Semester-VI (w.e.f. 2017-18)											
S N	Course No.	Course Title	Teaching Schedule				Allotment of Marks				Dur. of Exam (Hrs.)
			L	T	P	Hr/ Wk	Theory	Sessional	Practical	Total	
1	CHE-302 N	Mass Transfer-II	4	1	0	5	75	25	0	100	3
2	CHE-304 N	Chemical Reaction Engineering-II	4	1	0	5	75	25	0	100	3
3	CHE-306 N	Process Dynamics and Control	4	1	0	5	75	25	0	100	3
4	CHE-308 N	Numerical Methods in Chemical Engineering	4	1	0	5	75	25	0	100	3
5	CHE-310 N	Process Modeling	4	1	0	5	75	25	0	100	3
6	CHE-312 N	Mass Transfer -II(P)	0	0	3	3	0	40	60	100	3
7	CHE-314 N	Chemical Reaction Engineering-II (P)	0	0	3	3	0	40	60	100	3
8	CHE-316 N	Process Dynamics and Control (P)	0	0	2	2	0	40	60	100	3
9	CHE-318 N	Process Modeling (P)	0	0	2	2	0	40	60	100	3
		Total	**20**	**5**	**10**	**35**	**375**	**285**	**240**	**900**	

Note: The students will have to undergo another six weeks Industrial Training after VI sem and it will be evaluated during VII sem through submission of certified computerized report to the Head of the Department followed by viva-voce, seminar/presentation.

Objectives regarding Syllabus and Scheme for Bachelor degree of Chemical Engineering:

Chemical Engineering Bachelors courses such as Transfer Operations, Thermodynamics, Reaction Engineering, Process Control and Process Design help to develop a modularized understanding of these independent fields, with the expectation that the whole process is the sum of these individual parts.

Programme Objectives: The Chemical Engineering graduates will be able to:

1. Exhibit knowledge of basic sciences, concepts and principles of Chemical Engineering.
2. Comprehend, analyze, design and implement engineering systems with a focus on research, innovation and sustainability.
3. Work in multidisciplinary team & cater to the needs of process industry with appropriate safety, health & environmental issues.
4. Demonstrate effective communication skills, leadership qualities and develop into successful Entrepreneurs.

CHE-302 N	Mass Transfer-II					
Lecture	Tutorial	Practical	Theory	Sessional	Total	Time
4	1	-	75	25	100	3 (Hrs.)
Purpose	To understand the basic concept and application of Vapor Liquid equilibrium, McCabe Thiele Method , Absorption, Absorption and Extraction					
Course Outcomes						
CO1	To understand the concept of vapor liquid equilibrium, methods of distillation, McCabe Thiele method for number of plates					
CO2	To understand the concept of absorption, number of transfer units for the design of packed absorbers.					
CO3	To understand the concept of extraction, extraction efficiency, extractors.					
CO4	To understand adsorption and its characteristics, equilibrium stage wise adsorption					

Paper Setter Note: 8 questions of 15 marks each distributed in four sections are to be set taking two from each unit. The candidate is required to attempt five questions in all, taking at least one from each of the four sections.

UNIT-I

Distillation: Vapour Liquid Equilibrium (VLC) data for binary mixtures, principles of distillation. Distillation methods: Flash distillation, Steam distillation. Differential distillation of binary systems. McCabe Thiele method for number of plates. Reflux ratio. Multiple feed. Intermediate product with drawn ,Plate efficiency. Packed distillation columns azeotropic and extractive distillation. Introduction to multi component distillation.

UNIT-II

Absorption: Equilibria for absorption system, use of Raoult's law, Henry's Law for solubility predictions, selection of absorbent. Limiting liquid/gas ratios. Absorption factors use in design of plate absorbers. Kremsers equations. Concept of transfer units for the design of packed absorbers.

UNIT-III

Liquid Extraction: Single and multistage extraction. Determination of number of equilibrium stage by graphical methods. Liquid- Liquid extraction: Equilibrium relationship for partially miscible and immiscible system. Selectivity and choice of solvent.
Determination of number of stages by graphical methods. Exraction efficiency. Constructional details of mixer settler. Pulsed reactor, sieve tray extractor, Bollman extractor.

UNIT-1V

Adsorption: Adsorption, types of Adsorption characteristics of adsorbents. Adsorption equilibrium stage wise and continuous contacting of fluid and solid phase.

TEXT BOOKS:

1. Mass Transfer Operations, R.E.Treybal, McGraw hill Book Company, New Delhi.
2. Mass Transfer by T.K.Sherwood, R.L.Pigford and C.P.Wilke. McGraw Hill (1975).

