applications (English, Hardcover, Al-Malah K)

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Choice Based Credit System (With effect from 2022-2023)

B.Tech (Chemical Engineering)

Semester VI

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE inHours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	20CHC18	Chemical Reaction Engineering II	3		-	3	40	60	3
2	20CHC19	Plant Design &Economics	3	1	-	3	40	60	4
3	20CHC20	Instrumentation &Process Control	3	1	-	3	40	60	4
4	20 CHC21	Transport Phenomena	3	1	-	3	40	60	4
5		Professional Elective – III *	3	-	-	3	40	60	3
PRACTICAL									
6	20EGC03	Employability Skills			2	2	50	50	1
7	20CHC22	Plant Design Lab	-	-	3	3	50	50	1.5
8	20CHC23	Instrumentation &Process Control Lab	-	-	3	3	50	50	1.5
	TOTAL		**15**	**03**	**08**	**-**	**350**	**450**	**22**

	Course Code	**Professional Elective III**
1	20CHE09	Fuel Cell Technology
2	20CHE10	Petrochemical Technology
3	20CHE11	Pharmaceutical Technology
4	20CHE12	Safety and Hazard Analysis

20CHC18 CHEMICAL REACTION ENGINEERING II

Instructions:	3L Hours per
Duration of End Examination:	3 Hours
Semester End Examination:	60 Marks
CIE:	40 Marks
Credits:	3

Pre-requisites: Chemical Reaction Engineering I

Course Objectives This course helps the students to understand

1. Basic Concepts of Catalysis
2. Kinetics and Mechanistic aspects of Catalysts
3. Design and Rating of Catalytic Reactors
4. Design Aspects of Gas-Liquid Reactors

Course Outcomes At the end of the course, a student will be able to

1. Indentify and characterize solid catalysts
2. Explain the kinetics for solid catalyzed reactions
3. Interpret the kinetics of fluid and particle reactions
4. Identify regions of mass transfer control and reaction rate control in fluid-fluid reactions
5. Apply the concepts to fluid- fluid reactors
6. Apply the concepts to catalytic fluid- solid reactors

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	-	-	-	-	1	-	-	-	2	2
CO2	3	2	2	1	1	-	-	1	1	-	-	2	2	2
CO3	3	2	2	1	1	1	1	1	1	-	-	2	2	2
CO4	3	2	2	1	1	1	1	1	1	-	-	1	2	2
CO5	3	2	2	1	1	1	1	1	1	-	-	1	2	2
CO6	3	2	2	1	1	1	-	-	1	-	-	1	2	2

UNIT – I

Solid Catalysts - Adsorption, adsorption isotherms, surface area, void volume and solid density, pore volume distribution. Theories of heterogeneous catalysis, classification of catalysts, catalyst preparation, promoters and Inhibitors

UNIT – II

Solid Catalyzed Reactions - Introduction; Development of rate expressions from L- H - H - W models for reaction $A + B \leftrightarrow R + S$ under adsorption, surface reaction and desorption controlling condition. Pore diffusion resistance combined with surface kinetics (Single cylindrical pore, first order reaction) Porous catalyst particles, mass and heat transfer within catalyst pellets. Experimental methods for finding rates.

UNIT – III

Kinetics of fluid-particle reactions: selection of a model, PCM, SCM, comparison of models with real situations. Shrinking core model for spherical particles of unchanging size: Diffusion through gas film controls, Diffusion through ash layer controls, chemical reaction controls. Rate of reaction for shrinking spherical particles.

UNIT – IV

Kinetics of fluid - fluid reactions: The rate equation for straight mass transfer of A (absorption). The general rate equation and the rate equation for reaction with mass transfer (infinitely fast to very slow reaction).Clues to the Kinetic Regime from Solubility Data

UNIT V

Fluid- Fluid Reactors: Design of reactors for straight mass transfer and mass transfer plus not very slow reaction cases

Catalytic gas solid reactors: Design of single adiabatic fixed bed catalytic reactor

Textbooks

1. Levenspiel O., "Chemical Reaction Engineering", 3rdEdition, John Wiley & Sons, Singapore, (1999).
2. Smith J. M., "Chemical Engineering Kinetics", 3rd Edition, McGraw Hill, (1981).

Suggested References Books

1. Fogler H. S., "Elements of Chemical Reaction Engineering", 3rdEdition, Prentice Hall Inc., (1999)
2. Chemical and Catalytic Reaction Engineering, Carberry, J. J., Dover Books on Chemistry, 2001.
3. Chemical Reactor Analysis and Design Gilbert F. Froment, Kenneth B. Bischoff, Juray De Wilde, John Wiley & Sons, Incorporated, 2010

CBIT(A) **with effect from 2022-23**

20CHE19 **PLANT DESIGN AND ECONOMICS**

Instruction	3 L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Pre-requisites: MEBC, FM, HT, MUO

Course objectives: This course helps the students to understand the

1. Basics of plant design and plant layout.
2. Criteria of selecting process equipment, based on which optimized design can be identified.
3. Importance of process economics in process industries.

