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

SEMESTER III			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	MA 201T	Mathematics III	3	1	0	7	4	30	60	10	--	--	100	
2	SC 201T	Engineering Chemistry	3	0	--	6	3	30	60	10	--	--	100	
	SC 201P		--	--	2	1	2	--	--	--	25	25	50	
3	CH 201T	Fluid Flow Operation	3	0	--	6	3	30	60	10	--	--	100	
	CH 201P		--	--	4	2	4	--	--	--	25	25	50	
4	CH 202	Chemical Process Calculations	3	1	--	7	4	30	60	10	--	--	100	
5	CH 203	Chemical Engineering Thermodynamics I	3	1	--	7	4	30	60	10	--	--	100	
6	CH 204T	Heat Transfer Operations	3	0	--	6	3	30	60	10	--	--	100	
	CH 204P		--	--	4	2	4	--	--	--	25	25	50	
7		Civic and Social Service Internship, CSSI (Evaluation)	--	--	--	3	--	--	--	--	80^{+}	20	100	
		Total	**18**	**4**	**10**	**48**	**32**						850	

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

MA 201T MATHEMATICS III										
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

Definition and properties of analytics functions, Cauchy-Riemann equations, harmonic functions, Power series and their properties, Elementary functions, Gauchy's theorem and its applications.

UNIT II

Taylor series and Laurent expansions, Residues and the Cauchy residue formula, Evaluation of improper integrals, Conformal mapping, Inversion of Laplace Transform

UNIT III

Review of power series and series solutions of ODE's, Legendre's equation and Legendre polynomials, Regular and irregular singular points, method of Frobenius, Bessel's equation and Bessel's functions

UNIT IV

Strum-Liouville problems, Fourier series, D'Alembert solution to the Wave equation. Classification of linear second order PDE in two variables, Vibration of a circular membrane, Heat equation in the half space

Texts and References

1. R.V.Churchill and J. W. Brown, Complex variables and applications (7^{th} Edition), McGraw-Hill (2003)
2. J.M.Howie, Complex analysis, Springer-Verlag (2004)
3. M.J.Ablowitz and A.S.Fokas , Complex Variables : Introduction and Applications, Cambridge, University Press, 1998 (Indian Edition)
4. E.Kreyszig, Advanced Engineering Mathematics (8th Edition), JohnWiley (1999)
5. W.E.Boyce and R.Diprima, Elementary Differential Equations (8th Edition), John Wiley (2005).

SC 201T ENGINEERING CHEMISTRY										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	0	--	6	3	30	60	10	--	--	100

UNIT I

Electrochemistry: Specific, equivalent and molecular conductance, their determination, theories of electrolytic conductance, Debye Huckel theory of strong electrolytes, Galvanic cells, Reference electrodes and their potentials. Standard cell standard electrode potential determination of dissociation constants of acids and bases, solubility product, hydrolysis constant hydrogen ion concentration, Complex formation activity of electrolytes etc., theory of acid base indicators, electrolytes etc., theory of acid base indicators, electro-metric titrations. Photochemical reactions, Laws of Photo-chemistry.

UNIT II

Separation methods: Concepts of precipitation, fractional distillation, fractional crystallization, electro deposition, electro-dialysis, reverse osmosis, distribution (partition co efficient), Chromatography – Basic concepts; paper chromatography and thin layer chromatography with suitable examples.

Green Chemistry: Basic concepts, Factors affecting the environment like ozone layer depletion, green house effect, acid rain etc, application of green chemistry to the chemical industry processes

UNIT III

Reactions and Mechanisms: Organic reactions and their mechanisms: types of organic reactions; general methods of obtaining mechanisms, study of ionic, free radical and other reactions

Surface Chemistry: Interparticle forces, adsorption isotherms, determination of the surface area of fine powders using BET theory, surface films.

Colligative Properties and their Experimental Determination: Boiling Point Elevation, Freezing Point depression, Osmotic Pressure

UNIT IV

Nuclear Chemistry: Nuclear fission and fusion, nuclear energy, nuclear reactors, disposal of nuclear waste, radiation measurement and contentment

Instrumental methods of analysis: Basic principles and operations, applications, sampling techniques of gas chromatographs, GCMS , FTIR, NMR, HPLC, spectroscopy etc., TGA, DTA, XRD, SEM

Texts and References

1. Atkins, Peter, 'Physical Chemistry', 8th ed New Delhi : Oxford & IBH Publishing House, 2006
2. Das, Ishwar, 'An Introduction to Physical Chemistry', New Age International (P) Limited; New Delhi; , 2006
3. Manickam, Valli, 'A Textbook of Analytical Chemistry', Pharma Book Syndicate, 2006
4. Settle, Frank A, 'Handbook of Instrumental Techniques for Analytical Chemistry', Pearson Education, 2004
5. Skoog, Douglas A, 'Fundamentals of Analytical Chemistry', 8th ed New Delhi : Cengage Learning, 2004
6. Doble, Mukesh, 'Green Chemistry and Processes'New York : Elsevier, 2007
7. Jimenez-Gonzalez, Concepcion, 'Green Chemistry and Engineering: A Practical Design Approach', New York, John Wiley and Sons, Inc, 2011

