DEPARTMENT OF TECHNOLOGY,
SHIVAJI UNIVERSITY KOLHAPUR
THIRD YEAR B.TECH
Scheme of Teaching and Examination: Semester- V (Chemical Technology)

Subject Code	Subject	Teaching Scheme with Credits (Hours / Week)				Examination Scheme (Marks)					
						Theory			Practical		
		L	T	P	Credits	Scheme	Max. marks	Min. Passing	Scheme	Max. marks	Min. Passing
CH311	Thermal Engineering and Plant Utilities	04	-	-	04	CIE	50	20	-	-	-
						SEE	50	20	-	-	-
CH312	Chemical Reaction Engineering-I	03	01	-	04	CIE	50	20	-	-	-
						SEE	50	20	-	-	-
CH313	Inorganic Chemical Technologies	04	-	-	04	CIE	50	20	-	-	-
						SEE	50	20	-	-	-
CH314	Safety in Chemical Industry	03	-	-	03	CIE	50	20	-	-	-
						SEE	50	20	-	-	-
CH315	Mass Transfer Operations-I	04	01	-	05	CIE	50	20	-	-	-
						SEE	50	20	-	-	-
CH312L	Chemical Reaction Engineering-I Laboratory	-	-	02	01	-	-	-	IPE	50	20
CH315L	Mass Transfer Operations-I Laboratory	-	-	02	01	-	-	-	IOE	50	20
									EPE	50	20
CH316L	Case Studies and seminar	-	01	-	01	-	-	-	IOE	50	20
HS317L	Industrial Safety and Hazard Management Laboratory	-	-	02	01	-	-	-	EOE	50	20
CH318I	Internship I	-	-	-	01	-	-	-	EOE	50	20
	Total	**18**	**03**	**06**	**25**	-	**500**	-	-	**300**	-

Audit Course III											
LS311	Introduction to Foreign Language	**02**	-	-	-	Institute Level	-	-	-	-	-

Total contact hours per week: **27+2=29 and Total Credits=25**

CIE: Continuous Internal Evaluation SEE: Semester End Examination IPE: Internal Practical Evaluation
EPE: External Practical Examination IOE: Internal Oral Evaluation EOE: External Oral Examination

Note: **1.** Tutorials and Practical to be conducted in batches with batch strength not exceeding 15 students.

2. Under the title of 'Case Studies and seminar', every individual student has to select a technical and field relevant case study for seminar and he or she has to deliver the same in the class. This particular activity is equivalent to one Credit and it carries 50 marks as an Internal Oral Evaluation (IOE) which is included in Semester V. The students, besides the seminar delivery, have to submit a brief report (in specified format) on the chosen seminar topic.

3. Internship I, an activity performed after Semester IV will be evaluated as the part of Semester V. It is mandatory for all the students to submit to the institute, the Internship Report duly certified by the concerned organization.

DEPARTMENT OF TECHNOLOGY,
SHIVAJI UNIVERSITY KOLHAPUR
THIRD YEAR B.TECH
Scheme of Teaching with Credits: Semester- V (Chemical Technology)

Subject Code	Subject	Teaching Scheme with Credits (Hours / Week)			
		L	**T**	**P**	**Credits**
CH311	Thermal Engineering and Plant Utilities	04	-	-	04
CH312	Chemical Reaction Engineering-I	03	01	-	04
CH313	Inorganic Chemical Technologies	04	-	-	04
CH314	Safety in Chemical Industry	03	-	-	03
CH315	Mass Transfer Operations-I	04	01	-	05
CH312L	Chemical Reaction Engineering-I Laboratory	-	-	02	01
CH315L	Mass Transfer Operations-I Laboratory	-	-	02	01
CH316L	Case Studies and seminar	-	01	-	01
HS317L	Industrial Safety and Hazard Management	-	-	02	01
CH318I	Internship I	-	-	-	01
	Total	**18**	**03**	**06**	**25**

Audit Course III

LS311	Introduction to Foreign Language	**02**	**-**	-	Nil

Total contact hours per week: **27+2=29 and Total Credits=25**

DEPARTMENT OF TECHNOLOGY,
SHIVAJI UNIVERSITY KOLHAPUR
THIRD YEAR B.TECH

Scheme of Teaching and Examination: Semester- VI (Chemical Technology)

Subject Code	Subject	Teaching Scheme with Credits (Hours / Week)				Examination Scheme (Marks)					
						Theory			Practical		
		L	T	P	Credits	Scheme	Max. marks	Min. Passing	Scheme	Max. marks	Min. Passing
CH321	Chemical Reaction Engineering-II	04	01	-	05	CIE	50	20	-	-	-
						SEE	50	20	-	-	-
CH322	Industrial Pollution Control	03	-	-	03	CIE	50	20	-	-	-
						SEE	50	20	-	-	-
CH323	Mass Transfer Operations-II	04	-	-	04	CIE	50	20	-	-	-
						SEE	50	20	-	-	-
CH324	Organic Chemical Technologies	03	-	-	03	CIE	50	20	-	-	-
						SEE	50	20	-	-	-
CH325	Process Instrumentation and Control	04	-	-	04	CIE	50	20	-	-	-
						SEE	50	20	-	-	-
CH321L	Chemical Reaction Engineering-II Laboratory	-	-	02	01	-	-	-	EPE	50	20
CH323L	Mass Transfer Operations-II Laboratory	-	-	02	01	-	-	-	EPE	50	20
CH324L	Organic Chemical technologies Laboratory	-	-	02	01	-	-	-	IPE	50	20
CH325L	Process Instrumentation and Control Laboratory	-	-	02	01	-	-	-	IOE	50	20
CH326L	Mini Project	-	01	-	01	-	-	-	EOE	50	20
CH327	Industrial Visits	-	-	-	01	-	-	-	IOE	50	20
	Total	**18**	**02**	**08**	**25**	-	**500**	-	-	**300**	-

Audit Course IV											
RM321	Research Methodology	**02**	-	-	-	Institute Level	-	-	-	-	-

Total contact hours per week: **28+2=30 and Total Credits=25**

CIE: Continuous Internal Evaluation SEE: Semester End Examination IPE: Internal Practical Evaluation
EPE: External Practical Examination IOE: Internal Oral Evaluation EOE: External Oral Examination

Note: **1.** Tutorials and Practical to be conducted in batches with batch strength not exceeding 15 students

2. Mini project work carried out by a group of students (Preferably maximum 4 students in a group) throughout the semester will be evaluated as an EOE by an external examiner/s. Mini Project report submission and oral presentation by the group is mandatory. The work throughout the semester will be under the supervision of internal teachers with one tutorial per week.

3. There will be at least two industrial visits to reputed chemical industry (1-2 days) in the sixth week of the semester VI. The students will submit a report of the visits. This particular activity is equivalent

to one Credit and it carries 50 marks as an Internal Oral Evaluation (IOE) which is included in Semester VI. For submission of the visit report, the students will follow one specific format.

3. Internship II which is part of Semester VII evaluation will be the activity after the SEE of semester VI. It is mandatory for all the students to undergo the same and report to the institute for the semester VII along with the completion certificate by the concerned organization. The students have to submit a hard as well as soft copy of the activity report to the institute

DEPARTMENT OF TECHNOLOGY,
SHIVAJI UNIVERSITY KOLHAPUR
THIRD YEAR B.TECH

Scheme of Teaching with Credits: Semester- VI (Chemical Technology)

Subject Code	Subject	Teaching Scheme with Credits (Hours / Week)			
		L	**T**	**P**	**Credits**
CH321	Chemical Reaction Engineering-II	04	01	-	05
CH322	Industrial Pollution Control	03	-	-	03
CH323	Mass Transfer Operations-II	04	-	-	04
CH324	Organic Chemical Technologies	03	-	-	03
CH325	Process Instrumentation and Control	04	-	-	04
CH321L	Chemical Reaction Engineering-II Laboratory	-	-	02	01
CH323L	Mass Transfer Operations-II Laboratory	-	-	02	01
CH324L	Organic Chemical technologies Laboratory	-	-	02	01
CH325L	Process Instrumentation and Control Laboratory	-	-	02	01
CH326L	Mini Project	-	01	-	01
CH327	Industrial Visits	-	-	-	01
	Total	**18**	**02**	**08**	**25**

Audit Course IV

RM321	Research Methodology	**02**	-	-	-

Total contact hours per week: **28+2=30 and Total Credits=25**

Detailed Evaluation and Examination Scheme

1. Out of total 100 theory marks, 50 marks are assigned for Continuous Internal Evaluation (CIE). In CIE, obtaining minimum 20 marks is essential. It is similar to term work, the completion of which is mandatory to become eligible to appear for the Semester End Examination (SEE). Failing to complete the term in a particular course i.e. not obtaining 20 marks in CIE out of 50 shall be treated as term not granted in that course and it is on the part of the course teacher to officially inform the particular case through the respective Program Coordinator and the Director to the University Examination Section. The section will take a kind note of the same and it will not issue the hall ticket of the particular students for the SEE in the particular course/s.
2. CIE (50 marks) includes :
    - Internal Test - I, of 20 marks in 5^{th} week on 1^{st} & 2^{nd} unit
    - Internal Test - II, of 20 marks in 10^{th} week on 3^{rd} & 4^{th} unit
    - Activities for the students: 10 marks. It is at the course teachers' discretion to get the assignments of varied nature completed by the students. However, the course teacher will plan to cover those course objectives that suit course learning outcomes and program outcomes that may not be covered in the internal tests.
3. For the Semester End Examination (SEE), 100 marks (3 hours) paper will be set and finally it will be converted to 50 marks. The students must secure minimum 40 % i.e. 20 marks in SEE as the University examination passing head.
4. Final theory marks (out of 100) will be the addition of CIE (out of 50 marks) and SEE (out of 50 marks).
5. Internal Practical/Oral Evaluation (IPE/IOE) will be on the basis of Internal Oral/ Practical/Tutorials/Seminar in which students must secure minimum 40% i.e. 20 marks. It is similar to the term work, the completion of which is mandatory to be eligible to appear for the Semester End Examination (SEE).
6. External Practical/Oral Examination (EPE/EOE) will be conducted under the supervision by some external course expert. The minimum score 40% i.e. 20 marks is required to be secured as the University's passing head in EPE/EOE.
7. *Semester End Examination duration will be 4 hr.

8. Equivalence for the Course: As elaborated at the end of this whole curriculum document.

Academic Autonomy:

1. Flexibility in deciding Structure and Contents of Curriculum with reasonable frequency for changes in the same.
2. Continuous Assessment of Students performance with newly adopted - Credit System based on award of grade.
3. Credits are simply a means of attaching relative values to courses of different components. These are a currency of learning and in general regarded as a measure of the time typically required to achieve a given curricular outcome.
4. All courses (Courses) under each Program/Discipline are unitized.

Credit system:

Education at the Institute is organized around the semester-based credit system of study. The prominent features of the credit system are a process of continuous evaluation of a student's performance/progress and flexibility to allow him/her to progress at an optimum pace suited to his/her ability or convenience. Each course by every student needs to fulfill minimum requirements of credits for continuation.

A student's performance/progress is measured by the number of credits that he/she has earned, i.e. completed satisfactorily. Based on the course credits and grades obtained by the student, grade point average is calculated. A minimum grade point average is required to be maintained for satisfactory progress and continuation in the Program. Also a minimum number of earned credits and a minimum grade point average should be acquired in order to qualify for the degree. All Programs are defined by the total credit requirement and a pattern of credit distribution over courses of different categories.

Course credits assignment:

Each course, except a few special courses, has a certain number of credits assigned to it depending upon its lecture, tutorial and laboratory contact hours in a week. This weightage is also indicative of the academic expectation that includes in-class contact and self-study outside of class hours.

Lectures and Tutorials: One lecture or tutorial hour per week per semester is assigned one credit.

Practical/Laboratory: One laboratory hour per week per semester is assigned half a credit.

Example: Course: Chemical Reaction Engineering -I: 5 credits (3-1-2)

The credits indicated for this course are computed as follows:

3 hours/week lectures = 3 credits

1 hours/week tutorial = 1 credit

2 hours/week practical = 2 *x* 0.5 = 1 credit

The contact hours in this case of **5** credits course is 6 hours per week. (3 h Lectures + 1 h Tutorial + **2** h Practical=6 hours per week.)

For each lecture or tutorial and practical credit, the self study component is 1 hour/week per credit. In the above example, the student is expected to devote 3 + 1+1 = 5 hours per week on self study for this course, in addition to class contact of 6 hours per week.

Earning credits:

At the end of every course, a letter grade is awarded in each course for which a student had registered. On obtaining a pass grade, the student accumulates the course credits as earned credits. A student's performance is measured by the number of credits that he/she has earned and by the weighted grade point average.

The credit system enables continuous evaluation of a student's performance and allows the students to progress at an optimum pace suited to individual ability and convenience.

Features of Credit System at Shivaji University, Kolhapur:

Every course is allotted credits based on its academic importance/weightage.

