SCHOOL OF ENGINEERING
SRI SATYA SAI UNIVERSITY OF TECHNOLOGY AND MEDICAL SCIENCES

Undergraduate Degree Courses in Engineering & Technology
Department of Chemical Engineering (Syllabus)

CMA-601 Mass Transfer-II

CMA-601	**Mass Transfer-II**	**2L:1T:0P**	**3 credits**	**3Hrs/Week**

Course Preambles:

To provide students the basic learning and understanding skills towards the problems related to separation & purification and in turn the approach to solve it by applying the concepts/principles learned in the curriculum and to increase the student's ability to apply the principles for the design of Mass Transfer Equipments and their application in process industries.

Course Outcomes:

- Students will be able to
- List situations where liquid–liquid extraction might be preferred to distillation
- Explain the concept of breakthrough in fixed-bed adsorption
- Design cooling towers
- Distinguish among micro-filtration, ultra-filtration, nano-filtration, and reverse osmosis

Unit-I: Liquid-liquid extraction (10 Hours): Liquid-liquid Extraction, Ternary equilibrium. Solvent selection, Single stage, multistage cross-current, counter-current extraction, equipment for liquid-liquid extraction, continuous Contact extraction in packed towers.

Unit-II Solid-Liquid Extraction (12 Hours): Leaching & Washing, Preparation of solids for Leaching, Equilibrium diagrams, ideal stage equilibrium, stage efficiencies, Calculation of single Stage and multi-stage leaching operation.

Unit -III Adsorption (10Hours): Theories of adsorption, types of adsorbent, Isotherms, Break through curves, Stagewise operations, Adsorptions calculations and equipment's, Ion-Exchange; fixed bed absorbers, breakthrough.

Unit-IV: Humidification and Dehumidification (15 Hours): Principles, vapour-liquid equilibria, enthalpy of pure substances, basic definition of all humidification terms, methods of humidification and dehumidification, equipment like cooling towers, tray towers, spray chambers, spray ponds, cooling tower design – HTU, NTU concept, calculation of height of cooling tower.

Unit-V Drying (08 Hours): Drying Equilibria. Drying rate curves. Mechanism of drying. Calculation of batch and continuous drying. Drum dryers, spray and tunnel dryers. Membrane process, Ultrafiltration and Osmosis, Reverse Osmosis.

Text / References:

1. Binay K.Dutta, Principles of Mass Transfer and Separation Processes,2nd edition, Prentice Hall of India,2007
2. R.E.Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983.
3. AS. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980.
4. W.L. McCabe, J. Smith and P. Harriot, Unit Operations of ChemicalEngineering, 7th Edition, Tata McGraw Hill, India, 2014.
5. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition,Prentice Hall, India, 1993.

CMA-601	**Mass Transfer-II**	**0L:0T:1P**	**1 credits**	**2Hrs/Week**

List of Experiment:

1. To prepare the drying rate curve for fluidized bed dryer.
2. To study the characteristics of spray dryer.
3. To study the characteristics of drum and Tunnel dryer.
4. To study the drying characteristics of a wet granular material using natural and forced circulation in tray dryer.
5. Tray Dryer – To calculate rate of Drying
6. Rotary Dryer – To study the Characteristics of Rotary Dryer
7. To study the characteristics of cooling tower
8. Humidifier and Dehumidifier – To study the Characteristics
9. Liquid-liquid equilibrium for ternary system
10. Liquid – Liquid Extraction (single stage and multistage)
11. Characterization of Spray Extraction Column

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CMA-602 Chemical Reaction Engineering - II

CMA-602	**Chemical Reaction Engineering - II**	**2L:1T:0P**	**3 credits**	**3Hrs/Week**

Course Preambles:

- Basic Concepts of Catalysis
- Kinetics and Mechanistic aspects of Catalysts
- Design and Rating of Catalytic Reactors
- Design Aspects of Gas-Liquid Reactors

Course Outcomes:

Students will be able to

- Design catalytic reactors
- Identify regions of mass transfer control and reaction rate control and calculate conversion

Unit-I: Catalysis (10 Hours): Introduction to Catalysis, homogeneous and heterogeneous catalysis. Preparation and characterisation of catalysts. Physical and chemical adsorption, Adsorption isotherms, Determination of BET surface area and pore volume of the Catalyst. Kinetics of solid catalyzed gas phase reaction.

Unit-II Design of catalytic reactors (12 Hours): Laboratory reactors for catalytic gas solid reactions. Design concepts, Isothermal & adiabatic fixed bad reactor staged adiabatic reactors, Non isothermal, non adiabatic fixed bed reactors.