Course Outcomes: At the end of the course, the students will be able to

1. Learn the basic aspects of plant design and its elements
2. Select a suitable optimized cost-effective equipment for a given process.
3. Learn the basics of cost accounting and perform the cost analysis of a plant.
4. Identify methods of estimation of depreciation and profitability studies.
5. Design cost-effective process equipment and plants.
6. Design and optimize the process parameters

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO	PO	PO	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	2	-	2	1	-	1
CO2	3	1	1	-	-	-	-	-	2	-	1	1	1	1
CO3	3	2	2	-	-	-	-	-	2	-	1	1	-	2
CO4	3	2	2	-	-	-	-	-	2	-	1	1	-	2
CO5	3	2	2	-	-	-	-	-	2	-	1	1	3	2
CO6	3	2	2	-	-	-	-	-	2	-	1	1	3	2

UNIT−I

Basic Aspects of Process Design: Introduction – definitions of plant design, process synthesis, process simulation; design factors, design problem and steps; Process flow diagram and Block flow diagram; Mass and energy balances; Piping and Instrumentation diagram; Equipment Design Codes and standards.

UNIT− II

Selection of Process Equipment, Specification and Design; Process Utilities, Utility flow diagram with Examples; Materials choice; Plant location – general site considerations, Site layout and Plant layout, Ethics in Engineering design. Safety factors.

UNIT− III

Process Economics –Cost Accounting – Capitalinvestment, cost index, Equipment cost; Elements of cost; Expenses; Project cost and cost of production, Various components of cost of production and their estimation, Various components of project cost, variable cost, fixed cost, break even point and their estimation. Estimation of Working Capital. Balance sheets, Project financing, concept of interest, (Present Worth, Future Worth) time value of money, Margin of Safety.

UNIT – IV

Depreciation – Types, Methods of determining Depreciation

Profitability Analysis of Projects, Alternatives Investment, Replacements, Payout time and Rate of return, Total annualized cost, cost indices, payback period, discounted cash flow; Sensitivity analysis, Inflation.

UNIT −V

Design of Fluid Transport Equipment and costs–Pumps, Pressure vessels.
Design of Heat Transport equipment and costs– Heat exchangers, Evaporators
Design of Reactors and cost analysis
Design of Separation Equipment and costs– Distillation, Absorption, Stripping.
Optimization in Design – general procedures.

Textbooks:

1. Peters. M.S. and Timmerhaus, K.D., "Plant Design and Economics for Chemical Engineering", 4th Edition, McGraw Hill, Singapore, 1991.
2. Coulson, J.M., Richardson J.E. and Sinnott R.K., "Chemical Engineering", Vol. VI, Pergamon Press, 1991

Suggested Reading

1. Schweyer. H.E., "Process Engineering Economics", McGraw Hill, 1st edition, New York, 1955.
2. Edgar T.F. and Himmelblau D.M., "Optimization of Chemical Processes" 2nd edition, McGraw Hill, International editions, Chemical Engineering series, 2001.

20 CHC20 **INSTRUMENTATION AND PROCESS CONTROL**

Instruction	3 L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Pre-requisites: Fluid Mechanics, Process Heat Transfer

Course Objectives: This course helps the students to understand:

1. The components and characteristics of industrial measurement systems
2. The transient behavior of simple chemical processes
3. Control loop - concepts, terminology, methods, and performance
4. Tuning and stability of a controllers
5. Advanced control strategies

Course Outcomes: At the end of the course, the students will be able to:

1. Understand the measurement techniques for different process variables
2. Understand the dynamic behavior of different processes
3. Analyze different components of a control loop
4. Analyze stability of feedback control system
5. Identify the suitable controller for the given processes
6. Design controllers for first and second order processes

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	3	-	-	-	-	-	-	3	3
CO2	3	1	3	3	2	3	-	-	-	-	-	-	3	3
CO3	3	1	3	3	2	3	-	-	-	-	-	-	3	3
CO4	3	1	3	3	2	3	-	-	-	-	-	-	3	3
CO5	3	1	3	3	2	3	-	-	-	-	-	-	3	3
CO6	3	1	3	3	2	3	-	-	-	-	-		3	3

UNIT-I

Introduction to process control: process variables, Measurement of process variables, sensors and transducers, general Industrial instruments – I/P and P/I converters, pneumatic and electric actuators. P&ID diagrams and equipment symbols.