REFERENCE BOOKS:

1. Unit Operations of Chemical Engineering: W.L. McCabe and J.C. Smith, McGraw Hill, New Delhi.
2. Chemical Engineering: J.M. Coulson and J.F. Richardson Vol. 1, Pergamon, New York.

CHE-304 N	Chemical Reaction Engineering-II					
Lecture	Tutorial	Practical	Theory	Sessional	Total	Time
4	1	-	75	25	100	3 (Hrs.)
Purpose	To understand the concept of semi batch reactor, non ideal reactor, catalyst and catalysis, porous catalyst and designing of fixed and packed back reactor.					
Course Outcomes						
CO1	To understand the concept semi batch reactor and models for non ideal raector.					
CO2	To understand the basic concept catalyst, types of catalyst and characteristics of catalyst					
CO3	To familiarize with the concept of porous solids and design for gas-liquid and gas-solid non-catalytic reactor					
CO4	To familiarize with the concept of design of fixed bed and packed bed reactor.					

Paper Setter Note: 8 questions of 15 marks each distributed in four sections are to be set taking two from each unit. The candidate is required to attempt five questions in all, taking at least one from each of the four sections.

UNIT- I

Design equations for semi-batch reactor, concepts of non-ideality. Age Distribution function and interrelationship, Models for non-ideal flow patterns, estimation of parameters.

UNIT-II

Introduction to catalysis, Classification of catalysts. Preparation and physical characteristics of solid catalyst, concept of physical adsorption and chemisorptions.

UNIT-III

Diffusion of mass and heat in porous solids with and without external diffusion resistance, Effectiveness factor, Fluid- fluid reaction modeling based on film and penetration theory. Enhancement factor. Reactor system and design for gas-liquid and gas-solid non-catalytic systems.

UNIT- IV

Fixed bed catalytic reactors, single and multibed adiabatic reactors, multitublar fixed bed reactors. Design equations for fixed bed reactors using pseudo homogeneous one and two-dimensional models , Design aspects of fluidized bed reactors.

TEXT BOOKS:

1. Chemical Reaction Engineering: Octave LEVENSPIEL Whiley Eastern Limited, New Delhi.
2. Elements of Chemical Reaction Engineering, H.Scott Fogler- Prentice Hall of India Pvt. Ltd.New Delhi.

REFERENCE BOOKS:

1. Kinetics and mechanisms of Chemical Transformation, J. Rajaram and J.C. Kuriacose- MGH,N.Delhi.
2. Chemical Engineering Kinetics, J.M.Smith, McGraw Hill Book Company, New Delhi

CHE-306 N	Process Dynamics and Control					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
4	1	-	75	25	100	3 (Hrs.)
Purpose	To provide the knowledge and information about the laplace transformation, controllers, stability, Ziegler- Nichols Controller settings					
Course Outcomes						
CO1	To familiarize about the Laplace Transformation, first order systems and transportation lag					
CO2	To familiarize about Linear closed-loop systems, control systems, Controllers					
CO3	To understand the Stability, Routh Test of stability, Root Lacus					
CO4	To familiarize with the Controller tuning and testing of sine wave and step wave					

Paper Setter Note: 8 questions of 15 marks each distributed in four sections are to be set taking two from each unit. The candidate is required to attempt five questions in all, taking at least one from each of the four sections.

UNIT-I

Laplace Transformation, Inversion by partial fractions. Properties of transform, Linear Open-loop System, Response of first-order systems, physical examples of first order system, response of first order systems and Transportation Lag.

UNIT-II

Linear closed-loop systems control systems, Controllers and Final control elements, closed-loop Transfer functions. Transient response of Simple control Systems Control valve, Construction, valve sizing and characteristics.

UNIT –III

Stability, Route Test of stability, Root Locus. Introduction to Frequency Response, Bode diagram, Gain Margins and Phase Margins.

UNIT –IV

Controller Tuning (Ziegler- Nichols Controller settings), Process identification, Identification methods: Step test data, Sine Wave testing, Pulse testing, Introduction to advanced control technique, cascade control, ratio control, overwrite control, feed forward control, Auto tuning.

TEXTBOOKS:

1. Process Systems Analysis and Control, D.R.Coughanowr McGraw Hill.
2. Essentials of Process Control: William Luyben, Michael L. Luyben McGraw Hill.

REFERENCE BOOKS:

1. Process Dynamics and Control, J.M.Douglas, Prentice Hall of India, New Delhi.
2. An Introduction to Process Dynamics and Control, T.W.Web John Wiley.
3. Chemical Process Control- An Introduction to Theory and Practice, G.Stephan Opoulos- PHI, New Delhi.

