PANDIT DEENDAYAL PETROLEUM UNIVERSITY
SCHOOL OF TECHNOLOGY
COURSE STRUCTURE FOR B. TECH. CHEMICAL ENGINEERING

SEMESTER V			**B.TECH. CHEMICAL ENGINEERING**										
Sr No	**Course Code**	**Course Name**	**Teaching Scheme**					**Examination Scheme**					
			L	**T**	**P**	**C**	**Hrs/wk**	**Theory**			**Practical**		**Total marks**
								MS	**ES**	**IA***	**LW**	**LE/ Viva**	
1	CH 301T	Chemical Reaction Kinetics	3	1	--	7	4	30	60	10	--	--	100
	CH 301P		--	--	4	2	4	--	--	--	25	25	50
2	CH 302T	Mass transfer I	3	1	--	7	4	30	60	10	--	--	100
	CH 302P		--	--	4	2	4	--	--	--	25	25	50
3	CH 303T	Chemical Processes Technology II (Inorganic)	3	0	--	6	3	30	60	10	--	--	100
	CH 303P		--	--	2	1	2	--	--	--	25	25	50
4	**CH 312**	**Energy Technology**	3	--	--	6	3	30	60	10	--	--	100
5	CH 305	Process Instrumentation	3	--	--	6	3	30	60	10	--	--	100
6	CH 306	Transport Phenomena	3	1	--	7	4	30	60	10	--	--	100
7	**TP 210**	Industrial Orientation (Evaluation)	--	--	--	3	--	--	--	--	80	20	100
		Total	**18**	**3**	**10**	**47**	**31**						850

MS = *Mid Semester*, **ES** = *End Semester*; * **IA** = *Internal assessment* (like quiz, assignments etc)
LW = *Laboratory work*; **LE** = *Laboratory Exam*

CH 301T Chemical Reaction Kinetics										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	1	--	7	4	30	60	10	--	--	100

UNIT I

Mole balance , Kinetics of Homogeneous reactions - Definition of the rate of reaction, type of reactions, homogeneous and heterogeneous, Reaction mechanism, elementary and non-elementary reactions, Temperature and concentration dependent term of a rate equation, searching for a reaction mechanism.

UNIT II

Introduction to reactor design, Rate-Law and Stoichiometry - Basic definitions, Approach to reactor sizing and design

Collection and Analysis of rate data, integral and differential method of analysis of data, Batch reactor data, Variable and constant volume system, Method of initial rates, Method of half-life, Differential reactors, Least square analysis

UNIT III

Isothermal Reactor Design - General mole balance equation, ideal reactor, Batch Reactors, Continuous-flow reactors, Industrial reactors, Design for isothermal reactors, Scale up of liquid-phase batch reactor data to the design of a CSTR, Tubular reactors, Recycle reactors

Conversion and Reactor Sizing - Definition of conversion, Design equations, Applications of the design equations for continuous-flow reactors, Reactors in series

UNIT IV

Multiple Reactions – Design for parallel reactions, Maximizing desired product in parallel reactions, Maximizing desired product in series reactions, Temperature and pressure effect in single and multiple reactions, Adiabatic reactor design.

Texts and References:

1. H. S. Fogler, “Elements of Chemical Reaction Engineering”, 3rd Ed, New Delhi-Prentice Hall, 2001
2. O. Levenspiel,” Chemical Reaction Engineering” Willey Eastern, 3rd Ed., 2000
3. J. M. Smith, “Chemical Engineering Kinetics”, 3rd Ed., McGraw- Hill, 1988

CH 301P Chemical Reaction Kinetics										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
--	--	4	2	4				25	25	50

List of experiments

1. To determine the activation energy of the reaction using Arrhenius Equation.
2. To determine order of reaction for the given reaction.
3. To measure the kinetics of a reaction under condition of excess reactant at room temperature.
4. To determine the kinetics of the reaction at room temperature by the integral method of analysis.
5. To determine the activation energy and frequency factor for reaction at room temperature & at different temperature.
6. To determine the kinetics of the reaction at room temperature by the differential method of analysis.
7. To determine the kinetics of the reaction between n- butyl acetate and sodium hydroxide at room temperature by the differential method of analysis.