1. All Courses may not have same credits.
2. There will be 23 to 28 Credits / Semester.
3. Absolute Grading System with 7 Passing Grades viz. AA, AB, BB, BC, CC, CD, DD and FF for failure.
4. Getting FF grade in 4 heads in one academic year, he/she is considered as failed.
5. Continuous Evaluation: Internal Test I i.e. T_1 [20 marks], and Internal Test II i.e. T_2 [20 marks]. Activities will be for 10 marks and the course owner/in charge will have discretion to decide the nature of activities.
6. Standardization of courses: Each course is unitized in 6 numbers. Internal Test I on units I and II while Internal Test II on units III & IV, SEE will be based on all the units of the course curriculum.
7. Internal Test I & Internal Test II will be supervised and evaluated by internal course teachers while SEE will be evaluated mostly by external and internal teachers as joint examiner ships.
8. Any request for re-test will not be entertained after internal test.
9. For both the semesters' failure courses, re-examination will be only after the even Semester End Examination. No re-examination will be conducted for odd semester courses in even semester or vice-versa.

Attendance rule:

All students must attend every lecture, tutorial and practical class. However, to account for late registration, sickness or other such conditions, the attendance requirement will be a minimum of 75 % of the classes actually held. A student with less than 75 % attendance in a course during the semester, in lectures, tutorials and practical taken together (as applicable), will be awarded the 'F' grade in that course irrespective of his/her performance in the tests.

Taking into account the consolidated attendance record for the whole semester, the course in charge in consultation with the Program Coordinator will award 'XX' grade to the student who is deficient in attendance. For the purpose of attendance calculation, every scheduled practical class will be counted as one unit irrespective of the number of contact hours.

Attendance record will be maintained based upon roll calls (or any equivalent operation) in every scheduled lecture, tutorial and practical class. The course owner will maintain and consolidate attendance record for the course (lectures, tutorials and practical together, as applicable).

Evaluation system:

1. Semester Grade Point Average (SGPA) =

$$\frac{\sum (\text{course credits in passed courses X earned grade points})}{\sum (\text{Course credits in registered courses})}$$

2. Cumulative Grade Point Average (CGPA) =

$$\frac{\sum (\text{course credits in passed courses X earned grade points) of all Semesters}}{\sum (\text{Course credits in registered courses) of all Semesters}}$$

3. At the end of B. Tech Program, student will be placed in any one of the divisions as detailed below:

   I^{st} Division with distinction: CGPA $\geq$ 8.25 and above

   I^{st} Division : CGPA $\geq$ 6.75 and < 8.25

   II^{nd} Division : CGPA $\geq$ 6.25 and < 6.75

As per AICTE Handbook (2011-12), gradation is as follows:

Grade Points	Equivalent Percentage Range
6.25	55
6.75	60
7.25	65
7.75	70
8.25	75

Conversion of CGPA to corresponding equivalent percentage marks for CGPA>5.0 may be obtained using the following equation:

Equivalent Percentage marks = (Respective CGPA x 10) – 7.5

A specimen example of these calculations is given below:

Typical academic performance calculations - I semester

Course no.	**Course credits**	**Grade awarded**	**Earned credits**	**Grade points**	**Points Secured**
Col 1	Col 2	Col 3	Col 4	Col 5	Col 6 (Col 4* Col 5)
MALXXX	5	CC	5	6	30
CSLXXX	4	CD	4	5	20
PHLXXX	4	AA	4	10	40
PHPXXX	2	BB	2	8	16
MELXXX	4	FF	0	0	0
TTNXXX	2	AB	2	9	18
Total	21		17	38	124

1. Semester Grade Point Average (SGPA) =

$$\frac{(124)}{(21)} = 5.90$$

2. Cumulative Grade Point Average (CGPA) =

Cumulative points earned in all passed courses = 124 (past semesters) + 124 (this sem.) = 248 Cumulative earned credits = 23 (past semesters) + 21 (this sem.) = 44

$$\frac{\sum (124 + 124)}{\sum (23 + 21)} = 5.63$$

Chart for marks range and its corresponding grade and grade points

Marks Range	Grade Points	Grade	Description of Performance
91-100	10	AA	Outstanding
86-90	09	AB	Excellent
76-85	08	BB	Very Good
66-75	07	BC	Good
56-65	06	CC	Fair
46-55	05	CD	Average
40-45	04	DD	Poor
Below 40	00	FF	Fail
--	--	$	Passed in first attempt
--	--	PP	Passed (Audit Course)
--	--	NP	Not Passed (Audit Course)
--	--	** 2^{nd} *** 3^{rd} **** 4^{th}	One grade punishment for 2^{nd} ,3^{rd}, 4^{th}, …attempt,

Audit Courses:

Additional courses shall be included as audit courses from the third semester onwards. While the performance of the student in audited courses shall be included in the Grade Card, these grades do not contribute to SGPA or CGPA of the concerned student.

Award of Degree:

Following rules prevail for the award of degree:

1. A Student has registered and passed all the prescribed courses under the general institutional and departmental requirements.
2. A student has obtained CGPA$\geq$ 4.5.
3. A student has paid all the institute dues and satisfied all the requirements prescribed.
4. A student has no case of indiscipline pending against him/her.
5. Institute authorities shall recommend the award of B.Tech degree to a student who is declared to be eligible and qualified for above norms.

CGPA Improvement Policy for award of degree:

An opportunity shall be given to a student who has earned all the credits required by the respective program with CGPA greater than or equal to 4.00 but less than 4.50, to improve his/her grade by allowing him/her to appear for 100% examinations of maximum two theory courses of seventh and eighth semester. However, CGPA shall be limited to 4.5 even though the performance of a student as calculated through modified CGPA becomes greater than 4.5.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology) Part III, Semester V**				
Course Title	:	**Thermal Engineering and Plant Utilities**		*Course Code*:	:	**CH 311**
Teaching Scheme (Hours)	:	**4 hours/Week=4 x 13 Weeks= 52 hr minimum** **Tutorial= Nil** **Practical= Nil**		*Total Credits*	:	**04+00+00=04**
Evaluation Scheme (Marks)	:	**CIE= 20+20+10=50** **SEE= 50**	:	**Grand Total=100**	*Duration of SEE*	: **3 hours**
Revision:	:	**Third**			*Month*	: **June 2018**

Pre-requisites : In order to complete the course studies successfully, it is important to have a good command of English. Other Pre-requisites include knowledge of Thermodynamics, Refrigeration and Heat transfer.

Type of Course : Theory

Course Domain : Applied (Engineering) Sciences

Skills Imbibed : Cognitive: Recall, Understand, Apply, Analyze, Synthesize, Evaluate
Affective : Awareness, Respond, Value, Organize
Psychomotor: Imitation, manipulation, articulation, naturalization

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I & Unit Test II, Activities like regular tutorial, home assignments.
2. Semester End Examination.

Course Objectives:

1. To state the principles involved during water treatment, generation of steam and its uses.
2. To describe the different equipment used to run the process plant with different utilities.
3. To acquire the knowledge for selection of different utilities generation, psychometric operation and refrigeration.
4. To understand about steam traps and economizers.
5. To describe the different types of pumps and compressors
6. To provide students a strong background in the concept of solar engineering, solar energy and alternative energy.
7. To provide students a strong background in the air conditioning practices theory, basic principles and design of air conditioning systems.
8. To acquire the knowledge about inert gases and their production.

Course Outcomes: At the end of the course, the students will be able to :

1. Apply knowledge of mathematics, science and engineering for identifying and calculating the requirement of utilities in the industrial operations.
2. Explain refrigeration cycles.

3. Describe working and properties of different pumps and compressors.
4. Explain boilers and their types with their working.
5. This course will provide a gist of the theory behind the Air conditioning and will emphasize direct applications of theory to design of an Air conditioning system.
6. Apply the general principles of psychometric and applied psychometrics in Air conditioning with knowledge of load estimation, equipment selection, duct design etc.
7. Apply the general principles of solar thermal engineering to design solar energy harnessing devices and make professionals in power and energy industry fields.
8. Explain importance of inert gases and industrial inerting.

Curriculum Content	Hours
Unit: I Introduction to the course: List of various process utilities, their role and importance in chemical plants. Introduction to thermal energy applications.	**03**
Unit: II Thermal energy storage: Sensible heat storage, latent heat storage thermo chemical storage. Solar Water heater: Collection cum storage water heater, Natural circulation & forced circulation water heater, shallow solar ponds, Passive Solar House: Thermal gain, Thermal cooling, Ventilation Energy Storage: Sensible heat storage, Liquid, Solid, packed bed, Latent heat storage. Solar Distillation, Solar Cookers, Solar Refrigeration.	**08**
Unit: III Steam and Boilers: Steam generation and its application in chemical process plants, distribution and utilization, design of efficient steam heating systems, steam economy, condensate utilization, steam traps, their characteristics, selection and application, waste heat utilization. Classification of Boilers: Fire tube and water tube boilers Tube shape and position, firing, Head Sources, Fuel, Fluid, circulation, furnace position, furnace type, General Shape, Boiler mountings and accessories, Boiler draught.	**08**
Unit: IV Compressors and Pumps: Basic types of compressors and pumps and their performance characteristics. Study of vacuum pumps, Methods of vacuum development and their limitations, materials handling under vacuum, piping systems, lubrication and oil removal in compressors and in pumps.	**07**
Unit :V Refrigeration Systems and Insulation: Refrigeration systems, humidification and dehumidification equipments, drying and cooling tower, air blending, exhaust, ventilation, cryogenics, Importance of insulation for the process equipments, insulation materials and their effect on various materials of equipment, piping, fitting and valves, insulation for high, intermediate, low and sub zero temperatures including cryogenic insulation, determination of optimum insulation thickness.	**07**

Unit: VI Inert gases: Introduction**,** properties of inert gases and their use, sources and methods of generation, comparison of nitro generation routes, and general arrangement for inert gases. **08**

Text Books :

1. S P Sukhatme: Solar Energy
2. Eckenfelder, W. W, Jr. "Industrial Water Pollution Control" McGraw-Hill: New York, 1966.
3. P. L. Ballaney, "Thermal Engineering", Khanna Publisher New Delhi, 1986.
4. Perry R. H. Green D. W. "Perry's chemical Engineer's Handbook", McGraw Hill, New York, 2007.

Reference Books :

1. Jack Broughton, Process utility systems, Institution of Chemical Engineers U.K.
2. Reid, Prausnitz poling, The properties of gases and liquids, IV edition, McGraw-Hill International edition.
3. S.C.Arora & S.Domkumdwar, A course in refrigeration and air conditioning, Dhanpat Rai and Co. (P) Ltd.
4. R.L.Ballaney, Thermal Engineering, Khanna Publication
5. Gupta and Prakash, Engineering Thermodynamics, Nemchand and Brothers, Roorkee

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester V**						
Course Title	:	**Chemical Reaction Engineering-I**				*Course Code*:	:	**CH 312**
Teaching Scheme (Hours)	:	**3 hours/Week=3 x 13 Weeks= 39 hr minimum** **Tutorial= 01/Week** **Practical= 02/Week**				*Credits*	:	**03+01+01=05**
Evaluation Scheme (Marks)	:	**CIE= 20+20+10=50** **SEE= 50**	**IPE=50**	:	**Grand Total=150**	*Duration of SEE*	:	**03 hours**
Revision	:	**Third**				*Month*	:	**June 2018**

Pre-requisites : Basic knowledge of Mathematics, Thermodynamics, Process Calculation, and Heat transfer besides sound background of Physical Chemistry especially Chemical Kinetics.

Type of Course : Theory

Course Domain : Core Course.

Skills Imbibed : Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I & Unit Test II, Activities like regular tutorial, home assignments.
2. Semester End Examination.

Course Objectives:

1. To provide a basic understanding of chemical reaction engineering with emphases on the applications of chemical kinetics, thermodynamics, mass and energy balances, and transport phenomena to the design and performance of chemical reactors;
2. To define various rates of chemical reaction, express the temperature dependent term of a rate equation with Arrhenius' Law and other theories;
3. To write a rate law and define reaction order and activation energy using various methods;
4. To demonstrate the ability to quantitatively predict the performance of common chemical reactors using simplified engineering models;
5. To demonstrate the ability to regress the experimental data from which they determine the kinetic model of a multi-reaction system and use this information to design a commercial reactor;
6. To design ideal reactors (batch &continuous) for various operating requirements and compare the reactor performance and systems of multiple reactors;

Course Outcomes: At the end of the course, the students will be able to

1. Apply knowledge of mathematics, science and engineering and apply basic knowledge of classification of reactions.
2. Explain kinetics of competing reactions and their influence on product yield and selectivity.

3. Thorough with fundamentals of kinetics including definitions of rate and forms of rate expressions and relationships between moles, concentration, extent of reaction and conversion.
4. Plan and interpret experimental data to determine kinetic parameters for chemical reactions
5. Derive batch, CSTR, and PFR performance equations from general material balances etc.
6. Do size and performance calculations on isothermal plug, mixed, and batch reactors for a homogeneous and heterogeneous reaction from given rate data or a rate expression.
7. Develop skills to choose the right reactor among single, multiple, recycle reactors etc.
8. Apply mathematical techniques to analyze chemical reactions.

