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

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

CMA-501 Heat Transfer

CMA-501	**Heat Transfer**	**2L:1T:0P**	**3 credits**	**3Hrs/Week**

Course Preambles:

• Basic Concepts of Heat Transfer

• Design and Rating of Heat exchangers with and Without Phase Change

• Design and Rating of Compact Heat Exchangers

Course Outcomes:

Students will be able to

• Identify and select type of shell and tube exchanger based on TEMA classification

• Design double pipe heat exchanger, Shell and tube heat exchanger, finned tube and other compact heat exchangers.

Unit-I: Heat Transfer Fundamentals (8 Hours): Modes of heat transfer, thermal diffusivity and heat transfer coefficient; Differential equations of heat transfer.

Unit-II: Conductive heat transfer (8 Hours): One dimensional problems, heat transfer from extended surfaces, two and three dimensional problems, Insulation.

Unit-III: Convective heat transfer (10 Hours): Natural and forced convection; Dimensional analysis; Thermal boundary layer; Analogies and Correlations.

Unit-IV: Design of heat transfer equipment (12 Hours): Double pipe heat exchanger, concept of LMTD, DPHE sizing; shell and tube heat exchanger - Kern's method for design, effectiveness-NTU method, construction aspects in brief, Bell Delaware Method Design aspects of finned tube and other compact heat exchangers.

Unit-V: Basics of Heat transfer with phase change (15 Hours): Introduction to boiling, Introduction to condensation, Design aspects of Condensers, Reboilers and Evaporators, Heat Transfer to Agitated tanks, unsteady state heat transfer, Introduction to Radiative Heat Transfer, Design aspects of Furnaces.

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Text / References:

1. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 4th Ed.,Wiley (2007).
2. W. J. McCabe, J. Smith, P. Harriot, Unit Operations of Chemical Engineering, Sixth Edition, McGraw Hill (2005).
3. Holman, J. P., S. Bhattacharya, Heat Transfer, 10th Ed., Tata McGraw-Hill (2011).
4. D. Q. Kern, Process Heat Transfer, Tata-McGraw Hill (1997).
5. Bejan, A., A. D. Kraus, Heat Transfer Handbook, John Wiley (2003).

CMA-501	**Heat Transfer**	**0L:0T:1P**	**1 credits**	**2Hrs/Week**

List of Experiment:

1. To determine the thermal conductivity of metal rod.
2. To determine the equivalent thermal conductivity of composite wall.
3. To determine heat transfer coefficient in force convection.
4. To determine heat transfer coefficient in Natural convection.
5. To determine heat transfer coefficient with the help of Stefan Boltzmann Apparatus.
6. To calculate emissivity of the test plate by emissivity measurement apparatus.
7. To determine heat transfer coefficient in double pipe heat exchanger.
8. To study the heat transfer characteristics of a shell and tube heat exchanger (heating/cooling) of water.
9. To determine heat transfer coefficient in parallel and counter flow heat exchanger.
10. To measure the rate of evaporation using an open pan evaporator.
11. To measure the rate of condensation of pure water vapour and to determine the heat Transfer coefficient.
12. Demonstrate the film-wise drop-wise condensation and determination of the heat transfer coefficient.
13. To study the single effect evaporator and find out the heat transfer coefficient.

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CMA-502 Mass Transfer-I

CMA-502	**Mass Transfer-I**	**2L:1T:0P**	**3 credits**	**3Hrs/Week**

Course Preambles:

Basic Concepts of Mass Transfer, Staged and Continuous Contact equipment design, gas absorption and distillation

Course Outcomes:

Students will be

• Able to design staged and continuous contactors

• Familiar with special distillation techniques such as steam distillation and azeotropic distillation.

Unit-I: Fundamentals of Mass Transfer(10 Hours): Individual and film coefficients, overall mass transfer coefficient and their inter relationships; Analogies in transfer processes, determination of mass transfer co-efficient; two phase flow in packed beds, co-current and counter current processes flooding loading, column internals: types of trays/ plates and packing, point and plate efficiency.

Unit-II Diffusion phenomenon (10 Hours): Constitutive laws of diffusion unsteady state diffusion, Convective mass transfer, interphase mass transfer, mass transfer correlations, Mass transfer theories/models. Effect of chemical reaction on mass transfer Equilibrium stages and transfer units: number and height of transfer units; stage efficiency.

Unit -III Absorption (08 Hours): Solvent selection for absorption. Material balance and concept of driving force and minimum solvent rates. Gas absorption plate and packed column design; reactive absorption.

Unit-IV: Distillation (06 Hours): Introduction, Batch distillation; continuous binary fractionation, Azeotropic distillation; use of steam.

