Estd. 1962
NAAC 'A' Grade

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दुरध्वनी (ईपीएबीएक्स) २६०९००० (अभ्यास मंडळे विभाग– २६०९०९४)
फॅक्स : ००९१-०२३१-२६९१५३३ व २६९२३३३.e-mail:bos@unishivaji.ac.in

SU/BOS/Sci & Tech/ **Date 20/05/2022**

№ 0 0 3 9 3

To,

The Director,
Departments of Technology,
Shivaji University,
Kolhapur.

Subject: Regarding revised syllabus of **B. Tech. Programme (Department of Technology)** Part-III (Sem-V-VI) under the Faculty of Science and Technology.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the revised syllabus B. Tech. Part-III (Sem-V-VI) under the Faculty of Science & Technology.

B. Tech. Programme (Department of Technology)

1.	Civil Engineering
2.	Mechanical Engineering
3.	Computer Science and Technology
4.	Chemical Engineering
5.	Electronics and Communication Engineering
.6.	Food Technology

B. Tech Part-III (Sem-V-VI) all Branches syllabus and Rules, Regulation, Guidelines, Structure and equivalence shall be implemented from the academic year 2022- 2023 onwards. A soft copy containing syllabus is attached herewith and it is available on university website www.unishivaji.ac.in.

The question papers on the pre-revised syllabi of above mentioned course will be set for the two examinations. These chances are available for repeater students, if any.

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

Dy Registrar

Copy to:

1	The I/c Dean Faculty of Science & Technology	6	Appointment Section
2	The Chairpersan, Respective Board of Studies	7	Affiliation Section (T.1)
3	Director, Examination and Evaluation	8	Affiliation Section (T.2)
4	Eligibility Section	9	P.G.Admission Section
5	O.E. – 4	100	P.G Seminar Section

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

Scheme of Teaching and Examination: Semester- V (Chemical Engineering)

Course Code	Course Title	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	30	40	-	-	-
						SEE	70		-	-	-
CH312	Chemical Reaction Engineering-I	03	01	-	04	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH313	Inorganic Chemical Technologies	04	-	-	04	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH314	Safety in Chemical Industry	03	-	-	03	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH315	Mass Transfer Operations-I	04	01	-	05	CIE	30	40	-	-	-
						SEE	70		-	-	-
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	-	01		01	-	-	-	IOE	50	20
CH318I	Internship I	-	-	-	01	-	-	-	EOE	50	20
	Total	**18**	**04**	**04**	**25**	-	**500**	-	-	**300**	-

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

$ In theory student should appear for the CIE (Mid Semester Exam), submit the assignment and must secure 40% marks in SEE.

Total contact hours per week: **26+2=28 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. 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 Engineering)

Course Code	Course Title	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	-	01		01
CH318I	Internship I	-	-	-	01
	Total	**18**	**04**	**04**	**25**

Audit Course III

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

Total contact hours per week: **26+2=28 and Total Credits=25**

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

Course Code	Course Title	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	30	40	-	-	-
						SEE	70		-	-	-
CH322	Industrial Pollution Control	03	-	-	03	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH323	Mass Transfer Operations-II	03	01	-	04	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH324	Organic Chemical Technologies	03	-	-	03	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH325	Process Instrumentation and Control	04	-	-	04	CIE	30	40	-	-	-
						SEE	70		-	-	-
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	Micro Project	-	01	-	01	-	-	-	EOE	50	20
CH327	Industrial Visits	-	-	-	01	-	-	-	IOE	50	20
	Total	**17**	**03**	**08**	**25**	-	**500**	-	-	**300**	-

Audit Course IV						
RM321	Research Methodology	**02**	-	-	Nil	Evaluation at Institute Level

$ In theory student should appear for the CIE (Mid Semester Exam), submit the assignment and must secure 40% marks in SEE.

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. 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 a prescribed 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 Engineering)

Course Code	Course Title	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	03	01	-	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	Micro Project	-	01	-	01
CH327	Industrial Visits	-	-	-	01
	Total	**17**	**03**	**08**	**25**

Audit Course IV

RM321	Research Methodology	**02**	-	-	Nil

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

SHIVAJI UNIVERSITY, KOLHAPUR
DEPARTMENT OF TECHNOLOGY

Four-year B. Tech. Program: Academic Rules and Regulations

INDEX

Glossary of terms:

B. Tech.: Bachelor of Technology, an Under Graduate Degree awarded from the Shivaji University, Kolhapur

Director: Director, Department of Technology, Shivaji University, Kolhapur

DC: Department Committee

DEC: Departmental Examination Coordinator

Semester: The academic year shall be divided into two regular semesters of approximately 20 weeks duration each. Typically, the odd semester shall be from the first week of July to last week of November while the even semester shall be from the first week of January to the last week of May.