Curriculum Content	Hours
Unit: I Introduction: Scope of Chemical Reaction Engineering. Chemical Kinetics and thermodynamics of reaction; Classification of reactions - Homogeneous and Heterogeneous reactions. Rate equation and rate of reaction. Factors affecting rate of reaction. Broad definition for homogeneous and heterogeneous reactions.	05
Unit: II Kinetics of homogeneous reactions: Irreversible and reversible reactions, Equilibrium; Order and molecularity of reaction. Elementary and non elementary reactions; Stoichiometry, fractional conversion. Rate of reaction based on all components of the reaction and their interrelation. Law of mass action, Rate Constant-Based on thermodynamic activity, partial pressure, mole fraction and concentration of the reaction components and their interrelation, Temperature dependency of rate Constant -Arrhenius law, Transition state theory and collision theory.	07
Unit: III Interpretation of batch reactor data: Batch reactor concept, Constant volume Batch reactor system; Design equation for zero, first, Second and third order irreversible and reversible reactions, graphical interpretation of these equations and their limitations, Variable volume Batch reactors. Design equation for zero, first and second order irreversible and reversible reactions, Graphical interpretation of their limitations, Introduction to catalytic and auto catalytic reactions, Rate equation concept for these reactions. Multiple reactions-stoichiometry and Rate equations for series and parallel reactions.	07
Unit: IV Ideal flow reactors: Concept of ideality. Types of flow reactors and their differences, Space-time and Space velocity. Design equation for plug flow reactor and CSTR; Design equations for first and second order reversible and irreversible constant volume and variable volume reactor, Graphical interpretation of these equations; Mean holding time; Development of rate expression for mean holding time for a plug flow reactor.	07
Unit: V Single and multiple reactor system: Size comparison of single reactors; Optimum size determination; Staging of reactors, Reactors in series and parallel; Performance of infinite	

number of back mix reactors in series, Back mix and plug flow reactors of different sizes in series and their optimum way of staging; Recycle reactors, Optimum recycle ratio for auto-catalytic (recycle) reactors. **07**

Unit: VI Design for multiple reactions: Yield and selectivity, Parallel reactions Requirements for high yield, best operating condition for mixed and plug flow reactors, Series reactions Maximization of desired product rate in a plug flow reactor and back mixed reactor.

Text Books :

1. Levenspeil, O., Chemical Reaction Engineering, 3 rd Edition, John Wiley & Sons, 2001.
2. Fogler, H. S., Elements of Chemical Reaction Engineering, 3 rd Edition, Prentice Hall, 2001.

Reference Books :

1. Smith, J.M., Chemical Engineering Kinetics, 3 rd Edition, McGraw Hill, 1984.
2. S. M. Walas, "Reaction Kinetics for Chemical Engineers", McGraw Hill, New York.
3. J. Rajaram and J. C. Kuriacose, "Kinetics and Mechanics of Chemical Transformation", McMillan India Ltd., 1993.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester V**								
Course Title	:	**Chemical Reaction Engineering- I Laboratory**						*Course Code*:	:	**CH312L**
Teaching Scheme (Hours)	:	**2 hr /Week= 2 x13= 26 hours**						*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** **IOE**	: :	**50** **Nil**	**EPE** **EOE**	: :	**Nil** **Nil**	*Duration of Exam*	:	**Not applicable**
Revision	:	**Third**						*Month*	:	**June 2018**

Pre-requisites : Laboratory work in Engineering Chemistry and Chemistry-I. Other Pre-requisites include knowledge of fluid flow, heat transfer and the stoichiometric operations.

Type of Course : Laboratory Practical

Course Domain : Core

Skills Imbibed : Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

Students are evaluated during Internal Practical Evaluation. However, their overall response during entire semester is also considered for evaluation.

Course Objectives:

1. To study reaction kinetics for single, multiple, isothermal, non-isothermal reactions and reactor design procedures;
2. To learn the underlying principles of reaction kinetics through experiments;
3. To learn to evaluate the performance of various types of reactors;

Course Outcomes: After successful completion of this course, the student will be able to:

1. Design experiments involving chemical reactors, and analyzing and interpreting data.
2. Analyze chemical reactors and reaction systems.
3. Evaluate the activation energy of the reactions.
4. Solve problems of mass transfer with reaction in solid catalyzed reactions.
5. Do design and sizing of industrial scale reactor on the basis of kinetic data obtained at lab scale.

Practical List : **(Minimum 8 experiments to be performed from the list)**

1. To calculate value of activation energy for the saponification of ethyl acetate with NaOH in batch reactor
2. To calculate value of rate constant “K” for the saponification of ethyl acetate with NaOH in batch reactor (M=1)
3. To calculate value of rate constant “K” for the saponification of ethyl acetate with NaOH in batch reactor (M=2)
4. To calculate value of rate constant “K” for the saponification of ethyl acetate with NaOH in continuous stirred tank reactor
5. To calculate value of rate constant “K” for the saponification of ethyl acetate with NaOH in plug flow

reactor

6. To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in CSTR connected in series with PFR
7. To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in PFR connected in series with CSTR
8. To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in number of CSTR's connected in series
9. To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in packed bed reactor

Reference Books :

1. Fogler, H. S., Elements of Chemical Reaction Engineering, 3 rd Edition, Prentice Hall, 2001.
2. Smith, J.M., Chemical Engineering Kinetics, 3 rd Edition, McGraw Hill, 1984.
3. S. M. Walas, Reaction Kinetics for Chemical Engineers, McGraw Hill, New York.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology) Part III, Semester V**				
Course Title	:	**Inorganic Chemical Technologies**		*Course Code*:	:	**CH 313**
Teaching Scheme (Hours)	:	**4 hours/Week=4 x 13 Weeks= 52 hours minimum** **Tutorial= Nil** **Practical= Nil**		*Total Credits*	:	**04+00+00=04**
Evaluation Scheme (Marks)	:	**CIE= 20+20+10=50** **SEE= 50**	: : **Grand Total=100**	*Duration of SEE*	:	**3 hours**
Revision:	:	**Third**		*Month*	:	**June 2018**

Pre-requisites : In order to complete the course studies successfully, it is important to have a good command of English. Other Pre-requisites include knowledge of Chemistry-I which covers the fundamental topics underlying Inorganic Chemistry.

Type of Course : Theory

Course Domain : Applied (Engineering) Sciences

Skills Imbibed : Cognitive: Recall, Understand, Apply, Analyze, Synthesize, Evaluate
Affective : Awareness, Respond, Value, Organize
Psychomotor: Imitation, manipulation, articulation, naturalization

Course Assessment Methods:
1. Continuous Internal Evaluation: Unit Test I & Unit Test II, Activities like regular tutorial, home assignments.
2. Semester End Examination.

Course Objectives:
1. To understand sources and processes of manufacture of various fuels and fuel gases required for industry;
2. To study the manufacture of various industrial gases, their properties and applications;
3. To understand importance of clean utilization of coal and advances in fuels;
4. To study process technologies of various inorganic process industries;

Course Outcomes: At the end of the course, the students will be able to:
1. Explain manufacturing of various fuels, fuel gases and industrial gases.
2. Describe various ceramic based products.
3. Explain the manufacturing of various sodium based inorganic chemicals.
4. Explain the manufacturing of various sulphur based inorganic chemicals.
5. Explain the manufacturing of various potassium based inorganic chemicals.
6. Elaborate the manufacturing of various nitrogen and ammonia based based inorganic chemicals.

7. Draw process flow diagrams/process block diagrams for the manufacture of various inorganic chemicals from process description.

Curriculum Content	Hours
Unit I Fuels, fuel gases and Industrial gases: Introduction to Chemical Manufacturing and Processing sector. Study of the role of Chemical Engineers and Technologists in the development of the nation. Study of the manufacture: water gas, producer gas, natural gas, LPG, hydrogen, oxygen, nitrogen, carbon dioxide and acetylene. Concept, types and applications of fuel cells	**10**
Unit II Ceramic industries: Basic raw materials, Chemical Conversions, White wares, Structural clay products, Manufacture of refractory, Glass raw materials, Manufacture, types and applications of glass	**06**
Unit III Salt and sodium compounds, Chlor-alkali and electrolytic industries: Manufacture of sodium chloride, sodium sulphate and byproducts. Manufacture of Soda ash, caustic soda, chlorine, bleaching powder, sodium bicarbonate, aluminum, Sodium, chlorates and per chlorates.	**07**
Unit IV Hydrochloric acid and Sulfur industries: Manufacture of hydrochloric acid, aluminum sulphate and alums. Manufacture of sulfur and sulfuric acid.	**06**
Unit V Phosphate industries and Potassium industries: Study of elemental phosphorous, raw materials and processes for phosphoric acid manufacture, Manufacture of ammonium phosphate, baking powder. Manufacture of potassium, potassium chloride, potassium sulphate and potassium nitrate.	**06**
Unit VI Nitrogen industries: Manufacture of synthetic ammonia, nitric acid, ammonium nitrate, and urea.	**06**

Text Books :

1. George T. Austin, Shreve's Chemical Process Industries, 5th edition. , McGraw Hill Book Company, 1985.
2. C.E. Dryden, Outlines of Chemical Technology, Affiliated East-West Press, 1973.

Reference Books :

1. S.D. Shukla, G.N. Pandey, A Text book of Chemical Technology, 3rd Edition
2. D.Venkteshwaralu, Chemical Technology, I & III manuals of Chemical Technology, Chemical Engineering. Ed. Dev. III Madras, 1977.
3. Perry R. H. Green D. W., Perry's chemical Engineer's Handbook, McGraw Hill, New York, 2007.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology) Part III, Semester V**				
Course Title	:	**Safety in Chemical Industry**		*Course Code*:	:	**CH 314**
Teaching Scheme (Hours)	:	**3 hours/Week=3 x 13 Weeks= 39 hr minimum** **Tutorial= Nil** **Practical= Nil**		*Total Credits*	:	**03+00+00=03**
Evaluation Scheme (Marks)	:	**CIE= 20+20+10=50** **SEE= 50**	: : **Grand Total=100**	*Duration of SEE*	:	**3 hours**
Revision:	:	**Third**		*Month*	:	**June 2018**

Pre-requisites : In order to complete the course studies successfully, it is important to have a good command of English. Other Pre-requisites include knowledge of Chemistry-I, II which covers the fundamental topics underlying Physical, Inorganic, and Organic Chemistry. Background of fluid flow, heat transfer and thermodynamics is also necessary.

Type of Course : Theory

Course Domain : Ethics, environment and Safety

Skills Imbibed : Cognitive: Recall, Understand, Apply, Analyze, Synthesize, Evaluate
Affective : Awareness, Respond, Value, Organize
Psychomotor: Imitation, manipulation, articulation, naturalization

Course Assessment Methods:
1. Continuous Internal Evaluation: Unit Test I & Unit Test II, Activities like regular tutorial, home assignments.
2. Semester End Examination.

Course Objectives:
1. To know about Industrial safety programs and toxicology;
2. To get introduced to Industrial laws, regulations and source models;
3. To understand about fire and explosion, preventive methods, relief and its sizing methods;
4. To analyze industrial hazards and its risk assessment;

Course Outcomes: At the end of the course, the students will be able to
1. Analyze the effect of release of toxic substances.
2. Understand the industrial laws, regulations and source models.
3. Apply the methods of prevention of fire and explosions.
4. Explain the relief and its sizing methods.
5. Describe the methods of hazard identification and preventive measures.
6. Take the responsibility to ensure safety in chemical industry.

Curriculum Content **Hours**

Unit: I Introduction: Safety Programs, Engineering Ethics, Accident and Loss Statistics, Acceptable **06**

Risk, Public Perceptions, Nature of the Accident Process, Inherent Safety, Seven Significant Disasters. **Toxicology**: Effect of Toxicants on Biological Organisms, Toxicological Studies, Dose versus Response, Models for Dose and Response Curves, Relative Toxicity, Threshold Limit Values, National Fire Protection Association (NFPA) Diamond.

Unit: II Industrial Hygiene: Government Laws and Regulations, OSHA: Process Safety Management, **07**

EPA: Risk Management Plan, DHS: Chemical Facility Anti-Terrorism Standards (CFATS). Industrial Hygiene: Anticipation and Identification, Evaluation, Control. **Source Models:** Introduction to Source Models, Flow of Liquid through Holes, and Pipes, Flow of Gases or Vapors through Holes and Pipes, Flashing Liquids, Liquid Pool Evaporation or Boiling, Conservative Analysis. **09**

Unit: III Fires and Explosions: The Fire Triangle, Distinction between Fires and Explosions, Definitions, Flammability Characteristics of Liquids and Vapors, Limiting Oxygen Concentration and

Inerting, Flammability Diagram, Ignition Energy, Auto-ignition, Auto-Oxidation, Adiabatic Compression, Ignition Sources, Sprays and Mists, Explosions. **Concepts to Prevent Fires and Explosions:** Inerting, Static Electricity and its Control, Explosion-Proof Equipment and Instruments, Ventilation, Sprinkler Systems, Miscellaneous Concepts for Preventing Fires and Explosions. **07**

Unit: IV Introduction to Reliefs: Relief Concepts, Definitions, Location of Reliefs, Relief Types and Characteristics, Relief Scenarios, Data for Sizing Reliefs, Relief Systems. **Relief Sizing:** Conventional Spring-Operated Reliefs in Liquid and in Vapor or Gas Services, Rupture Disc Reliefs in Liquid in Vapor or Gas Services, Two-Phase Flow during Runaway Reaction Relief, Pilot-Operated and Bucking-Pin Reliefs, Deflagration Venting for Dust and Vapor Explosions, Venting for Fires External to Process Vessels, Reliefs for Thermal Expansion of Process Fluids. **07**

Unit :V Hazards Identification: Process Hazards Checklists, Hazards Surveys, Hazards and Operability **03**

Studies, Safety Reviews, Other Methods, **Risk Assessment:** Review of Probability Theory, Event Trees, Fault Trees, QRA and LOPA.