SC 201P ENGINEERING CHEMISTRY										
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 determination of partition coefficient of a given sample
2. To verify the Beer's Lambert's law
3. To determine the solubility and solubility product of a given solution
4. To determine the normality of a given solution using pH meter
5. To determine the normality and strength of a solution using conductivity meter
6. To determine the viscosity of a solution using solution viscometry
7. To study the principle, working, construction and operation of various instruments like FTIR, Gas chromatograph, spectrophotometers, conductivity meter etc.

CH 201T Fluid Flow Operations										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	0	--	6	3	30	60	10	--	--	100

UNIT I

Definition and properties of fluid, Types of flow, steady and unsteady, laminar and turbulent flows, relationship between shear stress and pressure gradient, Hagen Poiseuille equation. Prandtl mixing length theory and eddy diffusivity, losses in pipes and fittings.

UNIT II

Continuity equation for compressible and incompressible fluids. Bernoulli equation, Euler equation. Equation of motion.

Darcy-Weisbach equation for frictional head loss, friction factor, Moody diagram. Velocity profile and boundary layer calculations for turbulent flow.

UNIT III

Handling of fluids: Pumps, compressors and blowers for handling different fluids, Standards for pumps, compressors and blowers, valves, pipe fittings and their standards, power requirement for flow. Piping layout and economical pipe diameter.

Mixing and agitation: calculation of power numbers and mixing indices. Liquid-liquid and liquid solid mixing.

UNIT IV

Flow measuring devices: orificemeter, venturimeter, rotameter, pitot tube, anemometer etc. Flow through open channels such as notches, weirs, nozzles.

Vacuum producing devices; two phase flow: basic principles and applications

Texts and References

1. W. L. McCabe and J. C. Smith, P. Harriot, Unit Operations of Chemical Engineering 4th ed. McGraw Hill 1985.
2. J. M. Coulson and J. F. Richardson, Chemical Engineering Vol. I Pergamon Press, 1970.
3. S. Foust, L. A. Wenzel, C. W. Clump, L. B. Andersen. Principles of Unit Operations, 2nd ed. John Wiley, New York, 1980
4. Y A Cengel and J M Cimbala, Fluid Mechanic: Fundamentals and applications, 2nd Edition, Tata McGraw Hill
5. S. K. Gupta, Moment Transfer Operations, Tata McGraw Hill, 1979.
6. P N Modi and S M Seth, Hydraulics and fluid Mechanics, Standard Book House

CH 201P Fluid Flow Operations										
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. Study of flow patterns by Reynolds's apparatus
2. Study of Bernoulli's equation
3. Viscosity measurement by efflux time measurement
4. Study of friction factor in close conduits
5. Study of minor losses and determination of equivalent length of pipe fittings
6. Study of venturimeter
7. Study of orifice meter
8. Calibration of rotameter
9. Studies of Pitot tube
10. Characteristics of centrifugal pump
11. Study of friction factor in annular
12. Viscosity by Stokes's Law

CH 202T Chemical Process Calculations										
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

Basic Concepts of processes - Units and Dimensions, Steady state and dynamic processes, Lumped and distributed processes, Single and multiphase systems, unit processes and unit operations

Types of Variables - Intensive and extensive properties, Specific properties, State variables.
Types of Equations - Mass and energy conservation, equilibrium relations, Rate laws, Constitutive equations for material behavior, Correlations for physical and transport properties.

UNIT II

Steady State Processes Material Balances - Properties of gases, liquids and solids equations of state, phase equilibria for ideal mixtures, Reactions and stoichiometry,

Reacting single phase systems - Single and multiple units without recycle, Systems with recycle, bypass and purge, Non-Reacting multi-phase systems - Processes involving vaporization and condensation, Reacting systems.

UNIT III

Steady State Processes Energy Balances - Specific heat capacity, Enthalpy, Heat of reaction, Thermo-chemistry, Isothermal systems, Adiabatic systems, Simultaneous material and energy balances.

Unsteady State Material and Energy Balances - Reaction rate laws, Transport laws.
Introduction to Computer Aided Process Calculations - Degrees of Freedom and Specifications, Use of Spreadsheets, Tearing and Iterative techniques in Flow sheeting.

UNIT IV

Fuels and Combustion: Types of fuels, Proximate and ultimate analysis of fuel, Combustion theory, Combustion Equations Theoretical, excess air and equivalence ratio. Analysis of products of combustion Calorific value – HCV & LCV. Bomb and Boy's gas calorimeters (Numerical). First and second law analysis of reactive systems.