Unit-V Multistage distillation (10 Hours):: Introduction to multicomponent distillation, McCabe Thiele, and Ponchon-Savarit methods for multistage operations, tray efficiencies, concept of reflux, minimum reflux ratio, optimum reflux, total reflux, Murphree plate efficiencies.

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. E.D. Cussler, Diffusion - Mass Transfer in Fluid Systems, Cambridge University Press, Cambridge 1984.
4. S. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980.
5. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, Prentice Hall, India, 1993.

CMA-502	**Mass Transfer-I**	**0L:0T:1P**	**1 credits**	**2Hrs/Week**

List of Experiment:

1. To study steam distillation
2. To study batch distillation.
3. Studies on packed tower distillation unit.
4. Studies on bubble cap distillation column.
5. To study the absorption of a gas in a packed column and calculation of NTU and HTU.
6. Liquid Diffusion – To calculate the Diffusion Coefficient for a liquid –liquid system
7. To study Solid in air Diffusion
8. Interphase Mass Transfer Coefficient – To calculate the individual and overall Mass Transfer Coefficient.

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CMA-503 Chemical Reaction Engineering - I

CMA-503	**Chemical Reaction Engineering - I**	**2L:1T:0P**	**3 credits**	**3Hrs/Week**

Course Preambles:

- Basic Concepts of Kinetics and Rate Laws
- Design and Rating of Ideal Reactors including heat effects
- Interpretation of Rate data
- Design and Rating of Reactors involving multiple reactions including heat effects
- Analysis of Non-ideal flow Behavior in Reactors.

Course Outcomes:

Students will be able to

- Design chemical reactors involving heat effects optimally using minimum amount of data
- Fix some problems related to operability and productivity
- Operate reactors in a safe manner for single and multiple reactions
- Analyze the non-ideality in the reactors

Unit-I: Reactions and reaction rates (10 Hours): Reactions and reaction rates - stoichiometry, extent of reactions, conversion, Selectivity Reaction rate fundamentals - elementary reaction sequences, steady state approximation and rate limiting step theory.

Unit-II Design of ideal reactors (08 Hours): Ideal reactors - generalized material balance, design equations, graphical interpretation, Design of Isothermal and non-isothermal batch, CSTR, PFR, reactors.

Unit -III Sizing and analysis (12 Hours): Sizing and analysis of ideal batch, mixed (CSTR), plug flow and recycle reactors - solving design equations for constant and variable density systems, reactors in series and parallel, Analysis and correlation of experimental kinetic data - data collection & plotting, linearization of rate equations, differential and integral method of analysis.

Unit-IV: Design of reactors for multiple reactions (10 Hours): Multiple reactions - conversion, selectivity, yield, series, parallel, independent and mixed series-parallel reactions.

Unit-V Basics of Non Ideal flow (08 Hours): RTD theory and analysis of non-ideal reactors. RTD Dispersion model, evaluation of RTD characteristics, Tanks in series model, Conversion in non- ideal flow reactors for simple systems.

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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. Smith J.M; Chemical Engineering Kinetics; Mc Graw Hill.
4. Denbigh & Turner K.G; Chemical Reaction Theory An Introduction; United Press.
5. Copper & Jeffery‟s GVJ; Chemical Kinetics And Reactor Engineering; Prentice Hall

CMA-503	Chemical Reaction Engineering - I	0L:0T:1P	1 credits	2Hrs/Week

List of Experiment:

1. To study temperature dependency of rate constant, evaluation of activation energy and Verification of Arrhenius law
2. Study of non-catalytic homogeneous saponification reaction in CSTR.
3. To study a non-catalytic homogeneous reaction in a plug flow reactor.
4. To study the residence time distribution behavior of a back mix reactor.
5. To study the RTD behavior of a tubular reactor.
6. To study the RTD behavior of a packed bed reactor.
7. To study the kinetics of thermal decomposition of calcium carbonate.
8. To study a homogeneous catalytic reaction in a batch reactor under adiabatic conditions.
9. Study of non-catalytic saponification reaction in a tubular flow reactor.

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CMA-504 (A) Organic Process Technology

CMA-504 (A)	**Organic Process Technology**	**3L:1T:0P**	**4 credits**	**4Hrs/Week**

Course Preambles:

Objective of this subject is to expose students to understand the advancement in chemical process industries and its application to chemical engineering

Course Outcomes:

Students can synthesis production process of the required product.

Unit-I: Soaps and Detergents (08 Hours): Soaps and detergents, Difference between soaps and detergents, Classification of cleansing compounds, process of soap manufacture, Glycerol recovery, Manufacture of detergents: sulphated fatty alcohols and alkyl – aryl sulphonates.