CH 302T Mass Transfer I										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	1	--	7	4	30	60	10	--	--	100

UNIT I

Physico-chemical basis of separation processes, thermodynamic considerations

Diffusion - Fick's Law of diffusion equimolecular counter diffusion in fluids, diffusion in stationary gas. Maxwell's low of diffusion. Solid diffusion

UNIT II

Inter phase mass transfer - Mass transfer equilibrium, diffusion between two phases. Local mass transfer coefficient, Local and average overall mass transfer coefficients. Simultaneous heat and mass transfer. Steady state co and counter current processes

Material balance – steady state co current and counter current processes stage wise and differential contacts. Number of theoretical stages. Stage efficiency Height of mass transfer units.

UNIT III

Gas Absorption - Equilibrium solubilities of gases. Material balance for transfer of one component. Counter current multistage operations for binary and multi component systems. Continuous contactors, absorption with chemical reaction. Concept of HTU and NTU

Liquid–liquid extraction - Calculations with and without reflux for immiscible and partially miscible system.

UNIT IV

Leaching: Principle and theory, types of operations, Leaching single and multistage operations based on solvent free co ordinates

Gas–Liquid operations - Sparged vessels (bubble columns), mechanically agitated vessels for a single phase and gas liquid contact. liquid dispersed scrubbers, venturi scrubbers, wetted towers packed towers. Mass transfer coefficients for packed towers co-current flow of gas and liquid end effect and axial mixing.

Text and References

1. R. E. Treybal, Mass transfer operations, 3ed ed. McGraw Hill, 1980.
2. S. Foust et al. Principles of Unit Operations
3. J. M. Coulson and J. F. Richardson, "Chemical Engineering", Vol. 1 ELBS, Pergaman press, 1970
4. J. M. Coulson and J. F. Richardson, "Chemical Engineering" Vol. 2 ELBS, Pergaman press, 1970

CH 302P Mass Transfer I										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
--	--	4	2	4				25	25	50

List of Experiments

1. To determine the % extraction of diluted aqueous organic solution using suitable solvent.
2. To determine the diffusion co-efficient of CCl_4 in air & it's variation with temperature.
3. Determine mass transfer co-efficient of liquid (water) evaporation to atmospheric air at elevated temperature.
4. To determine the efficiency of single stage leaching operation.
5. To find out the liquid side mass transfer coefficient K_{La} in the packed column.
6. To determine the mass transfer co-efficient for dissolution of benzene acid with and without chemical reaction.
7. To prepare the ternary diagram for a system of three liquid one pair partially soluble system.
8. To study the (cross current) liquid-liquid extraction for binary system using solvent and determine:
   a) Efficiency stage wise & overall.
   b) Advantage of multistage cross current extraction over single stage through A. Solvent required to achieve the same recovery in single stage. B. % recovery when the same quality of solvent is used in single stage.
   c) % of acetic acid removed per stage & overall removal of acetic acid.
   d) Minimum & maximum solvent in 1^{st} sage
9. To determine the mass transfer coefficient in a stirred cell.
10. To determine the stage efficiency and the overall recovery for multistage cross current leaching operation using solvent.
11. To determine the mass transfer co-efficient of vaporization of solid into air.

CH 303T Chemical Process Technology II (Inorganic)										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	--	--	6	3	30	60	10	--	--	100

UNIT I

Introduction to inorganic chemistry and concepts: periodic table and main group elements, Lewis concept of acids and bases, Nomenclatures, structural isomers, stereoisomer.

Descriptive inorganic chemistry: coordination compounds, transition metal compounds, organometallic compounds, cluster compounds, bioinorganic compounds, solid state compounds. Various theories. Mechanistic inorganic chemistry.

Chemistry of raw materials used in industry: Glass, Refractory, Potteries, Ceramic coatings, Cement concrete, Synthetic raw materials: Properties, characteristics, importance & synthesis of important raw

UNIT II

Electrolytic industries: Electrolytic processes for the manufacture of aluminum sodium magnesium, chlorates and per chlorates.