Unit -III Non-catalytic gas-solid reactions (10 Hours): Non-catalytic gas-solid reactions, different model for gas-solid reactions, Mass transfer, Diffusion and Chemical reactions in catalysts. Effects of external mass transfer and heat transfer, Effectiveness factor. Design aspects of catalytic reactors.

Unit-IV: Gas liquid reactions (12 Hours): Gas liquid reactions, film and penetration theories, enhancement factor in gas-liquid reactions, gas-liquid reactors, Reaction design for instantaneous reactions and slow reactions.

Unit-V External transport processes (15 Hours): External transport processes and their effects on heterogeneous reactions yield and selectivity Reaction and diffusion in porous catalysts, Isothermal and non-isothermal effectiveness factors, Effect of intra-phase transport on yield, selectivity & poisoning, Global reaction rate.

Text / References:

1. Elements of Chemical Reaction Engineering by H. Scott Fogler, 2nd Edition, Prentice Hall 2001
2. Chemical Reaction Engineering by Octave Levenspiel, 3rd Edition, John Wiley & Sons 2001
3. Chemical and Catalytic Reaction Engineering, Carberry, J. J., Dover Books on Chemistry, 2001.
4. Chemical Reactor Analysis and Design Gilbert F. Froment, Kenneth B. Bischoff, Juray De Wilde, John Wiley & Sons, Incorporated, 2010

CMA-602	**Chemical Reaction Engineering -II**	**0L:0T:1P**	**1 credits**	**2Hrs/Week**

List of Experiment:

1. To determine the order and rate constant of saponification reaction at room temperature.
2. To determine the order and rate constant of esterification reaction at room temperature .
3. To study homogeneous catalytic reaction in a batch reactor under adiabatic conditions.
4. To study the rate constant of hydrolysis of an ester-catalyzed by acid.
5. Determine the rate constant and order of reaction between Potassium per sulphate and Potassium iodide
6. To study temperature dependency of rate constant, evaluation of activation energy and Verification of Arrhenius law
7. To study a homogeneous reaction in a semi-batch reactor under isothermal conditions.
8. Study of non-catalytic homogeneous saponification reaction in CSTR.
9. To study a non-catalytic homogeneous reaction in a plug flow reactor.
10. To study the residence time distribution behavior of a back mix reactor.

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CMA-603 (A) Transport Phenomena

CMA-603 (A)	**Transport Phenomena**	**3L:1T:0P**	**4 credits**	**4 Hrs/Week**

Course Preambles:

- This course will highlight coupling between three transport phenomena with applications in various disciplines in engineering and science, and will demonstrate to the students the common mathematical structure of transport problems.
- The course will deal with flow problems involving Newtonian and non-Newtonian fluids, solid-state heat conduction, forced and free convection, binary diffusion with or without chemical reaction.

Course Outcomes:

On completion of the course, students would be familiar with

- Basics of vector and tensor analysis
- Be able to solve transport problems using shell balances
- Formulate and solve one-dimensional transport problems by using the conservation equations
- Formulate simple multi-dimensional transport problems

Unit-I: Introduction (10 Hours): Introduction to Transport Phenomena, Formulation of transport problems from nature, Vector and Tensor Analysis: Basic concepts.

Unit-II: Basics of momentum transport (08 Hours): Basics of momentum transport: Euler/Lagrangian viewpoint, laminar and turbulent flows, boundary layers, stress tensor.

Unit-III: Shell Momentum Balances (10 Hours): Shell momentum balances, equations of change, dimensional analysis, applications to isothermal flow of Newtonian & non-Newtonian fluids.

Unit-IV: Basics of energy transport (12 Hours): Basics of energy transport, conductive, convective and viscous dissipation energy fluxes, Equations of change for non-isothermal systems, dimensional analysis, and applications to steady-state conduction and convection, Basics of mass transport, mechanisms, and mass and molar fluxes.

Unit-V: Unsteady-State Momentum (10 Hours): Derivation of equation of continuity for a binary mixture and its application to convection-diffusion problems, Unsteady-state momentum, heat and mass transport, formulation of basic equations and similarity transform method.

Text / References:

1. R. B. Bird, W. E. Stewart, and E. S. Lightfoot. Transport Phenomena, 2nd ed., Wiley India Pvt. Ltd., 2002.
2. Welty, C. E. Wicks, R. E. Wilson, and G. L. Rorrer. Fundamentals of Momentum, Heat, and Mass Transfer. 5th ed., Wiley India Pvt. Ltd., 2007.
3. W. M. Deen, Analysis of Transport Phenomena, Oxford University Press, 1998.
4. W. J. Thompson, Introduction to Transport Phenomena, Prentice Hall, 2000.