Unit-II: Indian Sugar Industry (10 Hours): Important features of Indian sugar industry, Major unit operation of sugar industry, Alcohol fermentation, Raw materials for pulp making, Kraft and Sulphite pulping methods, Semi-chemical pulping, chemical recovery, stock preparation and paper making,

Unit-III: Petrochemicals (12 Hours): Important petrochemicals, Feed stock, Common unit processes: cracking, alkylation-dealkylation and hydroalkylation, halogenation, oxidation, hydrogenation-dehydrogenation; hydrationdehydration, nitration, amination, esterification, hydrolysis, hydroformylation process.

Unit-IV: Polymerization Reactions (08 Hours): Basic principles of polymerization reactions: bulk, solution, suspension and emulsion polymerisation, Synthesis of phenol formaldehyde, polyethylene, polystyrene and PVC, Dyes and Dye intermediates, insecticides and pesticides, nitration and nitrating agents.

Unit-V: Fibers (07 Hours): Natural and synthetic fibres, Fibre properties important in textile production, Manufacture of nylon 6,6 and nylon 6 fibres, viscose rayon and polyester fibres, polyamides.

Text / References:

1. Dryden C.E; Outlines Of Chemical Technology; Affilicted. East West press, New Delhi, 1997
2. G.T. Austin, Shreve's Chemical Process Industries, Mc Graw Hill.
3. Gupta VB & Kathari VK; Manufacturing Fibre Technology; Chapman Hall, Newyork I Edition
4. Kathari V.K.; Progress In Textile, Sciences Technology, Vol I & II; IAFL Publications, S-351 Greater Kailash part I New Delhi – 48 I Ed.
5. Austin, G.T; Shreeves Chemical Progress Industries; . Mc. Graw Hill New York

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CMA-504 (B) Oil & Paint Technology

CMA-504 (B)	**Oil & Paint Technology**	**3L:1T:0P**	**4 credits**	**4Hrs/Week**

Course Preambles:

Painting companies of every size plan their future development and meet important revenue and profit targets. Painting companies decide where to focus their recruitment programs and their marketing resources.

Course Outcomes:

- To learn the basic ingredients required for paint formulation.
- The ability to understand the various factors to affect the stability of the paint.
- Students should be decided in the situation, and to decide the dosage of various additives in coating formulation.
- Basic knowledge of design paint formulation considering various ingredients.
- The ability to use different machinery and equipment in the laboratory and used on a commercial scale to handle.

Unit-I: Chemistry of Oils (10 Hours): Chemistry of Oils, Fats and Fatty Acids: i. Glycerides, ii. Fatty Acids, iii. Non Glyceride Components of Oils & Fats iv. Chemical Reactions of Fats and Fatty Acids.

Unit-II: Technology and Production of Oils & Fats (12 Hours): Technology and Production of Oils & Fats, Coconut, cotton seed, peanut, palm, sunflower, sesame, softlower, rice fran, rapeseed and mustard seed, linseed, soyabean, tung, casteroil lard and tallow. Minor Oils: Neem Oil and Salfat. a) Mechanical expression of oils, b) Solvent extraction of oilseed and oil bearing material, c) Fat splitting. Refining and Bleaching.

Unit-III: Degumming (10 Hours): Degumming, alkali refining (batch refining), Miscella refining, refining loses – Bleaching by absorption – continuous bleaching.

Unit-IV: Hydrogenation (10 Hours): Hydrogenation, Mechanism – selectivity as applied to the reaction and catalysis, Hydrogenation in practice (Batch & continuous) preparation of Raney Nickel catalyst, Soap manufacture, Raw materials required, selection of raw materials – full boiled process.

Unit-V: Nutritional functions of fats (12 Hours): Nutritional functions of fats, Testing and important analysis of oils and fats in determining the quality and quantity of oils / fats and oilseed; such as moisture, oil content, F.F.A., protein content, color of the raw / refined oil.

Text / References:

1. Feireidoon Shahidi, Bailey's Industrial Oil and Fat Products
2. E. Bernardini, Oils & fats Technology
3. W.M.Morgan, Outlines of Paint Technology
4. V.C.Malshe & Meenal Sikchi, Basics of Paint Technology, Part I & II.

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CMA-505 (A) Petroleum Processing Technology

CMA-505 (A)	**Petroleum Processing Technology**	**3L:1T:0P**	**4 credits**	**4Hrs/Week**

Course Preambles:

- An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering
- To understand and know Origin, occurrence, Exploration, Drilling and Production of Crude Oil. Be aware of the challenges involved in refining from viewpoint of product specifications, economic considerations and environmental regulations.
- Provide students with a basic understanding of polymer processing techniques and rheological behavior.
- To understand standard testing methods for the evaluation of different properties.