Inorganic Chemicals: Acids, sulphuric acid (DOSA and DCDA process), nitric acid, hydrochloric acid phosphoric acid and hydrofluoric acid.

UNIT III

Nitro-Fertilizers: Soda ash, Ammonia, urea, Ammonium sulphate and nitrate superphosphates and mixed fertilizers. biofertilizers

Chlor–Alkali Industries: Manufacture of soda ash, sodium bicarbonate chlorine and caustic soda calcium hypochlorite sodium hypochlorite and sodium chlorite potassium chloride.

UNIT IV

Furnace Products: Furnace products such as lime, cement, magnesia, elemental, phosphorus, activated carbon graphite etc.

Electrothermal Industries: Artificial abrasives, calcium carbide

Texts and References

1. George T. Austin, Shreve's Chemical process Industries, 5th ed. McGraw Hill, 1984
2. C. E. Dryden, outlines of chemical technology edited and revised by M. Gopala Rao and Marshall sitting end ed. Affiliated East-West press, New Delhi, 1973.
3. Kirk-Othmer, Encyclopedia of chemical Technology, 3rd ed. John-Willey, New York, 1981.
4. McKetta, Encyclopedia of Chemical Processing and Design, Marcel Dekker Inc., New York, 1994

CH 303P Chemical Process Technology II (Inorganic)										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
--	--	2	1	2				25	25	50

List of Experiments

1. To prepare sulphanilic acid from aniline.
2. To prepare hydrated lime from the given calcium carbonate powder.
3. To determine the acid value of the given sample of oil.
4. To determine the loss on igniting the cement sample.
5. To determine the total silica in the given sample.
6. To determine the amount of potassium in the given sample of fertilizer.
7. To determine the total insoluble residue in the cement sample.
8. To determine the adsorption isotherm of acetic acid by activated charcoal.
9. To determine the amount of Na_2CO_3 and $NaHCO_3$ in the given mixture of sodium carbonate and sodium bicarbonate.
10. To determine the amount of calcium in the given sample of fertilizer volumetrically.
11. Determination of percentage available chlorine in bleaching powder.

CH 312 Energy Technology										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	--	--	6	3	30	60	10	--	--	100

UNIT I

Introduction to Energy Sources (conventional & non-conventional), world production and reserve of conventional energy sources, Indian production and reserves, Energy alternatives.

Solid Fuels: wood & charcoal, peat, lignite, sub-bituminous & bituminous coals, semi-anthracite and anthracite coals, cannel & boghead coal, origin of coal, composition of coal, analysis & properties of coal, problems

UNIT II

Processing of Solid Fuels coal preparation, wash ability curve, dry & wet washing methods of coal, washer efficiency, gasification & liquefaction of solid fuels, problems

Solar Energy : solar constant, solar radiation & related terms, measurement of solar radiation, solar energy collectors – flat plate collector, air collector, collectors with porous absorbers, concentrating collectors, applications & advantages of various collectors, selective absorber coatings, solar energy storage systems (thermal, electrical, chemical & mechanical), solar pond, applications of solar energy

Wind energy: nature, power, forces, conversion and estimation. Components of wind energy system, types, design considerations. Generation systems, safety and environment.

UNIT III

Energy from bio mass: Generation, conversion technologies and utilization of biogas, design of biogas plants and gasifiers Fuel Cell Technologies

Geothermal Energy Systems. Tidal energy systems. Oceanic power generation. Design considerations, Installation and Performance Evaluation. MHD power generations, Energy from Oceans: OTEC, methods (open cycle & close cycle) energy from tides, components

UNIT IV

Fuel Cell: introduction, hydrogen – oxygen fuel cell, ion exchange membrane cell, fossil fuel cell, molten carbonate cell, advantages & disadvantages, conversion efficiency, polarisation, type of electrodes, applications of fuel cells

Nuclear Energy: fission, fusion, fuel for nuclear fission reactor, storage & transportation, fast & slow neutrons, multiplication factors & reactor control, uranium enrichment process, study of different reactors