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CMA-603 (B) Bio Chemical Engineering

CMA-603 (B)	**Bio Chemical Engineering**	**3L:1T:0P**	**4 credits**	**4 Hrs/Week**

Course Preambles:

1. To introduce the essential concepts of bioprocessing to traditional chemical engineers.
2. To make the student aware about advances in Biotechnology.
3. The Program encourages students to work in the field of biotechnology.

Course Outcomes:

The students will gain an ability to apply knowledge of mathematics, bioscience, and engineering. Students will learn to apply the principles of biology, engineering science, along with problem-solving skills and critical thinking to a broad spectrum of problems in biotechnology.

Unit-I: Introduction to Bioscience (10 Hours): Types of Microorganisms: Structure and function of microbial cells. Fundamentals of microbial growth, batch and continuous culture. Isolation and purification of Enzymes from cells. Assay of Enzymes. Functioning of cells and Fundamental Molecular.

Unit-II: Biology (12 Hours): Metabolism and bio-energetics, Photosynthesis, carbon metabolism, EMP pathway, tricarbocyclic cycle and electron transport chain, aerobic and anaerobic metabolic pathways. Synthesis and regulation of bimolecular, fundamentals of microbial genetics, role of RNA and DNA.

Unit-III: Enzyme Technology and Kinetics (10 Hours): Applications of enzymes in industry and medicine. Immobilization of enzymes, Kinetics of enzyme catalytic reactions involving isolated enzymes, Reversible inhibition. Reactions Catalysed By Enzymes.

Unit-IV: Reactors Analysis (10 Hours): Reactor Design and Analysis for soluble enzyme systems. Cofactor regeneration, Membrane reactor. Effect of mass transfer in immobilised enzyme particle systems. Reactors for immobilised enzyme systems. Bio Reactors, Effect of Transport Processes.

Unit-V: Introduction to Bioreactor design (12 Hours): Continuously Stirred aerated tank bioreactors. Mixing power correlation .Determination of volumetric mass transfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration on oxygen transfer rate, heat transfer and power consumption. Multiphase bioreactors and their applications. Downstream processing and product recovery in bioprocesses.

Text / References:

1. J. E. Bailey and D. F. Ollis, Biochemical Engineering Fundamentals.
2. Trevan, Boffey, Goulding and Stanbury, Biotechnology.
3. M. L. Shuler and F. Kargi, Bio Process Engineering: Basic concepts.
4. Inamdar S.T.A, Biochemical Engineering – Principles and Concepts.

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Undergraduate Degree Courses in Engineering & Technology
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CMA-604 (A) Environmental Pollution & Pollution Control

CMA-604 (A)	Environmental Pollution & Pollution Control	3L:0T:0P	3 credits	3 Hrs/Week

Course Preambles:

The Pollution Control and the protection of the environmental quality with sustainable development The practice also helps in stopping pollution of water due to reduction in discharges of waste into water bodies and the receiving body.

Course Outcomes:

- Describe the effects of water pollution on aquatic ecosystems.
- Describe the effects of air pollution on the environment and on human health
- Describe the effects of water pollution on human health
- Describe some key principles that support pollution prevention and control

Unit-I: Environment (10 Hours): Interaction of man and environment, overall picture of environmental pollution, environmental air and water quality criteria, standards and acts, effects of pollution.

Unit-II: Air Pollution (12 Hours): dispersion of pollutant in the atmosphere, meteorological factors of air, stability and inversion of atmosphere, control of air pollution, air pollution control equipments. Methods of measuring and sampling of gaseous and particulate pollutants in ambient air and industrial waste gases.

Unit-III: Water Pollution (10 Hours): Sources, types of pollutants in liquid wastes of chemical industries, methods for the treatment of liquid wastes to control pollution, selection of pollution control equipment, Methods of sampling of waste water, Odour and its control.

Unit-IV: Solid Waste Disposal (12 Hours): Characterization of solid wastes, problems of collection and handling, various processing techniques used in solid waste management, solid waste as resource material,

Unit-V: Noise pollution (06 Hours): Noise pollution: noise control criteria, noise exposure index, Control.

Text / References:

1. C. S .Rao, Environment Pollution Control and Environmental Engg.
2. Peavy and Row, Environmental Engineering.
3. A.C. Stern, Air Pollution – Engg. Control of Air Pollution Vol IV.
4. J. O .M. Bockris, Environmental Chemistry.