Unit: VI Case studies: At least two to three recent and major incidents to be discussed in the class. The Chemical Engineer's connectivity to the society and his role in reducing or eliminating the chances of accidents to be discussed.

Text Books :

1. D.A. Crowl and J.F. Louvar, *Chemical Process Safety (Fundamentals with Applications)*, Prentice Hall, 2011.

Reference Books :

1. R.K. Sinnott, Coulson & Richardson's, *Chemical Engineering*, Vol. 6, Elsevier India, 2006.
2. Fawcett H.H. and W.S.Wood, *Safety and accident prevention in Chemical operations* 2ndediton John Wiley and Sons Inc. (1982).

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester V**					
Course Title	:	**Mass Transfer Operations-I**			*Course Code*:	:	**CH 315**
Teaching Scheme (Hours)	:	**4 hours/Week=4 x 13 Weeks= 52 hr minimum** **Tutorial= 01** **Practical= 02/Week**			*Credits*	:	**04+01+01=06**
Evaluation Scheme (Marks)	:	**CIE= 20+20+10=50** **SEE= 50**	**IOE=50** **EPE=50**	:	**Grand Total=200**	*Duration of SEE*	:	**03 hours**
Revision	:	**Third**				*Month*	:	**June 2018**

Pre-requisites : The pre-requisite for this course is to possess the fundamental knowledge of basic chemistry, Chemical Process Calculations and Chemical thermodynamics.

Type of Course : Theory

Course Domain : Core Course.

Skills Imbibed : Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I & Unit Test II, Activities like regular tutorial, home assignments.
2. Semester End Examination.

Course Objectives:

1. To teach the fundamental principles of mass transfer and separation processes including unit operations for chemical and biological engineering systems;
2. To introduce the mass transfer principles and basic concepts of mass transport;
3. To analyze and solve mass transfer problems involving molecular diffusion;
4. To study the vapor liquid equilibrium;
5. To impart the basic concepts of mass transfer in distillation, extraction, leaching operations;
6. To gives details about method of conducting mass transfer operation, concepts of driving force, operating line; designing of stages for operations like absorption, distillation, extraction, leaching. Also it helps in process design and study of equipment for above mentioned operations;

Course Outcomes: At the end of the course, the students will be able to

1. Understand mass transfer operation with the concept of molecular diffusion.
2. Explain mass transfer operation with the concept of molecular diffusion, flux rate, theories of mass transfer, mass transfer coefficient, designed for equipment in which two phases are contacted.
3. Conceptually describe the role of mass transfer in various unit operations including distillation, extraction etc.
4. Use the McCabe-Thiele Method, Ponchon Savarit Method for solving distillation problems and analyze Distillation process.

5. Analyze implications of factors affecting distillation column operation and design like the effect of reflux ratio, feed conditions etc.
6. Describe processes like extraction and leaching, adsorption and use analytical, graphical techniques to solve these types of problems.
7. Develop and apply criteria for selecting among alternative separation technologies available.

Curriculum Content	Hours
Unit: I Importance of mass transfer operation Classification of mass transfer operations based on gas-liquid-solid contacts. Concepts of flux, resistance, driving force, equilibrium, direction of mass transfer, Dimensionless numbers in mass transfer. Diffusion, Fick's Ist and IInd law, Dependence of diffusivity on physical properties, Schmidt's number calculation, Determination of diffusivity in liquid-liquid, gas-gas, gas-liquid diffusion.	**08**
Unit: II Interphase mass transfer Various coefficient of mass transfer and their determination, resistance concept, controlling phase concept, Mass transfer in turbulent flow, Analogies of mass transfer, Empirical equations. Multi component mixture diffusion, Maxwell's law of diffusion. Diffusion in solids, Unsteady state diffusion, Theories of mass transfer, two film theory, Higbies penetration theory, Derivation of flux equation, surface renewal theory, Applications and problems. Application of mass transfer processes	**08** **12**
Unit: III Distillation Operation Introduction to distillation operation, Vapor- Liquid Equilibrium, Ideal Solutions, Relative volatility, Azeotropic mixtures, Methods Of distillation: Flash, Differential, Steam, Vacuum, Continuous, Multi component system, batch rectification, Introduction to reactive distillation. Analysis and determination of stages: Material balance, Analysis of Fractionating column by McCabe Thiele method, Ponchon Savarit method, Lewis – Sorrel method, Lewis Matheson, Transfer unit Concept in Packed Column Design.	**08**
Unit: IV Liquid –liquid extraction Liquid Equilibrium, coordinate systems, cross and counter current operation and its calculation, selection of contractors, Extraction Equipment.	**08**
Unit V Leaching Leaching Principles, Various Types of Leaching Operations with application, Method of Calculations, Leaching equipment.	**08**
VI Absorption Introduction to absorption operation, Choice of solvent, Material balance on cross current and counter current absorption or stripping ,Absorption factor and stripping factor, Tray efficiency , design equation for packed tower ,HETP,NTU,HTU calculation for packed tower.	

Text Books :

1. R. E. Treybal, Mass Transfer Operations, 3rd Ed., McGraw -Hill International Edition, 1981.
2. B.K. Dutta, Principles of Mass Transfer and Separation Processes, 1st Ed., Prentice Hall of India, 2007.

Reference Books **:**

1. W. L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 6th Ed., McGraw-Hill International Edition, 2001
2. P. C. Wankat, Equilibrium-Staged Separations, Prentice Hall, 1989
3. C. J. Geankoplis, Transport Processes and Unit Operations, 3rd Ed., Prentice Hall, India, 1993.
4. Thomas-K-Sherwood, Robert L. Pigford, Charles R. Wilke, "Mass transfer" International Student Edition, McGraw Hill, Kogakusha Ltd., 1975.
5. Richardson & Coulson, "Chemical Engineering", Vol. 2, Pergamon Press, 1970.
6. G. Astalita Elsevier, "Mass Transfer with Chemical Reaction", Publication.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester V**								
Course Title	:	**Mass Transfer Operations-I Laboratory**						*Course Code*:	:	**CH315L**
Teaching Scheme (Hours)	:	**2 hr /Week= 2 x13= 26 hours**						*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** **IOE**	: :	**Nil** **50**	**EPE** **EOE**	: :	**50** **Nil**	*Duration of Exam (in case of External Examination)*	:	**02 hours**
Revision	:	**Third**						*Month*	:	**June 2018**

Pre-requisites : Pre-requisites for Laboratory work in Mass Transfer-I include knowledge of basic chemistry, Chemical Process Calculations and Chemical thermodynamics, analytical chemistry and stoichiometry as well.

Type of Course : Laboratory Practical

Course Domain : Core

Skills Imbibed : Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

Students are evaluated during Internal Oral Evaluation as well as External Practical Examination. However, their overall response during entire semester is also considered for evaluation.

Course Objectives:

1. To deploy students for hand-on experiments relevant to the principles studied in the Mass Transfer Operations theory;
2. To enable them to estimate diffusivity coefficients and mass transfer coefficients;
3. To make them well versed to find out the equilibrium data for various systems;
4. To enable them to perform various experiments to understand the concept behind separation techniques;

Course Outcomes: After successful completion of this course, the student will be able to:

1. Perform experiments in relation to the Mass Transfer fundamentals.
2. Find out diffusivity and mass transfer coefficients.
3. Compare the equilibrium data developed with the theoretical data.
4. Evaluate the effectiveness of different separation techniques.
5. Motivation towards innovations of novel techniques in Mass Transfer.

Practical List : **(Minimum 8 experiments to be performed from the list)**

1. Estimation of diffusivity coefficients (any Two) (a) Vapors (b) solids (c) Liquids
2. Evaluation of Mass transfer coefficients (a) Surface Evaporation (b) Wetted wall column (c) with or without chemical reaction

3. Estimation of Equilibria (any Two) (a) Solid – Liquid (b) Liquid – Liquid (c) Vapor – Liquid
4. Distillation Experiments (any Two) (a) Steam distillation (b) Differential distillation (c) Packed bed distillation
5. Extraction Experiments:
   i. Ternary Liquid Equilibria (binodal curve)
   ii. Multi stage crosscurrent extraction
6. Leaching Experiment

Reference Books :

1. R. E. Treybal, Mass Transfer Operations, 3rd Ed., McGraw -Hill International Edition, 1981.
2. B.K. Dutta, Principles of Mass Transfer and Separation Processes, 1st Ed., Prentice Hall of India, 2007.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester V**								
Course Title	:	**Case Studies and Seminar**						*Course Code*:	:	**CH316L**
Teaching Scheme (Hours)	:	**Lecture=Nil** **Tutorial= 1hr/Week/Batch x13=13** **Practical= Nil**						*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** **IOE**	: :	**Nil** **50**	**EPE** **EOE**	: :	**Nil** **Nil**	*Duration of Exam*	:	**Not applicable**
Revision	:	**Third**						*Month*	:	**June 2018**

Pre-requisites : Pre-requisites include basic knowledge of soft skills, presentation and familiarity of chemical engineering field overview.

Type of Course : Seminar cum Tutorial

Course Domain : Presentation and Communication skills.

Skills Imbibed : Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

Students' evaluation is as an Internal Oral Evaluation during semester through a seminar presentation, also based on attendance during the entire semester and based on seminar report submission at the end of semester.

Course Objectives:

1. The purpose of this particular exercise is to promote self-study, critical thinking and independent research ability;
2. To initiate students for their own small conceptual or practical based projects individually or as a team;
3. To search for recent data available for the specific topics and case studies assigned;
4. To broaden their knowledge base about their own field of studies and to make them ready to present themselves;

Course Outcomes: After successful completion of this course, the student will be able to:

1. Gain self-confidence about their career path
2. Prepare for any presentation due to increased confidence and practiced soft skills.
3. Respond to the challenges through the varied case studies learnt and attended by them and their peer group.
4. Development their overall personality by carving their presentation, aptitude and research skills.
5. Work in a team for the benefit of their organization and the society.
6. Set themselves for lifelong learning approach.

Curriculum Content

Unit I: Seminar

1. Selecting the seminar topic.
2. Information retrieval (literature survey)

a) Source of Information i.e. names of the journals, reports, books etc.

b) Searching for the information i.e. referring to chemical abstracts etc.
3. Preparing the seminar report
4. Delivering the seminar

Unit II: Case Studies

Find the recent data about 2-3 cases by referring to chemical abstracts and journals or reports and write it in the form of assignment.

(The students will deliver minimum two seminars individually (each of 15 to 20 minutes). Prior to the seminar topic selection, the course in charge will guide them about searching of topic. One topic may be of a general nature but the other topic must be related to the Chemical Engineering field related case studies. The students have to submit the seminar reports on those two topics delivered by him/her as well as the summary of the topics delivered by the other students from the peer group i.e. the tutorial batch during the semester. The assessment of the term-work will be based on: 1. Attendance to the seminar 2. Performance of the seminar delivery 3. Seminar reports and 4. Participation in question–answer sessions during the seminars.)

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester V**									
Course Title	:	**Industrial Safety and Hazard Management Laboratory**						*Course Code*:	:	**HS317L**	
Teaching Scheme (Hours)	:	**2 hr /Week= 2 x13= 26 hours**						*Credits*	:	**1**	
Evaluation Scheme (Marks)	:	**IPE** **IOE**	: :	**Nil** **Nil**	**EPE** **EOE**	: :	**Nil** **50**	*Duration of Exam (in case of External Examination)*	:	**05 hours for entire class**	
Revision	:	**Third**						*Month*	:	**June 2018**	

Pre-requisites : Pre-requisites for Laboratory work in Mass Transfer-I include knowledge of basic chemistry, Chemical Process Calculations and Chemical thermodynamics, analytical chemistry and stoichiometry as well.

Type of Course : Laboratory Practical

Course Domain : Ethics and Environment

Skills Imbibed : Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

Students are evaluated during External Oral Examination. However, their overall response during entire semester is also considered for evaluation.

Course Objectives:

1. To develop an expert manpower to handle the complex industrial environment.
2. To give knowledge about occupational health, industrial hygiene, accidental prevention techniques to the students.
3. To make the student aware about safety auditing and management systems, pollution prevention techniques etc.
4. To train the students about risk assessment and management.

Course Outcomes: After successful completion of this course, the student will be able to:

1. Evaluate workplace to determine the existence of occupational safety and health hazards
2. Identify relevant regulatory and national consensus standards along with best practices that are applicable.
3. Select appropriate control methodologies based on the hierarchy of controls
4. Analyze injury and illness data for trends.