Characteristics of Measurement System: Elements of instruments, static and dynamic characteristics,

UNIT-II

Response of First order systems: Transfer Function, Transient response to step, impulse, sinusoidal forcing function, physical examples of first order systems, liquid level, mixing process, concept of time constant, linearization, response of first order systems in series, interacting and non-interacting systems

Response of Second Order Systems: Transient response of under damped, critically damped, over damped systems to step, impulse and sinusoidal forcing functions. Transportation lags. Dynamic responses of various systems, systems with inverse response

UNIT-III

Control Systems: Negative and Positive feedback control systems, Servo and Regulatory control problems, Development of Block diagram, Controllers and final control elements, Ideal transfer functions of P, PI, PD and PID controllers

Reduction of physical control systems to block diagrams: Closed loop transfer functions for servo and regulator problems. Overall Transfer functions for multi loop control systems. Transient response of simple control systems for servo and regulator problems, measurement lags. Stability of a control system by Routh's Criterion.

UNIT-IV

Root Locus: concept of root locus, plotting of the root locus diagram for feedback control systems, Transient response of control system from root locus plot.

Frequency response: Bode diagrams for first order, first order system in series, second order systems and for controllers and transportation lag. Bode stability criterion. Gain margin and phase margin

UNIT-V

Advanced Control Strategies: Cascade Control, Feed Forward Control, Ratio control

Controller tuning and Process Identification: ISE, ITAE, IAE, Ziegler – Nicholas and Cohen-Coon tuning methods, Process reaction curve, process identification by step, frequency and pulse testing.

Control valves: control valve characteristics

Textbooks:

1. Eckman Donald P., Industrial Instrumentation, Wiley Eastern Ltd., 2004
2. Donald R Coughanowr , Steven E LeBlanc ,Process Systems Analysis and Control, 3rd edition, McGraw Hill Education (India) Edition 2013.

Suggested books:

1. D Patranabis, Principles of Industrial Instrumentation, , 2nd ed., Tata McGraw Hill Edu. (India) Pvt. Ltd., New Delhi, 2013.
2. Seborg D.E., Edgar T. E and Millichamp D.A, Process Dynamics and Control, John Wiley & Sons, 2004
3. Stephanopolis G., Chemical Process Control, Prentice Hall India, 2008
4. Bequette, B.W., Process Control: Modeling, Design and Simulation, 2007.
5. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, 1st Edition, Tata McGraw-Hill Education Private Limited, 2009.
6. Peter Harriott , “Process Control”, Tata McGraw Hill Ltd.

CBIT(A) **with effect from 2022-23**

20CH C21 **TRANSPORT PHENOMENA**

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Basic knowledge of FM, HT, and MTO

Course Objectives: This course introduces the students to

1. Fundamentals to solve flow problems involving transport of momentum, mass and energyusing a unified approach
2. The analogy between momentum, mass and energy transport.
3. The common mathematical structure of transport problems.
4. The turbulentphenomena and the methods of characterizing the turbulent fluxes.
5. Equations of change for isothermal and non-isothermal systems and multi-component mixtures.

Course Outcomes: Atthe end of the course students will be able to

1. Identify analogy between momentum, mass and energy transport
2. Develop expressions for velocity profiles using shell balances
3. Develop expressions for temperature profiles using shell balances
4. Develop expressions for concentration profiles using shell balances
5. Apply equations of change to solve flow problems
6. Understand transport mechanism in turbulent flows

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	2	1	-	-	-	-	-	3	3
CO2	3	3	3	2	-	-	-	-	-	-	-	-	3	3
CO3	3	3	3	2	-	-	-	-	-	-	-	-	3	3
CO4	3	3	3	2	-	-	-	-	-	-	-	-	3	3
CO5	3	3	3	2	-	-	-	-	-	-	-	-	3	3
CO6	3	3	3	2	-	-	-	-	-	-	-	-	3	3

UNIT – I

Introduction - Mechanism of molecular transport of momentum, heat and mass transfer. Flux equations - Newton's, Fourier's' and Fick's laws - Similarities and differences- Temperature and pressure dependence of viscosity, thermal conductivity and Diffusivity.

Velocity distributions in laminar flow - shell momentum balances -flow of a falling film - flow of fluids through circular tubes, annulus and immiscible fluids between parallel plates.

UNIT – II

Temperature distributions in solids and in laminar flow – shell balances - Heat conduction with electrical, Nuclear, viscous and chemical heat source

Heat conduction through composite walls and cooling fin, Forced convection and free convection

UNIT – III

Concentration distributions in solids and in laminar flow - shell mass balances, diffusion through a stagnant gas film, Diffusion with homogenous chemical reaction and heterogeneous chemical reaction. Diffusion into a falling liquid film-chemical reaction inside a porous catalyst

UNIT – IV

Equations of change for isothermal systems – Equation of continuity, Equation of Motion, Equations of change in curvilinear coordinates, use of equations of change to set up steady flow problems. Equations of change for non-isothermal systems – Equation of energy – use of equations of change to set up steady state flow problems. Equation of change for a binary mixture

UNIT – V

Velocity distributions in turbulent flow-Turbulence -Introduction to Time smoothed equations of change; Eddy properties - Intensity of turbulence Reynolds stresses; Semi empirical expressions for turbulent -momentum, energy and mass fluxes

Text Books:

1. R B Bird, W E Stewart, and E NLightfoot, Transport Phenomena, Revised 2nd Edition, John Wiley & Sons Inc., 2007

Suggested Reading:

1. R S Broadkay, Introduction to Transport Phenomena, McGraw Hill Publications, 1980
2. J R Welty, C E Wicks and R E Wilson, Fundamentals of Momentum, Heat and Mass Transfer, 3rd Ed., 1984
3. Geankoplis, Transport Processes and Separation Processes Principles. 4th Edition, Prentice Hall, 2003

20CHE09 **FUEL CELL TECHNOLOGY**
(Professional Elective III)

Instruction	3L Periods per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Engineering Chemistry and CRE

Course Objectives: This course helps the students to:

1. Create awareness about alternate clean fuel available.
2. Evaluate the concepts and chemistry of fuel cell
3. Examine the details of fuel used in fuel cell technology
4. Explain the application of fuel cell in different sectors
5. Evaluate the fuel cell system balance plant and future opportunities

Course Outcomes: At the end of course, students will be able to

1. Apply know-how of thermodynamics, electrochemistry and principle of fuel cell
2. Understand the different types of fuel cell
3. Understand the components of hydrogen-based fuel cell
4. Evaluate the performance of fuel cells.
5. Explain the application of fuel cell in transport, stationary and portable sector
6. Understand the impact of this technology in a global and societal context

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	-	2	3	-	-	-	1	2	3	2
CO2	3	3	3	-	-	2	2	-	-	-	1	2	3	3
CO3	3	3	3	-	-	2	2	-	-	-	1	2	3	3
CO4	3	3	3	-	-	2	2	-	-	-	1	2	3	2
CO5	3	3	3	-	2	2	3	-	-	-	1	2	3	2
CO6	3	3	3	-	-	2	3	-	-	-	1	2	3	2

UNIT - I

Introduction: Electrochemical Systems and Fuel Cell, Fuel Cell Fundamentals and Basic Concepts, Fuel Cell Degradation, Fuel Cell Operation, Types Of Fuel Cell And Its Applications: Direct Carbon Fuel Cell, Solid Oxide Fuel Cell, Polymer Electrolyte Fuel Cell, Alkaline Fuel Cell, Phosphoric Acid Fuel Cell, Molten Carbonate Fuel Cell, Fuel Cell Thermodynamics - Heat, Work Potentials, Prediction of Reversible Voltage, Fuel Cell Efficiency.

UNIT – II

Fuels and Fuel Processing: Introduction, Feedstock for H_2 production: Natural gas, Liquefied petroleum gas, Liquid hydrocarbon Fuels: Gasoline and Diesel, Alcohols- Methanol and Ethanol, Ammonia, Biomass, Fuel processing for fuel cell applications: Desulfurization, fuel reforming, water gas shift reaction, Carbon monoxide Removal.

UNIT – III

Fundamental and Components of Portable Hydrogen Fuel Cell: Introduction, PEM Fuel cell Components and their properties: Membrane, Electrode, Gas diffusion layer, Bipolar plates, Stack design principles, system design, performance analysis, current/voltage, voltage efficiency and power density, ohmic resistance, direct methanol and other non-hydrogen fuel cells, biofuel cell

UNIT – IV

Application of Fuel Cell: Hydrogen fuel cell use in transport, stationary Fuel cell characterization: - in-situ and ex-situ characterization techniques, i-V curve, frequency response analyses; Fuel cell modelling and system integration: - 1D model - Analytical solution and CFD models.

UNIT – V:
Balance of plant and commercialization issues, Future Opportunities, obstacles and challenges associated in fuel cell systems, impact of this technology in a global and societal context

Text Books

1. Nigel M. Sammes ,Fuel Cell Technology, Reaching Towards Commercialization, Springer London, 2006.
2. David A Berry, Dushyant Shekhawat, J.J. Spivey, Fuel Cells: Technologies for Fuel Processing, , Elsevier Science, 2011.

Suggested Readings

1. Shigenori Mitsushima, Viktor Hacker Fuel Cells and Hydrogen, From Fundamentals to Applied Research, Elsevier Science, 2018.

CBIT(A) **with effect from 2022-23**

20CHE10 **PETROCHEMICAL TECHNOLOGY**
(Professional Elective III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Chemical Technology

Course objectives: This course helps the students to understand the
1. Petroleum refineries worldwide.
2. Extraction and production of oil and gas to meet energy needs.
3. Importance of refining crude oil for a wide spectrum of useful products such as petrochemicals, plastics.

Course Outcomes: At the end of the course, the students will be able to
1. Explain the composition, applications and formation theories of crude oil
2. Summarize the refining process of crude oil and the treatment methods for upgrading products.
3. Outline Ethylene derivatives and identify their manufacturing processes.
4. Outline Propylene and C4 derivatives and explain their manufacturing processes.
5. Classify higher paraffin derivatives and outline manufacturing processes.
6. Identify Aromatic derivatives sources and separation methods for aromatics.