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Undergraduate Degree Courses in Engineering & Technology
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CMA-604 (B) Fertilizer Technology

CMA-604 (B)	**Fertilizer Technology**	**3L:0T:0P**	**3 credits**	**3Hrs/Week**

Course Preambles:

- Provide exposure to Nitrogenous and Complex fertilizer production technologies.
- Overview to the most recent Nitrogenous fertilizer production technologies.
- Improve participants' technical knowledge over a varied range of fertilizer production techniques, understanding the best available technology options with cost effective, minimal energy consumption along with the best approaches to safety and environmental management.

Course Outcomes:

- Use reactions and unit operations steps in manufacturing of various fertilizers
- Characterize fertilizers on the basis of different properties.
- Identify engineering problems in fertilizer manufacturing.

Unit-I: Introduction (10 Hours): Introduction, Plant nutrients, different types of fertilizers and their production in India.

Unit-II: Nitrogenous Fertilizers (10 Hours): Different feed stocks, Synthesis gas production by steam-naptha reforming and gas purefication. Ammonia synthesis. Urea manufacturing processes. Manufacture of sulphuric acid and ammonium sulphate. Nitric acid and ammonium nitrate manufacture.

Unit-III: Phosphatic Fertilizers (12 Hours): Availability and grinding of rock phosphate, manufacturing processes for single and triple super- phosphate and phosphoric acid. Mixed Fertilizers: Availability and manufacture of muriate of potash.

Unit-IV: Mixed Fertilizers: (10 Hours): Mixed Fertilizers: Mono and di-ammonium phosphate, urea ammonium phosphates, NPK complex fertilizers, granulation techniques.

Unit-V: Engineering Problems (08 Hours): Fertilizers storage and handling. Corrosion problems in fertilizers industries. Fertilizer plant effluent treatment and disposal.

Text / References:

1. Slack A.V, Chemistry and Technology of Fertilizers.
2. Austin G.T., and Shreve‘s, Chemical Processes Industries.
3. Waggaman W.H., Phosphoric Acid, Phosphates and Phosphatic Ferilizers.
4. Rao M.G. and Sittig M Dryden‘s, Outlines of Chemical Technology.

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Undergraduate Degree Courses in Engineering & Technology
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CMA-605 (A) Nano Technology in Catalysis

CMA-605 (A)	**Nano Technology in Catalysis**	**3L:0T:0P**	**3 credits**	**3 Hrs/Week**

Course Preambles:

- To give exposure to various types of equipment.
- Handing the instruments related to the separation process.
- Designing the experiments

Course Outcomes:

Synthesis of various nanoparticles are performed and their themal property using analytical equipments are done.

Unit-I: Introduction (10 Hours): Introduction to Nanotechnology, Physical chemistry of solid surfaces: Electrostatic stabilization, steric stabilization. Synthesis of Nanomaterials: Matrix mediated growth technique, the sol-gel method, Chemical precipitation method etc,

Unit-II: Methods of Synthesis (08 Hours): Methods of synthesis of nanomaterial's fabrication- Top-down vs. bottom-up‖ approaches. Equipment and processes needed to fabricate nanodevices and structures.

Unit-III: Fundamental of Catalysis (10 Hours): Fundamental understanding of catalysis at nano-scale. Wet chemical synthesis, preparation and properties of iron, platinum, gold, cadmium, silver, copper and nickel nano-particles.

Unit-IV: Application in Chemical Technology (12 Hours): Synthesis and properties of composite nano-particles and coated nano-particles. Application in Chemical Technology: Polymer Nano composites-Synthesis, characterization, mechanical, thermal properties etc.

Unit-V: Characterization (10 Hours): Characterization of nano particles by Scanning probe microscopes (Atomic Force Microscopy, Scanning Tunneling Microscopy), Transmission Electron Microscopy, Scanning Electron Microscopy.

Text / References:

1. Nanotechnology: Principles and Practices, . S. K. Kulkarni .
2. Nano science and technology: novel structures and phenomena, Tang, Zikang and Sheng, Ping, Taylor and Francis,
3. Nanotechnology: Understanding small systems B. Rogers, S. Pennathur, J. Adams Nanotechnology in Catalysis Pinzhan.
4. Jurgen Schulte, Nanotechnology (strategies, industry trends, and applications, Willey, 1st Edition, England 2005.