Practical List : **(Minimum 8 experiments to be performed from the list)**

1. **NOISE LEVEL MEASUREMENT AND ANALYSIS:** Measurement of noise level for various sources – Impact, continuous and intermittent. Frequency and spectrum analysis of noise: Instrument – precision type of Noise level meter with frequency and spectrum analyzer.

2. **VIBRATION MEASUREMENT AND ANALYSIS:** Measurement of whole body vibration for various acceleration: Instrument – vibration simulator and vibration analyzer.
3. **FRICTION SENSITIVITY TEST:** Measurement of friction sensitivity for unstable materials: Instrument – BAM friction tester.
4. **IMPACT SENSITIVITY TEST:** Measurement of impact sensitivity for unstable materials: Instrument – BAM fall hammer.
5. **THERMAL REACTIVITY TEST :** Measurement of thermal reactivity for unstable materials: Instrument – DSC/TGA.
6. **EXHAUST GAS MEASUREMENT AND ANALYSIS:** Measurement of Exhaust gas measurement of IC engines: Instrument – Gas analyzer.
7. **BREATHING ZONE CONCENTRATION:** Measurement of breathing zone concentration of dust and fumes: Instrument – personal air sampler.
8. **AMBIENT AIR MONITORING:** Measurement of respirable and non-respirable dust in the ambient air: Instrument – High volume sampler.
9. **CONSEQUENCE ANALYSIS :** Soft computing skills on developing effects of fire & explosion and dispersion: Software – RISK PHAST V 6.6 (DNV) and ALOHA.
10. **STUDY OF PERSONAL PROTECTIVE EQUIPMENT:** Safety helmet, belt, hand gloves, goggles, safety shoe, gum boots, ankle shoes, face shield, nose mask, ear plug, ear muff, apron and leg guard.
11. **STUDY OF FIRE EXTINGUISHERS:** Selection and demonstration of first-aid fire extinguishers: soda acid, foam, carbon dioxide (CO_2), dry chemical powder, and halon.

First-Aid

Road safety signals and symbols

Equipment Required

1. Noise level meter: 1 No.
2. Friction tester: 1 No.
3. Impact tester: 1 No.
4. Exhaust gas analyzer: 1 No.
5. High volume sampler: 1 No.
6. PPE Set: 1 No.
7. Fire extinguisher set: 1 No.
8. Static charge tester: 1 No.
9. First aid kid: 1 No.
10. Software : CISION, FETI and Failure Mode analysis

Reference Books :

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester V**									
Course Title	:	**Internship I**						*Course Code*:	:	**CH318I**	
Teaching Scheme (Hours)	:	**Nil**						*Credits*	:	**1**	
Evaluation Scheme (Marks)	:	**IPE** **IOE**	: :	**Nil** **Nil**	**EPE** **EOE**	: :	**Nil** **50**	*Duration of Exam (in case of External Examination)*	:	**05 hours for entire class**	
Revision	:	**Third**						*Month*	:	**June 2018**	

Pre-requisites **:** The pre-requisite for this course is to have the idea of the overview of the fundamental courses of Chemical Engineering and Chemical Technology.

Type of Course **:** Industrial Training

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

Students are evaluated during External Oral Examination. The evaluation will be based on the internship report as well as attendance and punctuality certificate issued by the concerned organization.

Course Objectives:

1. To expose students to the 'real' working environment and get acquainted with the organization structure, business operations and administrative functions;
2. To have hands-on experience in the students' related field so that they can relate and reinforce what has been taught at the university;
3. To promote cooperation and to develop synergetic collaboration between industry and the university in promoting a knowledgeable society;
4. To set the stage for future recruitment by potential employers;

Course Outcomes: After successful completion of this course, the student will be able to:

1. Acquaint to actual working environment.
2. Acquire ability to utilize technical resources.
3. Write technical documents and give oral presentations related to the work completed.
4. Develop attitude of a team player and aptitude for lifelong learning.

Course Description

The primary objective of internship is to expose students to meaningful and relevant workplace attachment to better connect their learning to the workplace and deepen their skills, so that they are better prepared for their transition to the workplace after graduation.

As a part of the B.Tech Chemical Technology curriculum, 'CH318I Internship I' is similar to a practical

course, which the students of Chemical Technology must undergo in reputed Private / Public Sector / Government organization / companies as an Internship of minimum Four weeks after the IV Semester End Examination i.e. during the summer session after their Second Year B.Tech and Prior to the commencement of Third Year B.Tech.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester V**								
Course Title	:	**Introduction to Foreign Language**						*Course Code*:	:	**LS311**
Teaching Scheme (Hours)	:	**Lectures= 2 hr /Week= 2 x13= 26 hours**						*Credits*	:	**Nil**
Evaluation Scheme (Marks)	:	**Assignments** **Viva voce**	: :	**50** **25**	**Written Test** **Grand Total**	: :	**25** **100**	*Duration of Exam*	:	**Not Applicable**
Revision	:	**Third**						*Month*	:	**June 2018**

Pre-requisites : As it is the introduction to the language, it has no any pre-requisites

Type of Course : Audit Course at institute level

Course Domain : Linguistics

Skills Imbibed : Cognitive: Understand, Predicting Situation, Comprehend,
Affective : Receive, Listen, Respond, Showing self-reliance, Organize
Psychomotor: Imitation, adaptation, articulation, origination

Course Assessment Methods:

The students will be given five assignments each for 10 marks. At the end of the course, there will be a written test of 25 marks and a viva voce of 25 marks. There will be assessment for a total of 100 marks. Based on the marks obtained, they will be awarded with a grade similar to other credit courses. Though it is an audit course, obtaining passing grade is essential.

Course Objectives:

1. To make the students able to communicate and translate in foreign languages for the *technical and scientific documentation*, beneficial to Defense and other Government sector services;
2. To make them globally competent in the era of industrial liberalization;
3. To complement their core studies in international business;
4. To make them confident while opting for better career prospects in Multinational Companies (MNCs) for technical and scientific translation/ interpretation tasks while working for joint ventures or collaborative partnership;

Course Outcomes:

1. The students will be able to acquire a good knowledge the basic grammar of foreign language and learn Alphabet, Common Words and Phrases in foreign language.
2. The students will also be able to learn to read the simple texts in foreign language.
3. The students would be able to speak a little using the greetings, well wishes etc. in Foreign Language.
4. The students will learn to count numbers, answer to the questions like, what is your name, surname, tell age, and can initiate little communication in Foreign Language.
5. The students can also translate simple sentences in foreign language.

Curriculum Content	Hours
Unit I: General Information on Basic Grammar of the foreign language, Introduction to Alphabet.	**05**
Unit II: Gender of Noun, Number of Noun, Pronouns, Adjectives, Verbs and their usage in simple sentences, Numbers (up to 10), Simple Greetings in foreign language.	**05**
Unit III General Questions in foreign language, like What is your name/surname? Who/What is this? Etc.	**04**
Unit IV: Simple narration about self/family/friend/University in foreign language chosen for studies. Practicing the learnt topics in the class itself.	**05**
Unit V: Formation of simple sentences using Parts of Speech, Information on Cases, One or Two simple lessons from any book.	**05**
Unit VI: Basic information on Country & Culture of language under study.	**04**

Reference Books **:**

1. V.N.Wagner and V. G. Ovsienko, Russian, People's Publishing House, New Delhi.
2. S. Khavronina and A. Shirochenskaya, Russian in Exercises.
3. Genki – Japan Times
4. Aural Comprehension in Japanese – Osamu & Nobuko Mizutani.
5. An Introduction to Modern Japanese - Osamu & Nobuko Mizutani.
6. Japanese for Today – Y. Yoshida.
7. Lagune 1(Full set), Published by Langers, (An imprint of Saraswati House Pvt.Ltd), New Delhi 1 10002 (India).

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester VI**						
Course Title	:	**Chemical Reaction Engineering-II**				*Course Code*:	:	**CH 321**
Teaching Scheme (Hours)	:	**4 hours/Week=3 x 13 Weeks= 39 hr minimum** **Tutorial= 01/Week** **Practical= 02/Week**				*Credits*	:	**04+01+01=06**
Evaluation Scheme (Marks)	:	**CIE= 20+20+10=50** **SEE= 50**	**EPE=50**	:	**Grand Total=150**	*Duration of SEE*	:	**03 hours**
Revision	:	**Third**				*Month*	:	**June 2018**

Pre-requisites : Chemical Reaction Engineering-I as the pre-requisite for this course.

Type of Course : Theory

Course Domain : Core Course.

Skills Imbibed : Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I & Unit Test II, Activities like regular tutorial, home assignments.
2. Semester End Examination.

Course Objectives:

1. To be able design reactors for multiple reactions and non isothermal conditions, Study thermal characteristics of reactors and design;
2. To make the students learn the concept of RTD (residence time distribution) to diagnose and account for the non-idealities in flow patterns;
3. To make them learn the kinetics of fluid particle reactions and reactor design for non catalytic reactions;
4. To make them study the basic concepts of catalysis and the methods for estimation of catalytic properties;
5. To make them study the effectiveness of a porous catalyst and studies on reactors using porous catalyst;
6. To make them learn the performance of various types of reactors; energy and alternative energy;

Course Outcomes: At the end of the course, the students will be able to:

1. Apply knowledge of mathematics, science and engineering.
2. Understand and apply the concepts of heat capacity, latent heat, heat of reaction, heat of combustion, and heat of formation.
3. Recognize the limitations imposed by non-ideal flow.
4. Predict the conversion in a non-ideal reactor using tracer information.
5. Design reactors for fluid-solid reactions.
6. Develop the mechanism and determine the deactivation rate of catalytic reactions.

7. Determine the effectiveness of catalyst and can carry out the experimentation to find the rate.
8. Design towers for gas–liquid reactions with and without mass transfer considerations.

Curriculum Content	Hours
Unit: I Temperature effects in homogeneous reactions: Equilibrium Conversion, Optimum temperature progression, Adiabatic and non adiabatic operations, Rate, Temperature and conversion profiles for exothermic and endothermic reactions, Stable operating condition in reactors.	**08**
Unit: II Non-Ideal Flow: Basic concept: conversion in reactors having non ideal flow; The Residence Time Distribution Functions and their Relationships Determining RTD from Experimental Tracer Curves Tubular Reactor E- and F-Curves for a Series of Stirred Tank Reactors Analysis of RTD from Pulse Input and step input Models for predicting conversion from RTD data: Zero Parameter.	**09**
Unit: III Fluid-particle reactions: Kinetics- selection of a model, shrinking core model for spherical particles of unchanging size, rate of reaction for shrinking spherical particles, extensions, determination of rate controlling .Fluid –particle reactor design for non catalytic heterogeneous reactions	**09**
Unit: IV Fluid-fluid reactions: Introduction to catalysis. Steps in catalytic reactions, Adsorption on solid surfaces, Physical properties of catalysts, Classification and Preparation of catalyst, Estimation methods for catalytic properties. Promoters, inhibitors and accelerators. Mechanism of catalysis, Rate controlling steps and their derivation for finding rates. Deactivating catalysts-mechanisms of catalyst deactivation, the rate and performance equations.	**09**
Unit: V Fluid-Solid catalyzed reactions: Spectrum of kinetic regimes. Rate equation for surface kinetics. Pore diffusion resistance combined with surface kinetics. Porous catalyst particles. Heat effects during reaction. Performance equations for reactors containing porous catalyst particles. Experimental methods for finding rates.	**08**
Unit: VI Reactors, its stability and scale up: Fixed bed reactor- construction, operation and design, Isothermal operation, Adiabatic operation, Fluidized bed reactor, Slurry reactor, Trickle bed reactor. Choice of reactor, Factors affecting choice of reactor, Optimum yield and conversion, Selectivity and reactivity.	

Text Books :

1. Levenspeil, O., Chemical Reaction Engineering, 3 rd Edition, John Wiley & Sons, 2001.
2. Fogler, H. S., Elements of Chemical Reaction Engineering, 3 rd Edition, Prentice Hall, 2001.
3. S. M. Walas, "Reaction Kinetics for Chemical Engineers", McGraw Hill, New York.

Reference Books :

1. Smith, J.M., Chemical Engineering Kinetics, 3 rd Edition, McGraw Hill, 1984.
2. J. Rajaram and J. C. Kuriacose, "Kinetics and Mechanics of Chemical Transformation", McMillan India Ltd., 1993.
3. Carberry, J.J., Chemical & Catalytic Reaction Engineering, McGraw Hill.
4. Denbigh and Turner, Chemical Reactor Theory- An Introduction, 2nd Edition, ELBS.
5. Julian R.H. Ross, Homogeneous Catalysis-Fundamentals and Applications, Elsevier, 2011.
6. I. Chorkendroff, J.W., NiemountsVerdriet, Concepts of Modern Catalysis and Kinetics, John Wiley and Sons, 2006.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester VI**								
Course Title	:	**Chemical Reaction Engineering- II Laboratory**						*Course Code*:	:	**CH321L**
Teaching Scheme (Hours)	:	**2 hr /Week= 2 x13= 26 hours**						*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** **IOE**	: :	**Nil** **Nil**	**EPE** **EOE**	: :	**50** **Nil**	*Duration of Exam (in case of External Examination)*	:	**02 hours**
Revision	:	**Third**						*Month*	:	**June 2018**

Pre-requisites **:** For this course, besides laboratory work in Chemical Reaction Engineering-I, the laboratory work in Engineering Chemistry and Chemistry-I, Chemistry-II are the pre-requisite. It also requires knowledge of fluid flow, heat transfer and the stoichiometric operations.