CO, PO AND PSO MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-				1	1	-	-	-	-	1	1	2
CO2	2	1	-	-	-	1	1	-	-	-	-	1	1	2
CO3	2	1	-	-	-	1	1	-	-	-	-	1	2	1
CO4	2	1	-	-	-	1	1	-	-	-	-	1	2	1
CO5	2	1	-	-	-	1	1	-	-	-	-	1	2	1
CO6	2	1	-	-	-	1	1	-	-	-	-	1	2	1

UNIT−I

Origin and formation of Petroleum: Organic theories, Inorganic theories and biological methods for explaining the formation of Crude oil, History, Indian and World scenario of Petroleum Industry and Refineries; Composition of crude oil: Alkanes, Alkenes, Alkynes classification Petroleum Refining products, properties and testing methods: Overall refining of crude petroleum, Production of Natural gas, gasoline, kerosene and lubricating oils; API Gravity, Aniline point, Octane number, Cetane number, Smoke point, Fire point, Flash point, Diesel Index etc.

UNIT− II

Overview of Refining Processes; Crude pre-treatment methods
Rebuilding of Hydrocarbons and techniques involved:
Cracking: Definition, types, reactions, fluidized bed cracking, description of the reactors.
Alkylation: - Hydrofluoric acid process and sulphuric acid process
Isomerization: -Aluminum chloride process and isomerization with platinum catalyst.
Olefin Polymerization: Polymerization in presence of sulphuric acid, polymerizations in presence of phosphoric acid.
Reforming; Visbreaking; Coking

UNIT− III

Petrochemicals Overview: Classification of Various Feed stocks and products
Manufacture of Methanol from Synthesis gas; Formaldehyde from Methanol
Ethylene Derivatives: Ethylene Industry - Various products with ethylene as the starting materials. Manufacturing and applications of the following: Vinyl Chloride Monomer, Ethyl alcohol by direct hydration and liquid phase hydration methods, Vinyl acetate monomer, Ethylene oxide and Ethanol Amine, Polyethylene.

UNIT − IV

Propylene derivatives: List of propylene derivatives; Manufacturing of the following: Isopropyl alcohol, Acetone, Cumene, Acrylonitrile, Propylene oxide, Isoprene and Oxo-processing of Olefins.

Butylene Derivatives: List of butadiene derivatives, Manufacturing of butadiene from n-butylene and by oxidative dehydrogenation; butylene glycol.

UNIT −V

Derivatives of Aromatics and their Manufacture: Aromatic Industry; BTX and their derivatives; Production of Benzene, Toluene, Xylene and their separation; Phenol, Styrene manufacture by different routes.
Derivative of Higher Paraffins: Manufacturing of Isoprene, olefins of C5 , C6, long chain and straight chain Olefins.

Textbooks:

1. W.L.Nelson, "Petroleum refinery engineering" 4th ed., McGraw Hill company, 2013.
2. B.K.Bhasker Rao, "Modern petroleum refining process", 5th ed., Oxford and IBH, 2008.
3. Uttam Ray Chaudari, "Fundamentals of Petroleum and Petrochemical Engineering", CRC Press, 2011.

Suggested Reading

1. Ram Prasad, "Petroleum Refining Technology", Khanna Publishers, 1998.
2. N.K.Sinha, "Petroleum Refining and PetroChemicals", 1st edition, Umesh publications , 2003.
3. Kirk-Othmer, "Encyclopedia of Chemical Technology", 3rd Ed..John Wiley and sons.Inc, 2004.
4. Meyers Robert, "HandBook of Petroleum Refining Processes", 3rd edition McGraw Hill, 2003

20CHE11 **PHARMACEUTICAL TECHNOLOGY**

(Professional Elective III**)**

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: MEBC, MUO, Chemical Technology

Course Objectives: This course helps the students to understand:

1. Grade of chemicals, Principles &Various Tests.
2. Preparation & testing of Pharmaceuticals & fine chemicals.
3. The Concepts & Principles to draw the flow sheets.
4. Methods & equipment used for Tablets, Capsules Preparation
5. Sterilization methods.

Course Outcomes: Upon completing this course, students will be able to:

1. Identify the different grades of chemicals, their impurities and limit tests
2. Compare the properties Pharmaceuticals and fine chemicals
3. Apply the testing methods for Pharmaceuticals and fine chemicals
4. Draw flow sheets for manufacturing common Pharmaceuticals
5. Draw flow sheets for manufacturing fine chemicals
6. Preparation of tablets and capsules and sterilization methods

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	-	1	-	1	_	_	_	_	-	1	-	-
CO2	1	2	1	1	-	_	_	_	_	_	-	-	-	-
CO3	1	2	1	2	-	_	_	_	_	_	-	-	2	1
CO4	2	-	-	-	-	_	_	_	_	_	-	-	2	2
CO5	2	-	-	-	-	_	_	_	_	_	-	-	2	2
CO6	-	1	2	2	-	1	_	_	_	_	-	1	-	1

UNIT - I

Introduction and outline of grades of chemicals, sources of impurities in chemicals, principles (without going into details of individual chemicals) of limit test for arsenic, lead, iron, chloride and sulphate in Pharmaceuticals.