This shall include the period of academic delivery (14 to 15 weeks), Continuous Internal Evaluation (CIE) i.e. Mid Semester Examination and Assignments, Semester End Examination (SEE) assessment and declaration of results.

Course: Subject

Course Coordinator: Subject teacher

Course Credit: Weighted sum of the number of Lecture hours (L), Tutorial hours (T), and Practical hours (P) associated with the course.

Credits Earned: The sum of course credits for credit courses in which a student has passed.

Grade: Assessment of the student's performance in a course indicated by the letters, "AA", "AB", "BB", "BC", "CC", "CD", "DD", "FF", "XX", " ABSENT", "PP", "NP".

Grade Point: Number equivalent of the letter grades given by 10, 9, 8, 7, 6, 5, 4 corresponding to grades "AA", "AB", "BB", "BC", "CC", "CD", "DD" respectively. "FF" and "XX" carry zero grade points.

Instructor: Member of faculty who shall be assigned to teach a specific course.

Semester Grade Points: The sum of the products of credits and Grade Points for each course registered by a student in a semester.

SGPA: Semester Grade Point Average

CGPA: Cumulative Grade Point Average

ATKT: Allowed to Keep Terms.

R.B.T. 1 Admission:

Candidates are admitted to this course according to norms and conditions prescribed as per AICTE, DTE, Maharashtra.

R.B.T. 2 Award of Degree:

Following rules prevail for the award of degree:

1. B.Tech Degree shall be awarded to the student, who has registered and earned all the credits of prescribed courses under the general departmental requirements.
2. In addition to the credit requirement prescribed above for the Degree award, each student shall have to complete the requirements of Audit Course (AC) during the programme. All the students shall receive certification as PP *(for Passed),* and NP *(for not passed)* in AC, in the Grade Card. While obtaining certification as PP is a mandatory requirement for the Degree award of a student, this shall not be considered for computing the final Cumulative Grade Point Average.
3. A student has obtained CGPA ≥ 4.5.
4. A student has paid all the institute dues and satisfied all the requirements prescribed.
5. A student has no case of indiscipline pending against him/her.
6. University authorities shall recommend the award of B. Tech. Degree to a student who is declared to be eligible and qualified for above norms.

R.B.T. 3 Attendance Rule:

All students must attend every lecture, tutorial and practical class. However, to account for late registration, sickness or other such contingencies, 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 laboratories taken together (as applicable), will be awarded an 'XX' grade in that course irrespective of his/her performance in the tests.

The course coordinator will award 'XX' grade to the student who is deficient in attendance considering the consolidated attendance record for the whole semester. For the purpose of attendance calculation, every scheduled practical class will count 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 coordinator will maintain and consolidate attendance record for the course (lectures, tutorials and laboratories together, as applicable).

R.B.T. 4 Academic Progress Rules (ATKT Rules)

1. A student shall be allowed to register for the courses of the next year's odd semester only if he/she has earned all the credits of the previous year and has not failed in more than three passing heads (SEE, EPE/EOE) shall be considered for deciding the eligibility for ATKT.
2. For the promotion to the Third Year, student should not fail in more than three passing heads (SEE, EPE/EOE) of Second Year and all credits of First Year must be earned.

3. For the promotion to the Final Year, student should not fail in more than three passing heads (SEE, EPE/EOE) of Third Year and all credits of Second Year must be earned.
4. A student who has obtained 'FF' grade in SEE of a regular semester and has obtained 'FF' grade in 2nd attempt of SEE shall be eligible to choose one of the two options below to clear his/her backlog:
   i. Re-registration for the next regular semester course whenever that course is offered.
   ii. Application for Repeated Examination.
5. A student who has detained in a regular semester and obtained 'XX' grade can Re-register for the next regular semester whenever it is offered.
6. The maximum duration for getting B. Tech. degree for students admitted in the first semester of U.G. program shall be 12 semesters (six academic years) while for lateral entry students admitted in the third semester shall be 10 semesters (five academic years) from their date of admission. The maximum duration of the program includes the period of withdrawal, absence and different kinds of leaves permissible to a student but excludes the period of rustication of a student from the Department. If a student is unable to gain all credits of first year in three years from the date of his/her admission, then he/she shall be declared as "Not Fit for Engineering" leading to discontinuation of his/her registration with the Department.
7. If a student is unable to gain all credits of first year in three years from the date of his/her admission, then he/she shall be declared as "Not Fit for Engineering" leading to discontinuation of his/her registration with the Department.
8. Depending upon the academic progress of a student, Department may take a decision regarding continuation or discontinuation of his/her registration with the institute.