Type of Course **:** Laboratory Practical

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

Students are evaluated during External Practical Examination. However, their overall response during entire semester is also considered for evaluation.

Course Objectives:

1. To study about reaction kinetics for single, multiple, isothermal, non-isothermal reactions and reactor design procedures;
2. To study the underlying principles of reaction kinetics through experiments;
3. To learn to evaluate the performance of various types of reactors;

Course Outcomes: After successful completion of this course, the student will be able to:

1. Design experiments involving chemical reactors, and analyzing and interpreting data.
2. Analyze chemical reactors and reaction systems.
3. Evaluate the non ideality in the reactors.
4. Solve problems of mass transfer with reaction in solid catalyzed reactions.
5. Design and sizing of industrial scale reactor on the basis of kinetic data obtained at lab scale.

Practical List **: (Minimum 8 experiments to be performed from the list)**

1. Study of Adiabatic continuous stirred tank reactor
2. RTD studies in CSTR by step response
3. RTD studies in CSTR by pulse response
4. RTD studies in PFR by step response
5. RTD studies in PFR by pulse response

6. RTD studies in CSTR followed by PFR by step response
7. RTD Studies on mixed flow reactor in series by step response
8. Study of non-catalytic homogeneous reaction in a batch reactor
9. Study of non-catalytic homogeneous reaction in continuous stirred tank reactor
10. Study of non-catalytic homogeneous reaction in plug flow reactor

Reference Books :

1. Fogler, H. S., Elements of Chemical Reaction Engineering, 3 rd Edition, Prentice Hall, 2001.
2. Smith, J.M., Chemical Engineering Kinetics, 3 rd Edition, McGraw Hill, 1984.
3. S. M. Walas, "Reaction Kinetics for Chemical Engineers", McGraw Hill, New York.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology) Part III, Semester VI**				
Course Title	:	**Industrial Pollution Control**		*Course Code*:	:	**CH 322**
Teaching Scheme (Hours)	:	**3 hours/Week=3 x 13 Weeks= 39 hr minimum** **Tutorial= Nil** **Practical= Nil**		*Total Credits*	:	**03+00+00=03**
Evaluation Scheme (Marks)	:	**CIE= 20+20+10=50** **SEE= 50**	: : **Grand Total=100**	*Duration of SEE*	:	**3 hours**
Revision:	:	**Third**		*Month*	:	**June 2018**

Pre-requisites : In order to complete the course studies successfully, it is important to have a good command of English. Other Pre-requisites include knowledge of Engineering Chemistry, Environmental Studies and the Laboratory courses in Chemistry-I, II and Analytical Chemistry. Also sound background of fluid flow, heat transfer and mechanical operations is necessary.

Type of Course : Theory

Course Domain : Ethics and Environment

Skills Imbibed : Cognitive: Recall, Understand, Apply, Analyze, Synthesize, Evaluate
Affective : Awareness, Respond, Value, Organize
Psychomotor: Imitation, manipulation, articulation, naturalization

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I & Unit Test II, Activities like regular tutorial, home assignments.
2. Semester End Examination.

Course Objectives:

1. To study impacts of pollution on environment;
2. To apply the environment concept of control and management of various types of pollution and pollutants;
3. To develop the understanding about air, water pollution control;
4. To understand the scope of course in chemical industry;
5. To study the pollution prevention strategies in industrial processes;
6. To understand the pollution control in different process industries;

Course Outcomes: At the end of the course, the students will be able to:

1. Analyze the effect of pollutant on environment.
2. Explain the meteorological aspects of the air pollution.
3. Describe the air pollution control methods.
4. Select the technologies for water/ waste water removal.
5. Design unit operations for pollution control.
6. Apply the environmental concepts to control and management of air, water pollution.

Curriculum Content	Hours
Unit I: Introduction- Definition, causes, effects of pollution, types of pollution, prevention and control of environmental pollution, water and air pollution laws, regulations and standards. Clean development mechanism.	05
Unit II: Air pollution control in industries- air pollution sources, classification, effects of air pollutants on human health, plants, animals, materials. Economic pollution, sampling and measurement of air pollutants, Air pollution control methods and equipment- particulate pollution- separation of particulate matter from effluent gases, particulate collection systems- Gravity settling chamber, solid traps, cyclone separator fabric filters, liquids scrubbers and ESP., Numerical problems based on theory. Gaseous pollution control- absorption, adsorption, combustion, removal of SO_x, NO_x.	08
Unit III: Water pollution control in industries- sources, effects of water pollutants, waste water characteristics- DO, BOD, COD, TOC, total suspended solids, colour and odour determination of BOD and BOD constants, waste water treatment- activated sludge process, trickling filters, waste stabilization ponds etc. Numericals based on BOD removal. Advanced waste water treatment- UASB, photo catalytic reactors. Removal of heavy metals- methods of removal of mercury, chromium, Removal of nitrogen, phosphorous.	07
Unit IV: Industrial odour and noise control- sources and solutions, odour control by adsorption and wet scrubbing. Industrial noise control methods. Sludge treatment and disposal, industrial hazardous waste management, waste minimization concept. Concept of common effluent plant.	05
Unit V : Pollution control in major process industries Introduction to pollution control, Pollution control aspects of fertilizer industry: Introduction to pollution control in fertilizer industry. Removal of carbon in ammonia plant effluents by scrubbing with liquids using vacuum filtration, Removal of oil in ammonia plant effluents, Removal of hydrogen sulphide in ammonia plant effluent.	07
Unit VI: Pollution control in major process industries Pollution control in petroleum and petrochemical Units: Introduction, Refinery Liquid based treatment methods: Oxidation pond treatment, disposal of sludge Treatment of liquid effluents from petrochemical industries, Removal of hydrogen sulphide gas from sour gas by stripping, Removal of ammonia from gases. Alcohol industry: Treatment method by recovery of potash from distillery spent-wash.	07

Reference Books :

1. S. P. Mahajan, Pollution Control in Process Industries, Tata McGraw hill, 1985.
2. Metcalf and Eddy, Waste Water Engineering Treatment, Tata McGraw Hill, 1979.
3. Warren Riesman and Mark J. Hammer, Water supply and Pollution control, Harper & Row, New York, 1985.
4. M.V. Rao and A. K. Datta: Waste Water Treatment.
5. U. N. Mahida, Water Pollution and disposal of Waste Water on land.
6. Soli Arceivala, Waste Water Treatment for Pollution Control.
7. Lund H. F, Industrial Pollution Control, Hand Book, McGraw Hill, 1971.
8. H. C. Perkins, Air Pollution, McGraw Hill 1974.
9. L. D. Benfield and C. W. Randall, Biological Process Design for Waste Water Treatment, Prentice Hall, 1980.
10. C. P. Gaudy Jr. and H. C. Lim, Bio-logical Waste Water Treatment, 1980.
11. M. J. Hammer, Water & waste water Technology, Wiley, 1975.
12. Artur L. Kohi and Fred C. Reisenfled, Gas Purification, Gulf Publishing Co.1979.
13. Arcadio P. Sincero, Gregoria A. Sincero, Environmental engineering (Design approach), Prentice Hall of India Pvt. Ltd, New Delhi, 1999.
14. C. S. Rao, Environmental pollution control engineering, Wiley Eastern Ltd, 1994.
15. David H. F. Liu, Bela Liptak, Environmental engineers' handbook , Lewis Publishers, 2nd edition, New Jersey, 1996.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester VI**						
Course Title	:	**Mass Transfer Operations-II**				*Course Code*:	:	**CH 323**
Teaching Scheme (Hours)	:	**4 hours/Week=4 x 13 Week= 52 hr minimum** **Tutorial= Nil** **Practical= 02/Week**				*Credits*	:	**04+00+01=05**
Evaluation Scheme (Marks)	:	**CIE= 20+20+10=50** **SEE= 50**	**IOE=Nil** **IPE=Nil** **EOE=Nil** **EPE=50**	:	**Grand Total=150**	*Duration of SEE*	:	**03 hours**
Revision	:	**Third**				*Month*	:	**June 2018**

Pre-requisites : The pre-requisite for this course is to possess the fundamental knowledge of mass transfer operations-I or equivalent.

Type of Course : Theory

Course Domain : Core Course.

Skills Imbibed : Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I & Unit Test II, Activities like regular tutorial, home assignments.
2. Semester End Examination.

Course Objectives:

1. To study the principle and fundamental concept of mass transfer operations;
2. To learn about the various operations of mass transfer;
3. To execute the proper material balance of unit operations;
4. To solve the engineering problems related to mass transfer operations;
5. To understand the role of membrane separation operation in the field of chemical engineering;
6. To select the parameters for the designing of the equipment;

Course Outcomes: At the end of the course, the students will be able to:

1. Apply their fundamental knowledge in the area of chemical engineering.
2. Explain various operation of mass transfer use in worldwide chemical industry.
3. Execute proper material balance for different operations in chemical or pharmaceutical industry.
4. Solve the engineering problems of drying, adsorption, evaporation, crystallization operations etc.
5. Explain the significance, role and selection of membrane separations operations and handling.
6. Design the equipment on the basis of raw material and their parameter.

Curriculum Content	Hours
Unit: I Drying: Principles of drying, phase equilibrium, cross circulation drying, through circulation drying, drying of suspended particles, rate of drying curve, dryers for solids and pastes, dryers for solutions and slurries i.e. various types of dryers, selection of drying equipment	**08**
Unit: II Humidification: Terms, definitions, wet bulb temp., dry bulb temp., measurement of humidity, adiabatic saturation temp., study of temp humidity chart, Enthalpy-humidity charts, determination of humidity, and concept of dehumidification, Equipments for humidification operations.	**08**
Unit: III Crystallization : Principles of crystallization, crystal growth, properties of crystals nucleation, Effect of impurities in crystallization, Effect of temperature on solubility, caking and yield of crystals, calculation of yield, Fractional crystallization, various types of crystallizer's and their applications.	**10**
Unit: IV Adsorption and Ion Exchange: Types of adsorption, nature of adsorbents, adsorption equilibria, adsorption of liquids, adsorption operations-stage wise operation, continuous contact, ion exchange: principles of ion exchange, techniques and applications, ion exchange equilibria, rate of ion exchange.	**10**
Unit: V Evaporation: Principles of evaporation, applications of evaporation, liquid characteristics and types of evaporator, single effect evaporator calculation, pattern of liquor flow in multiple effect evaporators.	**08**
Unit: VI Membrane Separation Operations: Introduction to membrane separation process, different types of membrane separation process, (Ultra filtration, Reverse Osmosis, Dialysis, Electro Dialysis, Pervaporation), General membrane equation, Liquid membranes.	**08**

Text Books :

1. R. E. Treybal, Mass Transfer Operations, 3rd Ed., McGraw -Hill International Edition, 1981.
2. McCabe W.L, Smith J.C., Harriott P., "Unit Operations in Chemical Engineering", 6th&7th Eds.,McGraw-Hill, New York, 2001 & 2005.
3. B.K. Dutta, Principles of Mass Transfer and Separation Processes, 1st Ed., Prentice Hall of India, 2007. Coulson J.M., Richardson J.F., Backhurst J. R., Harker J.H. "Coulson & Richardson's Chemical Engineering", Vol. 1, 6th Ed., Elservier, New Delhi, 2004.

Reference Books :

1. C. J. Geankoplis, Transport Processes and Unit Operations, 3rd Ed., Prentice Hall, India, 1993.
2. Seader J.D. and Henley E.J., Separation Process Principles, 2nd edition, John Wiley &Sons, 2006.
3. Suryanarayana A., "Mass Transfer Operations", New Age International, New Delhi, 2002.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester VI**								
Course Title	:	**Mass Transfer Operations-II Laboratory**						*Course Code*:	:	**CH323L**
Teaching Scheme (Hours)	:	**2 hr /Week= 2 x13= 26 hours**						*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** **IOE**	: :	**Nil** **Nil**	**EPE** **EOE**	: :	**50** **Nil**	*Duration of Exam (in case of External Examination)*	:	**02 hours**
Revision	:	**Third**						*Month*	:	**June 2018**

Pre-requisites **:** Pre-requisites for Laboratory work in Mass Transfer-I include knowledge of basic chemistry, Chemical Process Calculations and Chemical thermodynamics, analytical chemistry and stoichiometry as well.

Type of Course **:** Laboratory Practical

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

Students are evaluated during External Practical Examination. However, their overall response during entire semester is also considered for evaluation.