Course Outcomes:

- An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development
- Know the Origin, occurrence, Exploration, Drilling and Production of Crude Oil.
- Know the composition of crude oil and its products, along with its properties and characterization methods
- Understand the process of fractionation of crude oil and Identify the specifications required for good quality petroleum product

Unit-I: Petroleum Crude (10 Hours): Origin and occurrence of petroleum crude, status of petroleum refining in India; composition of petroleum, classification and physical properties of petroleum.; evolution of crude oil and petroleum products, future refining trends.

Unit-II: Crude Oil Distillation Process (12 Hours): Crude oil distillation process, pretreatment of crude, atmospheric and vacuum distillation process; secondary conversion processes; catalytic reforming, catalytic cracking and deep catalytic cracking.

Unit-III: Polymerization (08 Hours): Heavy residue up-gradation technologies; hydro-cracking, hydro-treating, vis-breaking and delayed coking alkylation, isomerisation, dehydrogenation processes, polymerization.

Unit-IV: Lubricating Oil (10 Hours): Lubricating oil, grease and bitumen: de-waxing and de-oiling, de-asphalting, lube hydro-finishing, bitumen air blowing, sweetening and desulphurization; hydro-desulphurisation of petroleum products.

Unit-IV: Refinery Products (10 Hours): Refinery products, refinery gas utilization, LPG, propylene and hydrogen recovery, reformulated gasoline; present and future requirements.

Text / References:

1. Nelson WL; Petroleum refinery engineering ; Mc. Graw hill
2. Hobson GD; Modern petroleum technology Part I & II; John Wiely & sons.

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CMA-505 (B) Conventional & Non-Conventional Energy Sources

CMA-505 (B)	**Conventional & Non-Conventional Energy Sources**	**3L:1T:0P**	**4 credits**	**4Hrs/Week**

Course Preambles:

- Non-conventional resources or renewable resources such as solar energy, wind energy, hydroelectricity, geothermal energy and tidal energy.
- Energy crisis and its solution by using non-conventional sources to maximum extent.

Course Outcomes:

- Understand the different non-conventional sources and the power generation techniques to generate electrical.
- The concept of solar energy and their applications in different fields.
- The ways to harness energy from non-conventional energy sources like geothermal, wind and ocean.

Unit-I: Global and National energy scenario (10 Hours): Global and National energy scenario, Conventional & renewable energy sources, need & development of renewable energy sources, types of renewable energy systems.

Unit-II: Energy and Development (08 Hours): Energy and development role of energy in industrial activity. Contemporary energy crisis, conventional and non-conventional energy sources, energy demand and availability. Energy audit need for energy conservation.

Unit-III: Solar Energy System (10 Hours): Solar energy system, introduction to wind energy conversion, Wind turbines, Wind farms, Bio energy system, design and constructional features.

Unit-IV: Thermal Renewable Energy Systems (12 Hours): Thermal renewable energy systems, appropriate energy technology for rural development, energy conservation, environmental aspects of renewable energy systems.

Unit-V: Energy Conservation (12 Hours): Fluidized bed combustion, Energy conservation in use of heat. Economical design of furnace, water treatment, drying, conditioning and industrial space heating, boiler accessories etc. Heat recovery in waste heat boilers: Conservation, integrated energy systems for industries.

Text / References:

1. Rakosh das begmudre, Energy conservation systems
2. GD Das, Non conventional energy sources
3. S.P. Sukhatme, Solar Energy by Padmashree
4. Harvey A., Dunn J.J, Solid waste Conversionto Energy
5. S. Rao & B.B. Parulka, Energy Technology .

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CMA-506- Industrial Training

CMA-506	Industrial Training	0L:0T:4P	2 credits	4Hrs/Week

Objective of Industrial Training

The objective of undertaking industrial training is to provide work experience so that student's engineering knowledge is enhanced and employment prospects are improved. The student should take this course as a window to the real World and should try to learn as much as possible from real life experiences by involving and interacting with industry staff. Industrial training also provides an opportunity to students to select an engineering problem.

Scheme of Studies:

Duration: Minimum 2 weeks in summer break after IV semester, assessment to be done in V Semester

Scheme of Examination:

For the assessment of industrial training undertaken by the students, following components are considered with their weightage.

(a) Term Work in Industry Marks Allotted

Attendance and General Discipline 20
Daily diary Maintenance 20
Initiative and participative attitude during training 30
Assessment of training by Industrial Supervisor 30
Total 100*

(b) Practical/Oral Examination (Viva-Voce) in Institution Marks Allotted
1. Training Report 50
2. Seminar and cross questioning (defense) 100
Total 150

* - Marks of various components in industry should be awarded by the I/c of training in Industry but in special circumstances if not awarded by the industry then faculty in charge /T.P.O. will give the marks.

During training students will prepare a first draft of training report in consultation with section In charge. After training they will prepare final draft with the help of T.P.O. /Faculty of the Institute. Then they will present a seminar on their training and they will face viva-voce on training in the Institute.