Text and References

1. Energy Sources 2Ed. by G. D. Rai, Khanna Publications, New Delhi
2. Fuels & combustion by Samir Sarkar, Orient Longmans(1974)
3. Solar Energy by Sukatame, Tata McGraw Hill, New Delhi
4. Energy Technology by Rao & Parulaker

CH 305 Process Instrumentation										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	--	--	6	3	30	60	10	--	--	100

UNIT I

Fundamentals of Measuring Devices: Introduction to measurements. Elements of measuring systems and their functions. Characteristic and classification, error, accuracy, repeatability, drift, threshold etc

Measurement of Temperature: Temperature scales Mercury in glass thermometer, Bimetallic thermometer, pressure spring thermometer, Thermoelectric temperature measurements, thermocouples, thermal well and potentiometers, Resistance thermometer and pyrometers. working principles and applications, advantages and disadvantages

UNIT II

Measurement of Pressure: Various Manometers, working principles and applications, Pressure and vacuum gages, pressure transducer, working principles and applications, advantages and disadvantages

Measurement of liquid Level: Level measurements of open and pressure vessels measurement of interface level, working principles and applications advantages and disadvantages

UNIT III

Measurement of density: Density measurements by displacement meter, hydrometer and densitometer, working principles and applications advantages and disadvantages

Measurements of flow: Orifice, Venturi, Pitot, and Rota-meters, flow measurement of open channels.

UNIT IV

Instrumentation to flow plan symbols and chemical sensors. advantages and disadvantages

Measurement of pH, conductivity, composition of mixtures, working principles and applications, advantages and disadvantages

Signal transmission. Transmitters electronic pneumatic etc.

Preparation of instrumentation diagram for equipment like distillation, heat exchanger, condensers

Text / References:

1. D. P. Eclaman, Industrial Instrumentation, Wiley Estern, 1989.
2. J. P. Bentley, Principles of Measurement Systems, 2nd ed. Longman London, 1988.
3. J. W. Dally, W. F. Riley and K. G. McConnell, Instrumentation, Engineering Measurements, John Wiley and Sons, Singapore, 1984.
4. C. S. Rangan, G. R. Sarma and V. S. V. Mani, Instrumentation Devices and systems, Tata McGraw Hill, New Delhi, 1983
5. B. C. Nakra and K. K. Chaudhary, Instrumentation Measurement and Analysis, Tat McGraw Hill, New Delhi, 1985.

CH 306 Transport Phenomena										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	1	--	7	4	30	60	10	--	--	100

UNIT I

The role of transport Phenomena in the understanding of Chemical Engineering, Equation of motion

Viscosity and mechanism of momentum transport, thermal conductivity and mechanism of energy transport, diffusivity and mechanism of mass transport.

UNIT II

Shell Balance**:** Velocity distribution in laminar flow, temperature distribution in solids and laminar flow, concentration distributions in solids and in laminar flow (restricted to rectangular and cylindrical co-ordinates only).

Equations of change**:** Isothermal systems, non-isothermal system, multi-component systems (restricted to rectangular coordinate system).

UNIT III

More than one independent variable systems**:** Velocity distribution, temperature distribution, concentration distribution (restricted to rectangular and cylindrical co-ordinates only).

Turbulent Flow**:** Velocity distribution, temperature distribution, concentration distribution.

UNIT IV

Interphase Transport**:** Isothermal systems, non-isothermal system, multi-component systems.

Analogies between Momentum, heat and mass transfer

Texts/References:

1. J. M. Coulson and J. F. Richardson, Chemical Engineering Vol. I Pergamon Press, 1970
2. R. B. Bird, W. E Stewart, and E. N. Lightfoot, Transport Phenomena, Edition-I John Wiley, 1960.
3. C. O. Bannet, and J. E. Myers, Momentum, Heat and Mass Transfer 3rd ed. McGraw Hill, 1982.

TP 210 Industrial Orientation										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
		--	3	4	30	60	10	--	--	100

Evaluation of industrial Orientation

Visit to Industries during summer vacation 3,

Three credit course