Course Objectives:

1. To expose the students for practical training through experiments to understand and appreciate the concepts learnt in mass transfer operations;
2. To study drying parameters with operating different equipments;
3. To prepare solutions and observe the adsorption mechanism;
4. To make them understand simple techniques of without chemical reaction operation;
5. To provide them exposure in the laboratory like a miniature process plant environment using process utilities;

Course Outcomes: After successful completion of this course, the student will be able to:

1. Apply practical knowledge to industrial applications and for developing or modifying methods.
2. Explain the preparations of solid crystals using crystallization operation and evaporation of solution using different heating media.
3. Calculate the experimental work of drying, evaporation and crystallization operations.
4. Describe the kinetics of adsorption operation.
5. Acquire motivation towards innovations of novel techniques in mass transfer operations.
6. Develop attitude to work in group and imitate Standard Procedure for practical work.

Practical List **: (Minimum 8 experiments to be performed from the list)**

1. Atmospheric Tray Dryer: To study the drying characteristics of a given material under constant drying condition.
2. To find out yield of sample using batch crystallizer and to verify material balance

3. To Study of rotary dryer and hold up to rotary dryer
4. To determine humidity of air by using psychometric chart
5. Adsorption: To study the adsorption of acidic acid on activated charcoal
6. To drying of solids in fluidized bed dryer
7. To study of ion exchange adsorption
8. To calculate the economy and overall heat transfer coefficient of an open pan evaporator
9. To calculate the economy and overall heat transfer coefficient of calendria evaporator

Text Books :

1. W. L. McCabe, J. Smith and P. Harriot, *Unit Operations of Chemical Engineering*, 6th Ed., McGraw – Hill, International Edition, 2001.
2. R. E. Treybal, *Mass Transfer Operations*, 3rd Ed., McGraw –Hill, International Edition, 1981.

Reference Books :

1. Coulson J.M., Richardson J.F., Backhurst J. R., Harker J.H. "Coulson & Richardson's Chemical Engineering", Vol. 1, 6th Ed., Elservier, New Delhi, 2004.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester VI**						
Course Title	:	**Organic Chemical Technologies**				*Course Code*:	:	**CH 324**
Teaching Scheme (Hours)	:	**3 hours/Week=3 x 13 Week= 39 hr minimum** **Tutorial= Nil** **Practical= 02/Week**				*Credits*	:	**03+00+01=04**
Evaluation Scheme (Marks)	:	**CIE= 20+20+10=50** **SEE= 50**	**IOE=Nil** **IPE=50** **EOE=Nil** **EPE=Nil**	:	**Grand Total=150**	*Duration of SEE*	:	**Not applicable**
Revision	:	**Third**				*Month*	:	**June 2018**

Pre-requisites : The pre-requisite for this course is to possess the fundamental knowledge of Physical Chemistry, Chemistry-II i.e. Organic Chemistry.

Type of Course : Theory

Course Domain : Core Course.

Skills Imbibed : Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I & Unit Test II, Activities like regular tutorial, home assignments.
2. Semester End Examination.

Course Objectives:

1. To understand nature of various process industries based on organic compounds and their chemistry;
2. To list such organic based industries and to study the basics of organic chemical processes with a view to future application;
3. To study the process technology of various organic process industry;
4. To understand the complexity of any organic process;

Course Outcomes: At the end of the course, the students will be able to

1. Explain manufacturing processes of organic products and also the associated troubleshoot.
2. Describe process flow diagram and various parameters concerning various industries and products.
3. Analyze and solve engineering problems during production of respective products.
4. Acquire awareness for organic process based industry practices and their importance for the society.
5. Adapt to thinking of internship and entrepreneurship in the field of organic products and processes.
6. Respond to various hands on skills required while working in these types of industries.

Curriculum Content	Hours
Unit: I Food industries: Types of food processing, preservation method, products. Sugar and Starch industries, sugar and starches, Introduction to fermentation industries: Fermentation, Applications, Vinegar, lactic acid.	**03**
Unit: II Oil, Fat, Waxes and surfactants: Manufacture of Vegetable oils, animal fats and oils, Waxes, Surfactants: Types and properties, Soaps and detergents.	**06**
Unit: III Pharmaceutical industries: Classification of pharmaceutical products, Manufacture of antibiotics, Isolates of plant and animals, vitamins.	**08**
Unit: IV Pulp and paper industries: Manufacturing of pulp, manufacturing of paper and structural boards.	**06**
Unit V Explosives, Plastic industries: Types of explosives, Explosive characteristics, Industrial explosives, propellants, rockets, Missiles, pyrotechnics, matches, toxic chemical weapons. Raw materials, general polymerization processes, manufacturing processes, Compounding and Moulding operation	**07**
Unit VI Petroleum and Petrochemical, Dyes and their intermediates: Petroleum production and refining, manufacturing of Methanol, Formaldehyde, Ethylene and acetylene, Ethylene dioxide, Isopropanol, Acetone, Isopropyl, Benzene, Butadiene, Phenol styrene, Classification and manufacturing of dyes and their intermediates.	**08**

Text Books :

1. George T. Austin, "Shreve's Chemical Process Industries",5th Edition, McGraw Hill Book company
2. C.E.Dryden, Outline of Chemical Technology, Affiliated East West Press. 1973.
3. S.D Shukla, G.N. Pandey, A textbook of Chemical technology, 3rd Edition.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester VI**								
Course Title	:	**Organic Chemical Technologies Laboratory**						*Course Code*:	:	**CH324L**
Teaching Scheme (Hours)	:	**2 hr /Week= 2 x13= 26 hours**						*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** **IOE**	: :	**50** **Nil**	**EPE** **EOE**	: :	**Nil** **Nil**	*Duration of Exam*	:	**Not applicable**
Revision	:	**Third**						*Month*	:	**June 2018**

Pre-requisites **:** Pre-requisites for Laboratory work in Mass Transfer-I include knowledge of basic chemistry, Chemical Process Calculations and Chemical thermodynamics, analytical chemistry and stoichiometry as well.

Type of Course **:** Laboratory Practical

Course Domain **:** Core

Skills Imbibed **:** Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

Students are evaluated during Internal Practical Examination. However, their overall response during entire semester is also considered for evaluation.

Course Objectives:

1. To gain more knowledge about organic chemical laboratory;
2. To acquire laboratory skills (tactile skills as well as technical skills);
3. To develop intellectual skills like problem solving, scientific thinking, studying, research etc.
4. To develop scientific curiosity and to develop research based learning;
5. To develop team spirit and co-operative skills;

Course Outcomes: After successful completion of this course, the student will be able to:

1. Acquire firm foundation in the fundamentals and application of current chemical theories including those in analytical organic and physical chemistry.
2. Design and carry our scientific experiments as well as accurately record and analyze the results of such experiments.
3. Communicate the results of scientific work.
4. Explore new areas of research in both chemistry and allied fields of science and technology.

Practical List **: (Minimum 8 experiments to be performed from the list)**

1. Estimation of sugar / glucose
2. Determination of saponification value of an oil
3. Determination of acid value of an oil
4. Determination of iodine value of an oil
5. Preparation of azo dye

6. Preparation of soap and analysis of soap
7. Preparation of green pigment
8. Preparation of yellow pigment
9. Preparation of blue pigment
10. Preparation of drug aspirin
11. Preparation of adipic acid and its analysis
12. Preparation of benzaldehyde and its analysis
13. Preparation of o- and p- nitrophenol and its analysis

Reference Books :

1. George T. Austin, Shreve's Chemical Process Industries, 5th Edition, McGraw Hill Book Company.
2. C.E.Dryden, Outline of Chemical Technology, Affiliated East West Press. 1973.
3. S.D Shukla, G.N. Pandey, A textbook of Chemical technology, 3rd Edition.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester VI**						
Course Title	:	**Process Instrumentation and Control**				*Course Code*:	:	**CH 325**
Teaching Scheme (Hours)	:	**4 hours/Week=4 x 13 Weeks= 52 hr minimum** **Tutorial= Nil** **Practical= 02/Week**				*Credits*	:	**04+00+01=05**
Evaluation Scheme (Marks)	:	**CIE= 20+20+10=50** **SEE= 50**	**IOE=50** **IPE=Nil** **EOE=Nil** **EPE=Nil**	:	**Grand Total=150**	*Duration of SEE*	:	**03 hours**
Revision	:	**Third**				*Month*	:	**June 2018**

Pre-requisites : In order to complete the course studies successfully, it is important to have a good command of English. The learners ought to be sound in the basic concepts of Mathematics. The learners should be well versed with Material & Energy Balance Calculations.

Type of Course : Theory

Course Domain : Core Course.

Skills Imbibed : Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

1. Continuous Internal Evaluation: Unit Test I & Unit Test II, Activities like regular tutorial, home assignments.
2. Semester End Examination.

Course Objectives:

1. To understand working principles of basic instruments available for flow, pressure, level and temperature measurement;
2. To understand dynamic behavior and modeling of process systems and equipments;
3. To learn the Laplace and Inverse Laplace Transforms in order to obtain transfer functions and dynamic responses;
4. To understand and analyze stability characteristics of dynamic systems;
5. To provide knowledge of P, PI and PID controllers in chemical and process industries;
6. To understand frequency response of dynamic systems;

Course Outcomes: At the end of the course, the students will be able to

1. Explain working principles of basic instruments available for flow, pressure, level and temperature measurement
2. Model dynamical systems.
3. Describe the use and measurement of transfer functions.
4. Apply knowledge of mathematics [Laplace Transforms] to model and solve the models describing dynamics of

chemical processes.
5. Evaluate stability of control loops.
6. Describe dynamic behavior and stability of chemical process control systems.

Curriculum Content	Hours
Unit: I Measuring Instruments: Theory, practice and applications of measurements of temperature, mass and levels. Measurement of pressure, vacuum, humidity and pH in process industry.	**07**
Unit: II Flow measuring instruments: Flow measuring devices for incompressible and compressible fluids. Electro-hydraulic valves, hydraulic servomotors, electro-pneumatic valves. Pneumatic actuators.	**07**
Unit: III Dynamic behavior of Chemical Processes: Characteristics of Chemical Process Control, Mathematical Modeling of Chemical Processes, Linearization of non linear systems, Solution of Linear differential equation using Laplace Transform. First and higher order systems. Pure capacity process, First order system with variable time constant and gain, Response of first order system in series: Interacting and Non-interacting systems, Dynamic behavior of second order system: Under damped and over damped and critically damped systems, Transportation lag.	**10**
Unit: IV Introduction to feedback control: Elements of Control loop - controller, measuring device, final control element, transmission lines, transducers, transmitters, development of block diagram. Concept of servo and regulatory problems. Selection of measured, manipulated and controlled variables. Types of controller - on-off, P, PI, PID. Effects of proportional, integral and derivative actions.	**10**
Unit: V Stability and Frequency response: Stability analysis by Routh criteria, Root Locus Diagram. Design of feedback control system using frequency response technique: Bode's stability criteria, gain and phase margin. Ziegler- Nichols tuning technique. Nyquist stability criteria.	**08**
Unit: VI Other control strategies: Feed forward controller - design with steady state model, design with dynamic model, combination of feed forward-feedback structure, Cascade control structure - analysis and design, Ratio control, split range control, selective control, override control, auctioneering control.	**10**

Reference Books :

1. Stephanopoulos, G., Chemical Process Control: An Introduction to Theory and Practice , Prentice-Hall, New Jersey, 1984.
2. Coughanowr, D. R. and L. B. Koppel, Process systems Analysis and Control, Mc-Graw-Hill, 2nd. Ed.,

1991.

3. Luyben, W. L., Process Modelling Simulation and Control for Chemical Engineers McGraw Hill, 1990.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester VI**									
Course Title	:	**Process Instrumentation and Control Laboratory**						*Course Code*:	:	**CH325L**	
Teaching Scheme (Hours)	:	**2 hr /Week= 2 x13= 26 hours**						*Credits*	:	**1**	
Evaluation Scheme (Marks)	:	**IPE** **IOE**	: :	**Nil** **50**	**EPE** **EOE**	: :	**Nil** **Nil**	*Duration of Exam*	:	**Not applicable**	
Revision	:	**Third**						*Month*	:	**June 2018**	

Pre-requisites : In order to complete the course studies successfully, it is important to have a good command of English. The learners ought to be sound in the basic concepts of Mathematics. The learners should be well versed with Process dynamics and control theory.

Type of Course : Laboratory Practical

Course Domain : Core

Skills Imbibed : Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

Students are evaluated during Internal Oral Evaluation. However, their overall response during entire semester is also considered for evaluation.

Course Objectives:

1. To understand the dynamic behavior of the systems.
2. To evaluate the effect controller on the control system.
3. To understand the basic components of feedback control system.

Course Outcomes: After successful completion of this course, the student will be able to:

1. Describe the modern hardware and instrumentation needed to implement process control.
2. Analyze different components of a control loop.
3. Realize practical issues in control engineering and the benefits of control engineering.
4. Explain effect of P, PI and PID controllers in process control.
5. Choose PID modes that effect controllability, speed of response the control systems.