UNIT - II

Properties, uses and testing of Pharmaceuticals like sulfacetamide, paracetamol, riboflavin, nicotinamide. Fine chemicals like Methyl orange, fluorescence, procaine hydrochloride, isonicatinic acid hydrazide, para-amino salicylic acid.

UNIT - III

Flowsheet and process description for manufacturing common Pharmaceuticals like aspirin, penicillin, calcium gluconate with uses, properties, flow sheets and testing Methods.

UNIT - IV

Flowsheet and process description for manufacturing of fine chemicals like ferric ammonium citrate, phthalic anhydride. Comparison of phenol fluorobenzene process and benzene sulphate process.

UNIT - V

Tablet making, coating, granulation and granulation equipments. Preparation of capsules, extraction of crude drugs. Introduction to sterilization, risk factor, methods of sterilization like heating with bactericide, gaseous and radiation type.

Textbooks:

1. Ajay Semalty and Mona Semalty Essentials Of Pharmaceutical Technology, 2nd Edition, BS publishers, 2018
2. Dr Shaik Harun Rasheed, A Textbook of Pharmaceutical Technology, Sia publishers, 2017

Suggested Reading:

1. Blently's Text Book of Pharmaceutical Chemistry, 8th ed, H A Rawlins, B Tindell and Box,. Oxford University Press, London, 1977.
2. Industrial Chemicals, 3rd ed., Faith, Kayes and Clark, John Wiley &Sons,. 1965.
3. Remington's Pharmaceutical Science, 17th ed, Mac publishing company, 1985

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20CHE12 **SAFETY AND HAZARD ANALYSIS**
(Professional Elective III**)**

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Chemical Technology

Course Objectives: This course will help the students to understand the

1. Importance of safety culture in process industry.
2. Disregard for ethical decision making based on numerous case studies.
3. Interaction and implementation of trade-offs concept in chemical plant operation.
4. Examples of problems that can occur with inadequate process design, improper process modification.
5. Different case studies related to industrial processes

Course outcomes: At the completion of this course, students will be able to

1. Evaluate effect of chemical hazards and risks of toxicants.
2. Analyze chemical incidents and possible consequences to plant facilities, workers, and the general public.
3. Analyze fire and explosion hazards.
4. Integrate safety concepts into chemical plant design.
5. Apply ethics during process plant operation
6. 6.Understand the overall safety aspects and safety audit norms for chemical process plant

CO, PO AND PSO MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	3	1	1	0	0	1	3	1
CO2	3	3	3	2	2	2	3	1	1	0	0	1	3	1
CO3	3	3	3	2	2	2	3	1	1	0	0	1	3	1
CO4	2	2	3	2	2	2	3	1	1	0	0	1	3	1
CO5	2	2	3	2	2	2	3	1	1	0	0	1	3	1
CO6	2	2	3	2	2	2	3	1	1	0	0	1	3	1

UNIT-I

Introduction: Process industrial safety –definition, importance. Safety awareness – Safety aspects of site selection, plant planning and layout, check list, inline arrangement of tower drums, exchangers, pumps and main pipelines.
Case studies of major disasters due to safety violations: Chernobyl disaster, Bhopal disaster, recent oil spills. Chemical hazards and workers safety, industrial process case studies.

UNIT – II

Organized labor interest in safety: Involvement of unions in accident prevention, recommendation of occupational health committees. Work Policy of MCA in accident prevention at process industries. Risk assessment procedures (HAZOP) and typical operational practices. Necessary precautionary measures (OSHA). Hazards: Identification and operability studies. Involvement of chemical criminals in process industries and their prevention. DOW Fire and explosion index, calculation of the DOW Fire and EI. Chemical safety data sheets and guides.

UNIT – III

Safety education and training: Training of personnel, on- the- job and job instructed training, meeting and instructional presentations. Effects of toxic Agents, chemicals and smoke on skin, eyes, respiratory tract, digestive tract. Primary protection equipment (PPE) – types, significance and applications. Measuring safety effectiveness: criteria for effective measurement, disabling (Lost-time) injuries, frequency rate, severity rate. Problem related safe-t-score. The technique of safe process design, separation sections, materials handling, storage sections, flow sheet review.

UNIT – IV

Fires and explosions: Types of Explosions, Runaway reactions, Safety valve rupture and risk assessment. Definition of fire, fire triangle, Classification of fires as Class-A, B, C and D. Reaction of fires. Fire extinguishers: Portable fire

extinguishers applications and their uses, Construction and working of water, Mechanical foam, CO2, stored powder, ABC powder. Automatic multiple CO2 extinguishers in chemical process industries.