CHE-308 N	Numerical Methods in Chemical Engineering					
Lecture	Tutorial	Practical	Theory	Sessional	Total	Time
4	1	-	75	25	100	3 (Hrs.)
Purpose	To understand the concept of types of errors, Eigen values and Eigen vectors of matrices, Non linear algebraic equations, Function evaluation, Ordinary differential equations					
Course Outcomes						
CO1	To Introduce the concept of error, linear algebraic equations					
CO2	To familiarize with the Eigen values and Eigen vectors of matrices, non linear algebraic equations					
CO3	To understand the Linear Regression, Interpolation and Extrapolation Technique					
CO4	To familiarize with the Ordinary Differential Equations					

Paper Setter Note: 8 questions of 15 marks each distributed in four sections are to be set taking two from each unit. The candidate is required to attempt five questions in all, taking at least one from each of the four sections.

UNIT-I

Errors: Classification, significant digits and numerical stability.
Linear algebraic equations: Cramer's rule, Gauss Elimination and LU Decomposition Gauss-Jordan elimination, Gauss-Seidel and Relaxation Methods.

UNIT-II

Eigen values and eigenvectors of matrices: Faddeev Leverrier's Method, Power Method
Non linear algebraic equations: Single variable successive substitutions (Fixed Point Method), Multivariable successive substitutions, single variable Newton-Raphson Technique, Multivariable Newton-Raphson Technique.

UNIT-III

Function evaluation: Least squares curve-fit (Linear Regression), Newton's interpolation formulae (equal intervals), Newton's Divided Difference Interpolation Polynomial, Lagrangian Interpolation Unequal intervals), differentiation formulae, Integration formulae or Quadratures (Trapezoidal, Simpson's 1/3 and 3/8 rules), Extrapolation Technique of Richardson and Gaunt

UNIT-IV

Ordinary differential equations: Initial value problems; ode-ivps The Finite difference Technique

TEXT BOOKS

1. Numerical methods with programming in 'C', T. Veerarajan, and T. Ramachandran, TMGH(2007).
2. Numerical Methods for Scientists and Engineers , Sankara Rao K, 3rd edition PHI, New Delhi, (2007).

REFERENCE BOOKS:

1. Numerical Methods for Engineers, S.C. Chapra and R.P. Canale, 5th Edition, TMGH, New Delhi, 2007.
2. Numerical Methods in Engineering and Science, B.S. Grewal, and,J.S. Grewal, 6th Ed,Khanna Pub.2004.

CHE-310 N	Process Modeling					
Lecture	Tutorial	Practical	Theory	Sessional	Total	Time
4	1	-	75	25	100	3 (Hrs.)
Purpose	To understand mathematical models of heat transfer, mass transfer, fluid flow, process dynamics and control					
Course Outcomes						
CO1	To understand the scope of mathematical model and transport equations					
CO2	To understand the mathematical model of batch reactor and multicomponent flash drum					
CO3	To understand Mathematical Modeling of Mass Transfer and Heat transfer Processes					
CO4	To familiarize with mathematical modeling of interacting and non interacting system					

Paper Setter Note: 8 questions of 15 marks each distributed in four sections are to be set taking two from each unit. The candidate is required to attempt five questions in all, taking at least one from each of the four sections.

UNIT-I

Introduction: Uses of mathematical models. Scope of coverage. Principles of formulations
Fundamental Laws: Continuity equations, energy equations, equations of motion, Transport equations, equation of state, equilibrium. Chemical kinetics.

UNIT-II

Mathematical Models: Series of isothermal CSTR & constant hold-up CSTR's, CSTR's With variable hold ups two heated tanks, gas phase pressurized CSTR' Non isothermal CSTR & single component vaporizer, multicomponent flash drum, batch reactor with Mass transfer.

UNIT –III

Mathematical Modeling of Mass Transfer and Heat transfer Processes: Ideal binary distillation column multi component non ideal distillation column, batch distillation with hold up, liquid extraction, absorption, adsorption, heat exchanger.

UNIT-IV

Interacting and Non-Interacting Systems: Real CSTR modeled with and exchange volume Real CSTR modeled using by passing and dead space. Two CSTR's with interchange.

TEXT BOOKS:
1. Process Modeling and Simulation Control for Chemical Engineering by luynben McGraw Hill.
2. Elements of Chemical Reaction Engineering by Fogler, prentice hall of India

REFERENCE BOOK:
1. Process optimization in chemical Engineer in by Edger Himmelblau.

