Chemical and Biochemical Engineering

Semester V						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	CH302T	Process Equipment Design and Economics	3	0	0	6
2	HS201T	Economics	3	0	0	6
3	CL304T	Applications of Mass Transfer	3	0	0	6
4	CH308T	Advanced Chemical Reaction Engineering	3	0	0	6
5	CH307T	Process Dynamics and Control	3	0	0	6
6	CH301L	Chemical Engineering Lab II (Heat transfer and Solid mechanics)	0	0	3	3
		Total Credits				**33**

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1	**Title of the course** (L-T-P-C)	**Applications of Mass Transfer (3-0-0-6)**
2	**Pre-requisite courses(s)**	CL 203 (Mass Trasfer)
3	**Course content**	**Liquid-Liquid Extraction**: Liquid equilibria, single-stage and multi-stageextraction, Fractional extraction, emulsions, and dispersions. **Cooling tower:** saturated and unsaturated vapor-gas mixtures, Air-water system, gas-liquid contact operations, adiabatic, non-adiabatic operations. **Adsorption**: Types of adsorptions, Adsorption Equilibria, Heat of adsorption, adsorption operations, single stage and multistage operations, Ion exchange.**Drying:** Drying Operations, Batch drying and mechanisms, continuous drying**Leaching:** Steady and unsteady state operation, methods of calculations, stage efficiency, single and multi-stage leaching
4	**Texts/References**	1. R.E.Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi,1983. 2. E.D. Cussler, Diffusion - Mass Transfer in Fluid Systems, Cambridge UniversityPress, Cambridge 1984. 3. A. S. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980. 4. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, PrenticeHall, India, 1993.

1	**Title of the course** (L-T-P-C)	**Process Equipment Design and Economics (3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Mechanical design of process equipment: pressure vessels, tall columns, etc., process piping design; Materials and Fabrication Selection; Design Strategy and Optimum Equipment Design: Economic Design criteria; Cost and Asset Accounting; Cost Estimation; Interest and Investment Costs; Taxes and Insurance; Depreciation; Profitability, Alternative Investments and Replacement; Illustrative Case Study in Process Equipment Design and Costing of Equipment in each of the following categories: Material Transfer, Handling and Treatment Equipment Heat Transfer Equipment: Shell and tube heat exchangers (Kern and Bell-Delaware design methods), Plate heat exchangers, Evaporators Mass Transfer Equipment: Absorption/ Stripping columns (packed/tray), Multicomponent distallation colum (FenskeUnderwood-Gilliland correlations) Reactors: choice of reactors, non-isothermal reactors, reactor
4	**Texts/References**	• R.E.Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983. • E.D. Cussler, Di usion - Mass Transfer in Fluid Systems, Cambridge University Press, Cambridge 1984. • A. S. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980. • C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, Prentice Hall, India, 1993.

1	**Title of the course (L-T-P-C)**	**Economics (3-0-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Basic economic problems. resource constraints and Welfare maximizations. Nature of Economics: Positive and normative economics; Micro and macroeconomics, Basic concepts in economics. The role of the State in economic activity; market and government failures; New Economic Policy in India. Theory of utility and consumer choice. Theories of demand, supply and market equilibrium. Theories of firm, production, and costs. Market structures. Perfect and imperfect competition, oligopoly, monopoly. An overview of macroeconomics, measurement, and determination of national income. Consumption, savings, and investments. Commercial and central banking. Relationship between money, output, and prices. Inflation - causes, consequences, and remedies. International trade, foreign exchange and balance payments, stabilization policies: Monetary, Fiscal and Exchange rate policies.
4	**Texts/References**	**1.** P. A. Samuelson & W. D. Nordhaus, Economics, McGraw Hill, NY, 1995. **2.** A. Koutsoyiannis, Modern Microeconomics, Macmillan, 1975. R. Pindyck and D. L. Rubinfeld, Microeconomics, Macmillan publishing company, NY, 1989. **3.** R. J. Gordon, Macroeconomics 4th edition, Little Brown and Co., Boston, 1987. **4.** William F. Shughart II, The Organization of Industry, Richard D. Irwin, Illinois, 1990. **5.** R.S. Pindyck and D.L. Rubinfeld. MicroeconomicsThe (7th Edition), Pearson Prentice Hall, New Jersey,2009. **6.** R. Dornbusch, S. Fischer, and R. Startz. Macroeconomics (9th Edition), McGraw-Hill Inc. New York, 2004.

1	**Title of the course** (L-T-P-C)	**Advanced Chemical Reaction Engineering** **2-1-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Unsteady state ideal reactors (isothermal and non-isothermal), Non-ideal Reactors and Reactor Safety: Dispersion Models, The Tank in Series model, Convection and laminar flow, Segregation and RTD, Reactor Stability & Reactor Safety. Gas-Solid Reactions: Shrinking core and volume reaction models to treat External diffusion, Internal Diffusion & Reaction control reactions. Catalytic rate equation, catalyst deactivation, catalytic reactor design, Various fluid-particle reactors and its designs. Gas-Liquid Reactions: Rate equation for mass transfer and reaction limited reactions, Factors important to design Gas-liquid reactors and various gas-liquid contactors and its design aspects. Solid- Solid Reactions: Kinetic models and reactor design for solid processing units. Special, Reactors and, photoreaction and photoreactors, Vacuum and aerosol systems for material synthesis. Fundamentals of catalysis, including kinetics and mechanistic models. Heterogeneous and homogenous catalysis. The fundamentals of electrocatalysis and the effects of coupling proton and electron transfer for catalytic redox reactions. Surface properties and function in heterogeneous catalysis, Fischer- Tropsch process etc.,
4	**Texts/References**	Text books: **1.** H.S.Fogler, Elements of Chemical Reaction Engineering, 5th ed., Prentice Hall, New Jersey, 2016. **2.** O.Levenspiel, Chemical Reaction Engineering, 3nd ed., Wiley Eastern, 2021. **3.** J.M.Smith, Chemical Engineering Kinetics, 3rd ed., McGraw Hill, 2013. **4.** J. F. Hartwig, Organotransition Metal Chemistry: From Bonding to Catalysis, 1stEd, University Science Books, 2010.

1	**Title of the course** (L-T-P-C)	**Process Dynamics and Control** **2-1-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	First Principles model development; dynamics of first, second and higher order linear systems, open loop and closed loop systems; linearization; feedback control; stability; root locus diagram; frequency response analysis; Bode stability criterion; Nyquist stability criterion; design of controller; dynamics of some complex processes; control valves and introduction to real time computer control of process equipment; cascade, feed forward, adaptive control; SISO; MIMO; A/D conversion, PLC architecture; Multi-variable control strategies.
4	**Texts/References**	**1.** G. Stephanopoulos, Chemical Process Control: An Introduction to Theory and Practice, Prentice-Hall, New Jersey, 2015. **2.** D. R. Coughanowr, and L. B. Koppel, Process systems Analysis and Control, 3 rd Ed., Mc-Graw-Hill, 2009. **3.** W. L. Luyben, Process Modelling Simulation and Control for Chemical Engineers, McGraw Hill, 1990 (this is the latest edition).

1	**Title of the course** (L-T-P-C)	**Chemical Engineering Lab II (Heat transfer and Solid mechanics) (0-0-3-3)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Heat Transfer: Experimental on Conduction, convection, radiation, heat exchanger, thin-metal foil technique Solid mechanics: Tensile and compression testing of materials, impact, torsion, hardness, thick and thin pressure vessels, strain gauges.
4	**Texts/References**	--