UNIT – V

Emergency preparation and accident investigation: On-site and off-site emergency plan and infrastructure, learning from accidents, layered investigation, equipment aiding in diagnosis. Safety audit: Introduction, essentials, requirements, programs and procedures.

Text Books

1. D. A. Crowl and J.F. Louvar, "Chemical Process Safety", Prentice Hall, New Delhi, 2011.
2. Howard H. Fawcett and W. S. Wood, "Safety & Accident prevention in chemical operations", 2nd Ed., John Wiley and Sons Inc, 1982.

Suggested Reading:

1. Coulson and Richadson, "Chemical Engineering Design", 3rd ed., Vol 6, TMH, 1999.
2. Fulekar M.H, "Industrial Hygiene and Chemical Safety", I.K. International Publisher, 2006.
3. Sanders R.E., "Chemical Process Safety: Learning from case Histories", Butterworth-Heinemann (Elsevier) pub, 2005.

20EGCO3 **EMPLOYABILITY SKILLS**
(BE/BTech V & VI semester - Common to all Branches)

Instruction	2L Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Course Objectives: To help the students

1. Learn the art of communication; participate in group discussions and case studies with confidence and to make effective presentations.
2. With- resume packaging, preparing them to face interviews.
3. Build an impressive personality through effective time management, leadership qualities, self-confidence and assertiveness.
4. Understand professional etiquette and to make them learn academic ethics and value system.
5. To be competent in verbal aptitude.

Course Outcomes: By the end of the course**,** the students will be able to

1. Become effective communicators, participate in group discussions with confidence and be able to make presentations in a professional context.
2. Write resumes, prepare and face interviews confidently.
3. Be assertive and set short term and long-term goals, learn to manage time effectively and deal with stress.
4. Mak**e** the transition smoothly from campus to work, use media with etiquette and understand the academic ethics.
5. Enrich their vocabulary, frame accurate sentences and comprehend passages confidently.

UNIT 1

Verbal Aptitude: Error Detection, Articles, Prepositions, Tenses, Concord and Transformation of Sentences- Jumbled Words/Sentences- Vocabulary, Synonyms, Antonyms, One Word Substitutes, Idioms and Phrases, Word/Sentence/Text Completion- Reading Comprehension.

UNIT 2

Group Discussion & Presentation Skills: Dynamics of Group Discussion-Case Studies- Intervention, Summarizing, Modulation of Voice, Body Language, Relevance, Fluency and Accuracy, Coherence. Elements of Effective Presentation – Structure of a Presentation – Presentation tools – Body language - Preparing an Effective PPT

UNIT 3

Behavioural Skills: Personal strength analysis-Effective Time Management- Goal Setting- Stress management-
Corporate Culture – Grooming and etiquette-Statement of Purpose (SOP).

UNIT 4

Mini Project: Research-Hypothesis-Developing a Questionnaire-Data Collection-Analysis-General and Technical Report - Writing an Abstract –Technical Report Writing-Plagiarism-Project Seminar.

UNIT 5

Interview Skills: Cover Letter and Résumé writing – Structure and Presentation, Planning, Defining the Career Objective, Projecting ones Strengths and Skill-sets – Interviews: Concept and Process, Pre-Interview Planning, Opening Strategies, Answering Strategies, Mock Interviews.

Suggested Reading:

1. Leena Sen, “Communication Skills”, Prentice-Hall of India, 2005
2. Dr. Shalini Verma, “Body Language - Your Success Mantra”, S Chand, 2006
3. Edgar Thorpe and ShowickThorpe , “Objective English”, 2nd edition, Pearson Education, 2007
4. Ramesh, Gopalswamy, and Mahadevan Ramesh, “The ACE of Soft Skills”, New Delhi: Pearson, 2010
5. Gulati and Sarvesh, “Corporate Soft Skills”, New Delhi: Rupa and Co., 2006
6. Van Emden, Joan, and Lucinda Becker, “Presentation Skills for Students”, New York: Palgrave Macmillan, 2004

7. A Modern Approach to Verbal & Non-Verbal Reasoning by R S Aggarwal, 2018
8. Covey and Stephen R, “The Habits of Highly Effective People”, New York: Free Press, 1989

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20CHE22 **PLANT DESIGN LAB**

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	35 Marks
CIE	15 Marks
Credits	1.5

Pre-requisites: MEBC, FM, HT, MUO

Course Objectives: This course will

1. Provide students the opportunity to acquire simulation skills in Chemical Plant equipment design.
2. Introduce students to the importance and principles of design of a plant
3. Provide an overall view of design concepts of various unit operations and processes.
4. Demonstrate the overview of plant layout, flow sheeting and perform economic evaluation and sensitivity analysis of the plant
5. Help students to develop simulation skills using various chemical Engineering software like Aspen Plus, Aspen Hysys software, CAD, Pro-II etc.