Texts and References

1. D.M. Himmelblau, "Basic Principles and Calculations in Chemical Engineering", 6th Edition Prentice Hall of India, 1997

2. B. I. Bhat and S. M. Vora, "Stoichiometry" Tata McGraw-Hill, New Delhi.

CH 203T Chemical Engineering Thermodynamics I										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	1	--	7	3	30	60	10	--	--	100

UNIT I

Laws of Thermodynamics**:** Review of First Law (Law of conservation of energy), Second Law (law of degradation of energy) and their utility in chemical processes , types of system: open and close, thermodynamic analysis of chemical processes

UNIT II

Thermodynamics of matter and their property relationship**:** PVT behavior, equation of states, viral and cubical equations, generalized correlations, PVT behavior of mixtures, Gibb's energy and its role in generating function, Helmholtz free energy, relation between properties

UNIT III

Ideal and non-ideal solutions, Raoult's law, Henery's law, Fugacity and fugacity coefficient. Excess properties, activity and activity coefficient

Entropy: Concept, Entropy Balance and Reversibility, Heat, Work, Engines and Entropy. Entropy changes of Matter. Applications of the Entropy Balance.

UNIT IV

Properties of Steam and Vapor Processes**:** Formation of steam, Phase changes, Properties of steam, use of Steam Tables, Study of P-V, T-S and Mollier diagram for steam,

Vapour Power Cycles: Vapour absorption and compression cycle, Carnot cycle, Rankine cycle, Comparison of Carnot cycle and Rankine cycle, Efficiency.

Introduction to *Engineering Equation Solver (EES)* for solution of numerical problems

Texts and References

1. S. I. Sandler. "Chemical Engineering Thermodynamics", Wiley, New York, 1999
2. J. M. Smith and H. C. Van Ness "Introduction to Chemical Engineering Thermodynamics" 4th ed. McGraw Hill, 1987.
3. Y. V. C. Rao, "Chemical Engineering Thermodynamics", University Press 1997
4.

CH 204T Heat Transfer Operations										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	0	--	6	3	30	60	10	--	--	100

UNIT I

Fundamentals of heat transfer, types of heat transfer, mechanism of heat transfer, heat transfer rate, flux, resistances

Conductive heat transfer: Conduction through a single homogeneous solid, thermal conductivity of solids, liquids and gases. Conduction through objects (flat surfaces, cylindrical bodies, spherical object, finned surfaces) in series. Contact resistances. Composite walls, heat losses and insulation, types of insulation materials

UNIT II

Convective Heat transfer: Film and overall heat transfer coefficients, Resistance concept, solid-fluid heat transfer, natural and forced convection, Laminar and turbulent flow heat transfer, Coefficients for scale deposits, concept of L.M.T.D. in heat exchangers with co and counter current flow. Effectiveness – N T U method in finned tube heat exchangers

UNIT III

Heat transfer with phase change: Nucleation and boiling, Film wise and drop wise condensation, film wise condensation on vertical and inclined surfaces, condenser design, fundamentals of pervaporation
Unsteady state heat conduction, lumped heat capacity system, transient heat flow in a semi-infinite solid.

UNIT IV

Radiation**:** Black and gray body radiations, plank's law, Stephen-Boltzmann law, view factor, luminous and non-luminous gases. Combined heat transfer, i.e. conduction, convection and radiation together.
Concept of critical insulation thickness.

Texts and References

1. J. M. Coulson and J. F. Richardson, "Chemical Engineering", Vol. 1 and 2, ELBS, Pergamon press, 1970
2. W. L. McCabe J. C. Smith and P. Harriot, "Unit Operations of Chemical Engineering", 4th ed. McGraw Hill 1985
3. D. Q. Kern, "Process Heat Transfer", McGraw Hill, 1950.
4. J. P. Holman, "Heat Transfer", McGraw Hill Higher Education, 8th edition, 2001

CH 204P Heat Transfer Operations										
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. Determination of thermal conductivity of solids
2. Studies in heat transfer by natural convection
3. To compare overall heat transfer coefficients for parallel flow and counter flow in double pipe heat exchanger
4. To study the performance of 1-2 fixed tube sheet heat exchanger and calculate overall heat transfer coefficient
5. Effectiveness of fin tubes
6. Determination of Heat transfer coefficient in laminar flow
7. Heat transfer in turbulent flow
8. Heat transfer in agitated vessel/coils
9. Radiation heat transfer
10. Heat transfer studies in plate heat exchanger
11. Heat Transfer studies in fluidized bed

XX XXXP Civic and Social Services Internship							
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Report Writing	V/V	Total
--	--	--	3	--	80	20	100
Duration: three weeks after second semester Examination of CSSI will be conducted in III semester.							