Practical List : **(Minimum 8 experiments to be performed from the list)**

A. Dynamic behavior of first order system: 1. Mercury Thermometer 2. Single tank system. 3. C.S.T.R.

B. Dynamic behavior of first order system in series: 4. Two tank non-interacting system. 5. Two tank interacting system.

C. Dynamic behavior of second order system: 6. Mercury Manometer

D. Dynamic behavior of final control Element :

7. Pneumatic control valve. Study of Pneumatic controllers.
8. Proportional Controller
9. Proportional Derivative Controller
10. Proportional Integral Controller
11. Proportional Integral Derivative

E. Controller Control Systems: 12. Study of closed loop control system.

Reference Books :

1. Stephanopoulos, G., Chemical Process Control: An Introduction to Theory and Practice, Prentice-Hall, New Jersey, 1984.
2. Coughanowr, D. R. and L. B. Koppel, Process systems Analysis and Control, Mc-Graw-Hill, 2nd. Ed., 1991.
3. Luyben, W. L., Process Modelling Simulation and Control for Chemical Engineers McGraw Hill, 1990.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester VI**								
Course Title	:	**Mini Project**						*Course Code*:	:	**CH326L**
Teaching Scheme (Hours)	:	**Lecture= Nil** **Tutorial= 1hr/Week/Batch x13=13** **Practical= Nil**						*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** **IOE**	: :	**Nil** **Nil**	**EPE** **EOE**	: :	**Nil** **50**	*Duration of Exam (in case of External Examination)*	:	**05 hours for entire class**
Revision	:	**Third**						*Month*	:	**June 2018**

Pre-requisites : Pre-requisites include basic knowledge of soft skills, presentation and familiarity of chemical engineering field overview.

Type of Course : Laboratory

Course Domain : Research Skills.

Skills Imbibed : Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

Students' evaluation is as an External Oral Evaluation at the end of the semester, also based on attendance during the entire semester and based on project report submission at the end of semester.

Course Objectives:

1. To plan for various activities of the project and distribute the work amongst team members;
2. To promote self-study, critical thinking and independent research ability;
3. To make the students initiate their own small conceptual or practical based projects individually or as a team of no more than 2 members;
4. To make them use Research Methodology for the task undertaken;
5. To have a trial exercise that may help them to satisfactorily complete their major project in the final year;

Course Outcomes: After successful completion of this course, the student will be able to:

1. Develop the ability to choose the problem and formulate it.
2. Apply their fundamental knowledge according to their competency for solve engineering problems.
3. Develop their leadership quality.
4. Achieve the project's goals.
5. Prepare a technical report based on the Mini project.
6. Deliver technical seminar based on the Mini Project work carried out.

Curriculum Content

The students either individually or in a group of maximum 2 members will undertake a mini project on a particular topic under the guidance of an internal course teacher. Prior to the topic selection, the course in charge will guide them about searching topic. The work progress will be monitored from time to time in batch wise tutorials conducted during the semester.

A 15 to 20-pages report is to be written upon completion of the activity. The report should include academic content such as the background, objectives, product/system description, the work done, the achievements and difficulties encountered. The Department will provide a specific format for report writing.

The assessment of the mini project work will be based on the: 1. Attendance to the tutorials 2. Physical Demonstration of their work 3. Seminar delivery based on the work carried out and 4. Mini Project reports submitted.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester VI**								
Course Title	:	**Industrial Visits**						*Course Code*:	:	**CH327**
Teaching Scheme (Hours)	:	**Nil**						*Credits*	:	**1**
Evaluation Scheme (Marks)	:	**IPE** **IOE**	: :	**Nil** **50**	**EPE** **EOE**	: :	**Nil** **Nil**	*Duration of Exam*	:	**Not applicable**
Revision	:	**Third**						*Month*	:	**June 2018**

Pre-requisites : The pre-requisite for this course is to have the idea of the overview of the fundamental courses of Chemical Engineering and Chemical Technology.

Type of Course : Industrial Training/Visits

Course Domain : Core

Skills Imbibed : Cognitive: Understand, Apply, Analyze, Evaluate, Create
Affective : Awareness, Respond, Value, Organize
Psychomotor: Perception, Imitation, Manipulation, Articulation

Course Assessment Methods:

Students are evaluated during Internal Oral Examination. The evaluation will be based on the visit report certified by the concerned organization.

Course Objectives:

1. To make students aware and familiar with Industry Practices;
2. To increase practical awareness of various Industrial Sectors;
3. To acquaint them with interesting facts and newer technologies;
4. To give them exposure of practical application of instruments handled during course curriculum;

Course Outcomes: After successful completion of this course, the student will be able to:

1. Get the exposure to the real workstations, plants, machines and systems.
2. Interact with the senior functional experts / supervisors to explain about company functions.
3. Receive expert's briefing about the functioning of machines and systems.
4. Have the face to face session with technical or administrative experts of the organization to ask questions and clarify doubts.
5. Acquainted about the company policies in terms of production, quality, and service management.

Course Description

As a part of the B.Tech Chemical Technology curriculum, the 'Industrial Visits CH327' there will be at least two industrial visits to reputed chemical industry (1-2 days) in the sixth week of the semester VI. The students will submit a report of the visits. This particular activity is equivalent to one Credit and it carries 50 marks as an Internal Oral Evaluation (IOE) which is included in Semester VI. For submission of the visit report, the students will follow one specific format.

1. Every student will visit minimum two industries/ research laboratories separately or in a group during the

tour 1 to 2 days at different Industries.

2. Students must submit written report about the visits individually at the end of the semester VI. The report should contain information about the following points:

(a) The organization - activities of organization and administrative setup technical personnel and their main duties.

(b) The project/ industry brief description with sketches and salient technical information.

(c) The work / processes observed with specification of materials, products, equipments etc. and role of engineers in that organization.

(d) Suggestions (if any) for improvement in the working of those organizations.

3. The industrial visit report should be presented by using PPTs well as in the form of face to face interaction with the examiner/s.

Class & Semester	:	**T. Y. B.Tech (Chemical Technology), Part III, Semester VI**								
Course Title	:	**Research Methodology**						*Course Code*:	:	**RM 321**
Teaching Scheme (Hours)	:	**2 hr /Week= 2 x13= 26 hours**						*Credits*	:	**Nil**
Evaluation Scheme (Marks)	:	**Assignments** **Viva voce**	: :	**50** **25**	**Written Test** **Grand Total**	: :	**25** **100**	*Duration of Exam*	:	**Not Applicable**
Revision	:	**Third**						*Month*	:	**June 2018**

Pre-requisites : H.S.C level English Language Competency and background of basic courses of specialization

Type of Course : Audit Course at institute level

Course Domain : Research Skills

Skills Imbibed : Cognitive: Understand, Predicting Situation, Comprehend,
Affective : Receive, Listen, Respond, Showing self-reliance, Organize
Psychomotor: Imitation, adaptation, articulation, origination

Course Assessment Methods:

The students will be given five assignments each for 10 marks. At the end of the course, there will be a written test of 25 marks and a viva voce of 25 marks. There will be assessment for a total of 100 marks. Based on the marks obtained, they will be awarded with a grade similar to other credit courses. Though it is an audit course, obtaining passing grade is essential.

Course Objectives:

1. To gain familiarity with research phenomenon or to achieve new insights into it (known as exploratory or formulative research studies);
2. To develop an understanding of various research designs and techniques;
3. To identify various sources of information for literature review and data collection;
4. To judge the frequency with which something occurs or with which it is associated with something else (known as diagnostic research studies);
5. To know about testing a hypothesis of a causal relationship between variables (known as hypothesis-testing research studies);

Course Outcomes: At the end of the course, the students will be able to:

1. Understand some basic concepts of research and its methodologies.
2. Identify appropriate research topics.
3. Select and define appropriate research problem and parameters.
4. Prepare a project proposal (to undertake a project).
5. Organize and conduct research (major project) in a more appropriate manner write a research report.

Curriculum Content	**Hours**
Unit I: Introduction to Research: Definition and basic Types of research, Research process and steps in it, Concept of Hypothesis, Research proposals and aspects.	**03**
Unit II: Basic Statistics required for any research	**06**

Introduction to Descriptive Statistics, Statistical data, Variable, Classification of data, exploratory data analysis, Measures of central tendency, Dispersion-Standard deviation, Correlation and regression analysis.

Unit III: Introduction to Design of Experiment: Concept of design of experiment, its objectives, strategies, Factorial experimental design, designing engineering experiments, basic principles, of replication. Guidelines of experiments. **06**

Unit IV : Single Factor Experiment: Hypothesis testing, Analysis of Variance components (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effects model, Estimation of variance components, goodness of fit tests, Chi-Square test, Kolmogorov-Smirnov(K-S) test. **07**

Unit V: Two factor Factorial Design: Basic definitions and principles, main effect and interaction, response surface and contour plots, General arrangement for a two-factor factorial design; Models-Effects, means and regression, Hypothesis testing. **07**

Reference Books **:**

1. Kothari, C.R., Research Methodology –Methods and techniques, New Age Publications, New Delhi, 2009.
2. Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, Wiley India.
3. Montgomery, Douglas C. & Runger, George C. (2007), 3/e, Applied Statistics & Probability for Engineers, Wiley India.
4. J.Medhi, Statistics Methods, New Age Publications, New Delhi 2009.
5. Nabendu Pal and Saheb Sarkar, Statistics: Concepts and Applications, Prentice Hall of India Pvt. Ltd. New Delhi, 2004.
6. Panneerselvam, R., Research Methodology, Prentice-Hall of India, New Delhi, 2004.

Equivalence of Third Year B.Tech (Chemical Technology) Semester V and VI

The above detailed syllabus is a revised version of the Third Year B.Tech (Chemical Technology) Program being conducted by Shivaji University at its Technology Department. This syllabus is to be implemented from June 2018, (Academic year 2018-19). *Prime feature of this revision is the transformation of existing curriculum into the concept of Outcome Based Education as specified in NBA rules and regulations.*

The Equivalence for the subjects/courses of Chemical Technology at Third Year B Tech Semester V and VI pre-revised Program under the faculty of Engineering and Technology is as follows.

Third Year B.Tech Semester V (Chemical Technology)

Sr. No	Third Year B.Tech(Chemical Technology) Semester V Pre-revised syllabus	Third Year B.Tech(Chemical Technology) Semester V Revised syllabus	Remark
1.	Chemical Plant Utilities	Thermal Engineering and Plant Utilities	Modification in the content with change in the title
2.	Inorganic Chemical Technologies	Inorganic Chemical Technologies	Slight modification in the content
3.	Industrial Economics and Management	Safety in Chemical Industry	Existing one is shifted to semester VII and introduced new course related to safety
4.	Mass Transfer –I	Mass Transfer Operations-I	Slight modification in the content and title as well
5.	Process Instrumentation, Dynamics and Control	-	Shifted to semester VI with slight change in content and title as well
6.	Industrial Electronics and Measurements	-	Shifted to semester IV with slight change in curriculum with title change too
7.	Mass Transfer –I Laboratory	Mass Transfer Operations-I Laboratory	Slight modification in the content and title
8.	Process Instrumentation, Dynamics and Control Laboratory	-	Shifted to semester VI with slight title change
9.	Industrial Electronics and Measurements Laboratory	-	Shifted to semester IV with slight change in curriculum with title change too
10.	Seminar	Case Studies and Seminar	Modified title
11.	-	Chemical Reaction Engineering-I	Shifted from semester VI with slight modification in content and title as well
12.	-	Chemical Reaction Engineering-I Laboratory	
13.	-	Industrial Safety and Hazard Management Laboratory	Shifted from semester VIII with some modification in the content.
14.		Internship I	A new concept launched as per the mandate by AICTE. It is for increasing the employability of the graduates.

Third Year B.Tech Semester VI (Chemical Technology)

Sr. No	Third Year B Tech(Chemical Technology) Semester VI Pre-revised syllabus	Third Year B.Tech(Chemical Technology) Semester VI Revised syllabus	Remark
1.	Reaction Engineering-I	Chemical Reaction Engineering-II	New one is Shifted from semester VII with slight modification in the content and title as well
2.	Organic Chemical Technologies	Organic Chemical Technologies	Slight modification in the content
3.	Industrial Pollution Control	Industrial Pollution Control	Slight modification in the content
4.	Mass Transfer-II	Mass Transfer Operations-II	Slight modification in the content and title as well
5.	Process Equipment Design and Drawing	-	Shifted to semester VII with slight modification in content and title as well
6.	Reaction Engineering -I Laboratory	Chemical Reaction Engineering-II Laboratory	Slight modification in the content and title
7.	Organic Chemical Technologies Laboratory	Organic Chemical technologies Laboratory	Slight modification in the content
8.	Mass Transfer-II Laboratory	Mass Transfer Operations-II Laboratory	Slight modification in the content and title as well
9.	Process Equipment Design And Drawing Laboratory	-	Shifted to semester VII with slight modification in content and title as well
10.	Mini Project	Mini Project	Mentioned objectives and outcomes
11.	Report of Industrial Tour	Industrial Visits	Changed the title and mentioned objectives and outcomes
12.	-	Process Instrumentation and Control	Shifted from semester V with slight modification in content and Title as well
13.	-	Process Instrumentation and Control Laboratory	

Audit courses have been assigned no any credits. The students will be evaluated for these courses by the concerned course in charge. There will be grade conferred to the student. The grade will be based on conversion of marks obtained out of 50. Obtaining passing grade is essential condition. Please refer to chart in the detail examination scheme. The chart shows the range of marks and the respective grade.