CHE-312 N	Mass Transfer –II (P)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
-	-	3	60	40	100	3 (Hrs.)
Purpose	To provide knowledge about operation of adsorption and absorption, solid- liquid extraction, distillation column					
Course Outcomes						
CO1	To understand Batch distillation equation for known number of plates					
CO2	To familiarize operation of adsorption and absorption					
CO3	To understand how to calculate number of plates in distillation column experimentally					
CO4	To understand the concept of solid- liquid extraction					

LIST OF EXPERIMENTS:

1. To estimate the batch distillation for a binary system and verify batch distillation equation for a known number of plate
2. To operate the column under different reflux conditions
3. To operate the column under total reflux conditions and estimate the minimum number of theoretical plates required
4. To calculate the percentage of recovery of phenol by using activated carbon as adsorbent
5. To study the effect of various system parameters like solvent temperature , solvent rate and particle size on the % recovery of oil from solid and determine the volume mass transfer coefficient in solid liquid extraction
6. To study absorption of CO_2 in aqueous NaOH solution in a sieve plate column
7. Calculate the overall mass transfer coefficient (absorption)

CHE-314 N	Chemical Reaction Engineering-II (P)					
Lecture	**Tutorial**	**Practical**	**Practical**	**Sessional**	**Total**	**Time**
-	-	3	60	40	100	3 (Hrs.)
Purpose	To provide practical knowledge of the Trickle Bed Reactor, RTD curve for a Packed Bed Reactor, Saponification Reaction in PFR Reactor					
Course Outcomes						
CO1	Student will be able to determine hydrodynamics of Trickle Bed Reactor					
CO2	Student will be able to study the Saponification Reaction in PFR Reactor.					
CO3	Student will be able to determine the critical Reynolds's no. of a fluid flowing through a coil.					
CO4	Student will be able to study kinetics of Emulsion Polymerization of Styrene					

LIST OF EXPERIMENTS:

1. To Determine the hydrodynamics of Trickle Bed Reactor and involving the measurement of pressure drop holdup and flow regime
2. To Plot the RTD curve for a Packed Bed Reactor and determine the dispersion number
3. Performance of Semi-batch Reactor to Study the Second Order Saponification Reaction between Ethyl Acetate and NaOH
4. Study the Saponification Reaction in PFR Reactor and determine the reaction rate constant.
5. To Study the Saponification reaction in isothermal PFR and determine reaction rate constant
6. To determine the critical Reynolds's no. of a fluid flowing through a coil. To compare the pressure drop in a helical coil with that in straight pipe of same length inside diameter and surface roughness
7. To Study kinetics of Emulsion Polymerization of Styrene in Batch reactor under isothermal conditions

CHE-316 N	Process Dynamics and Control (P)					
Lecture	Tutorial	Practical	Practical	Sessional	Total	Time
-	-	2	60	40	100	3 (Hrs.)
Purpose	To provide the practical knowledge of First Order Linear and non linear System, interacting and non interacting system, Dynamic characteristics of Control Valve					
Course Outcomes						
CO1	Students will be able to Compare dynamics of First Order and Second Order System Linear System					
CO2	Students will be able to know dynamics of First Order linear and non Linear System					
CO3	Students will be able to know dynamics of Interacting System and non interacting system.					
CO4	Students will be able to study Dynamic characteristics of Control Valve					

LIST OF EXPERIMENTS:

1. Comparison between dynamics of First Order and Second Order System Linear System
2. To Study dynamics of First Order Linear System
3. To Study dynamics of First Order Non Linear System
4. To Study dynamics of dynamics of Manometer
5. To Study dynamics of Non Interacting System
6. To Study dynamics of Interacting System
7. To Study dynamics of Level Trainer
8. To study the Dynamic characteristics of Control Valve
9. To Study dynamics of Temperature Trainer

CHE-318 N	Process Modeling (P)					
Lecture	Tutorial	Practical	Practical	Sessional	Total	Time
-	-	2	60	40	100	3 (Hrs.)
Purpose	To provide the knowledge of mathematical modeling of mass transfer, heat transfer equipments and reactors in Chemical Reaction Engg.					
Course Outcomes						
CO1	Students will be able to know the concept of Drag coefficient, Sedimentation, Size reduction.					
CO2	Students will be able to know the principle and working of grinding in a ball mill, separation of dust particles from air and filtration of slurry.					
CO3	Students will be able to know the solid separation techniques and size distribution of particles					
CO4	Students will be able to determine the pressure drop in a packed bed.					

LIST OF EXPERIMENTS:

1. To Model and Simulate a Gravity Flow Tank Using Euler Integration
2. To Model and Simulate Three CSTR in Series Using Euler Integration
3. To Model and Simulate a Non Isothermal CSTR
4. To Model and Simulate Binary Distillation Column
5. To Model and Simulate a Batch Reactor
6. To Model and Simulate Two Non Interacting Tank in Series
7. To Model and Simulate Two Interacting Tank in Series