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CMA-605 (B) Fluidization Engineering

CMA-605 (B)	**Fluidization Engineering**	**3L:0T:0P**	**3 credits**	**3Hrs/Week**

Course Preambles:

- To study the fluidization phenomena, fluidized bed regimes and models.
- Investigate effect of the size and density of spherical particles on the minimum fluidization velocity. At least three different particle sizes and three different densities should be considered.
- Investigate effect of fluid properties on the fluidization process by comparing air- and water-based fluidized beds.

Course Outcomes:

- Understand the fluidization phenomena and operational regimes.
- Design various types of gas distributors for fluidized beds and determine effectiveness of gas mixing at the bottom region.
- Analyze fluidized bed behavior with respect to the gas velocity.
- Develop and solve mathematical models of the fluidized bed.

Unit-I: Introduction (10 Hours): The phenomenon of fluidization; liquid like behaviour of a fluidized bed; Comparison with other contacting methods; Advantages and disadvantages of fluidized beds. Industrial applications of fluidized beds.

Unit-II: Coal gasification (12 Hours): Coal gasification; gasoline from other petroleum fractions; Gasoline from natural and synthesis gases; Heat exchange; Coating of metal objects with plastics; Drying of solids; Synthesis of phthalic anhydride; Acrylonitrile; Polymerization of olefins; FCCU; Fluidized combustion of coal; incineration of solid waste; Activation of carbon; gasification of waste; bio-fluidization.

Unit-III: Fluidization and Mapping of Regimes (10 Hours): Minimum fluidization velocity; Pressure drop vs. velocity diagram; effect of temperature and pressure on fluidization; Geldart classification of particles; terminal velocity of particles; turbulent fluidization; pneumatic transport of solids; fast fluidization; solid circulation systems;

Unit-IV: Bubbling Fluidized Beds (12 Hours): Bubbling Fluidized beds: Experimental findings; Estimation of bed porosities; Physical models: simple two phase model; K-L model.High velocity

Fluidization: Turbulent fluidized bed; Fast fluidization pressure drop in turbulent and fast fluidization. Solids Movement, Mixing, Segregation and staging: Vertical movement of solids.

Unit-V: Horizontal Movement of Solids (15 Hours): Horizontal movement of solids; Staging of fluidized beds.Gas Dispersion and Gas interchange in Bubbling Beds: Dispersion of gas in beds; Gas interchange between bubble and emulsion; Estimation of gas interchange coefficients. Particle to Gas Mass Transfer: Experimental interpolation of mass transfer coefficients; Heat transfer; Experimental heat transfer from the bubbling bed model.

Text / References:

1. Fluidization Engineering Kunil, Diazo and Octave Levenspiel Fluidization Max Leva.
2. Fluidization Engineering O. Levenspiel and D. Kunii,
3. Gas-Liquid-Solid Fluidization Engineering Liang-Shih Fan,

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Undergraduate Degree Courses in Engineering & Technology
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CMA-606 Minor Project

CMA-606	Minor Project	0L:0T:4P	2 credits	4Hrs/Week

Objectives of the course Minor Project are :

To provide students with a comprehensive experience for applying the knowledge gained so far by studying various courses. To develop an inquiring aptitude and build confidence among students by working on solutions of small industrial problems. To give students an opportunity to do something creative and to assimilate real life work situation in institution. To adapt students for latest development and to handle independently new situations. To develop good expressions power and presentation abilities in students.

The focus of the Minor Project is on preparing a working system or some design or understanding of a complex system using system analysis tools and submit it the same in the form of a write up i.e. detail project report. The student should select some real life problems for their project and maintain proper documentation of different stages of project such as need analysis market analysis, concept evaluation, requirement specification, objectives, work plan, analysis, design, implementation and test plan. Each student is required to prepare a project report and present the same with a demonstration of the working system (if any)

Working schedule the faculty and student should work according to following schedule:

Each student undertakes substantial and individual project in an approved area of the subject and supervised by a member of staff. The student must submit outline and action plan for the project execution (time schedule) and the same be approved by the concerned faculty.

Action plan for Minor Project work and its evaluation scheme (Suggestive)

Task/Process	Week	Evaluation	Marks For Term Work
Orientation of students by HOD/Project Guide	1st	-	-
Literature survey and resource collection	2nd	-	-
Selection and finalization of topic before a Committee*	3rd	Seminar-I	20
(Detailing and preparation of Project) Modeling, Analysis and Design of Project work	4th to 5th	-	20
Testing, improvements, quality control of project	6th to 10th - 11th	-	25
Report Writing	12th to 15th		25
Presentation before a committee (including user manual, if any)	16th	Seminar-II	30

* Committee comprises of HOD, all project supervisions including external guide from Industry (if any)

NOTE: At every stage of action plan, students must submit a write up to the concerned guide.