Course Outcomes: At the end of the course, the student will be able to:

1. Acquire simulation skills in Chemical Plant equipment design.
2. Understand and apply the design concepts to various unit operations and processes.
3. Design various Heat and mass transfer equipment.
4. Design pumps, pressure vessels and reactors.
5. Analyze the performance of a process plant using economic evaluation and sensitivity analysis.
6. Perform simulation of design case studies in Aspen Plus/Aspen Hysys software/CAD/Pro-II.

CO-PO-PSO Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO	PO11	PO12	PSO11	PSO12
CO1	3	2	2	2	2	-	-	-	2	-	-	2	3	2
CO2	3	2	2	2	2	-	-	-	2	-	-	2	3	2
CO3	3	2	2	2	2	-	-	-	2	-	-	2	3	2
CO4	3	2	2	2	2	-	-	-	2	-	-	2	3	2
CO5	3	2	2	2	2	-	-	-	2	-	-	2	3	2
CO6	3	2	2	2	2	-	-	-	2	-	-	2	3	2

LIST OF EXERCISES (Minimum of 10 experiments in the list are to be performed)

1. Symbols for Piping and Instrumentation, Flow sheet symbols for unit operations.
2. Design and analysis of pumps and pressure vessels.
3. Design of Heat Transfer Equipment - Shell and Tube Heat Exchanger
4. Design of Heat Transfer Equipment - Condensers/Evaporators
5. Design of Reactors - 1
6. Design of Reactors - 2
7. Design of Mass Transfer Equipment - 1
8. Design of Mass Transfer Equipment - 2
9. Economic Evaluation Analysis in Aspen Plus - Case Study 1
10. Economic Evaluation Analysis in Aspen Plus - Case Study 2
11. Performing Sensitivity Analysis in Aspen Plus - Case Study 1
12. Performing Sensitivity Analysis in Aspen Plus - Case Study 2
13. Overall Plant layout and Design - Case Study

Text Books

1. Vilbrandt, C.T. and Dryden, C.E., “Chemical Engineering plant design”, 4th Ed., Kogakusha, 1979.
2. Joshi, M.V. “Process Equipment Design”, 2nd Ed., McMillan Co. of India Limited, Madras, 1976.
3. Bachurst, J.R. and Harker, J.A. “Process Plant Design”, Heiman Education Books, London, 1973.
4. Peters. M.S. and Timmerhaus, K.D., “Plant Design and Economics for Chemical Engineering”, 4th Edition, McGraw Hill, Singapore, 1991.

5. Evans, F.L., "Equipment Design HandBook for Refineries and Chemical Plants", Vol .I, 1979, Vol. II, 1980, Gulf Publishing Co., Houston, Texas.
6. Chemical Process Design and Simulation: Aspen Plus and Aspen Hysys Applications, JumaHaydary, AICHE, Wiley Pub.

20 CHC23 INSTRUMENTATION & PROCESS CONTROL LAB

Instruction	3P Hours per week
Duration of SEE	3Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Pre-requisites: Instrumentation & Process Control theory

Course Objectives: This course helps the students to understand the:

1. Dynamic response of first and second order processes
2. The difference between interacting and non-interacting systems
3. Characteristics of various controller modes
4. Method and significance of controller tuning
5. Relation between valve stem position and the fluid flow through a control valve

Course Outcomes: At the end of the course, the students will be able to:

1. Calibrate the different process instruments
2. Evaluate the performance of a first and second order systems
3. Analyze step response of simple feedback control systems
4. Determine frequency response of control systems
5. Analyze the behavior of a control system using different modes of control when subjected to a permanent disturbance
6. Apply closed loop and open loop techniques to tune process controllers

CO-PO-PSO Matrix

CO	PO	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	3	-	3	-	-	3	-	3	-	3	2
CO2	2	1	-	2	-	3	-	-	3	-	3	-	3	2
CO3	2	1	-	1	-	3	-	-	3	-	3	-	3	2
CO4	2	2	-	2	-	3	-	-	3	-	3	-	3	2
CO5	2	2	-	-	-	3	-	-	3	-	3	-	3	2
CO6	3	2	-	-	-	3	-	-	3	-	3		3	2

List of Experiments (Minimum of 10 Experiments in the list are to be performed)

1. Calibration of thermocouples
2. Calibration of differential pressure transmitter
3. Determination of dynamics of a first order system (thermometer)
4. Determination of second order under damped characteristics from the dynamics of second order system (manometer/thermo well)
5. Determination of dynamics of interacting liquid level system
6. Determination of dynamics of non-interacting liquid level system
7. Level control trainer
8. Flow control trainer
9. Temperature control trainer
10. Control valve characteristics

Text Books:

1. Donald R Coughanowr , Steven E LeBlanc ,Process Systems Analysis and Control, 3rd edition, McGraw Hill Education (India) Edition2013.
2. D Patranabis, Principles of Industrial Instrumentation, , 2nd ed., Tata McGraw Hill Edu. (India) Pvt. Ltd., New Delhi, 2013.