R.B.T. 5 Academic Flexibility

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 quite simply a means of attaching relative values to courses 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 subjects (year-wise) under each course/discipline are unitized

R.B.T. 6 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 a student to progress at an optimum pace suited to his/her ability or convenience, subject to fulfilling minimum requirements 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.

R.B.T. 7 Features of Credit System at Department of Technology, Shivaji University, Kolhapur:

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

1. All courses (subjects) may not have same credits.
2. 25 Credits / Semester.
3. Absolute Grading System with 7 Passing Grades viz. AA, AB, BB, BC, CC, CD, DD and FF for failure.
4. Standardization of courses; each course is of 6 units.
5. Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), both having (70:30) weightage in the student's performance in Course Work/Laboratory Work and other activities. A student's performance in a subject shall be judged by considering the results of CIE and SEE together. Students must score 40% marks in SEE irrespective of the CIE marks.

   (Note: The CIE shall be conducted as Mid Semester Exam and assignments throughout the semester on dates announced in advance by the department, and its results made known to the students from time to time. However, the dates for the SEE shall be fixed at the University level.)
6. Continuous Internal Evaluation consists of Mid Semester Examination of 20 marks and assignment of 10 marks handled by Department of Technology and setting of question papers should be done by course coordinator. Assignments may be of varied nature for each course based on the need of the course coordinator.
7. Semester-End Examination (SEE), to be conducted by the Department of Technology, setting of question papers should be done by course coordinator and jointly with an external examiner; this shall include a written examination for theory courses and practical/design/drawing examination with built-in oral part for laboratory/ design/drawing courses.
8. Request for Mid Semester Examination for the students representing in co-curricular, extracurricular activities or on medical grounds will be considered only. On receipt of application from the student the DC will take decision for the conduct of the Mid Semester Examination.

9. Care shall be taken to ensure that the total numbers of days for academic work are ≥180 per year.
10. Academic schedule prescribed shall be strictly adhered to all the Branches.

R.B.T. 8 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 weight-age 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 credit.
Example: Course: Organic Chemical Technologies: 4 credits (3-0-2)
The credits indicated for this course are computed as follows:
3 hours/week lectures = 3 credits
0 hours/week tutorial = 0 credit
2 hours/week practical = 2 × 0.5 = 1 credit
Also, (3-0-2) **4** credit course = (**3** h Lectures + **0** h Tutorial + **2** h Practical) per week
= **5** contact hours per week

R.B.T. 9 Detailed Evaluation Scheme:

1. Out of total 100% theory weightage, 30% weightage is allotted for Continuous Internal Evaluation (CIE). Appearing for CIE is must and student must submit the assignments to become eligible for Semester End Examination (SEE) of respective course.

CIE (30% weightage) includes:

a. Mid Semester Exam of 20 Marks, an hour duration;
b. Assignment of 10 Marks during entire semester.

2. For the Semester End Examination (SEE), 100 marks paper will be set and finally it will be converted to 70 marks, in which student must secure 40% (28 Marks out of 70) as university examination pass head and must appear for CIE to become eligible for SEE of respective course.
3. Final theory marks (out of 100) will be the addition of CIE (30 Marks) and SEE (70Marks).
4. Final laboratory letter grade will be awarded (100%) will be the addition of CIE (50%) and SEE (50%).
5. Semester End Examination (SEE) for laboratory consists of External Practical Evaluation (EPE)/External Oral Examination (EOE). Continuous Internal Evaluation (CIE) for laboratory consists of Internal Practical Evaluation (IPE) / Internal Oral Evaluation (IOE).

6. There shall be no (SEE) for laboratory courses of First Year. The entire assessment of a student shall be based on CIE (IPE/IOE) 100% weightage and a minimum performance of 40% in CIE shall be required to get the passing grade. CIE of laboratory work consists of (IPE/IOE) shall be based on turn-by-turn supervision of the student's work and the quality of his/her work as prescribed through laboratory journals and his/her performance in oral or Practical/Oral examinations uniformly distributed throughout the semester. Student must submit and secure 40% marks in the IPE/IOE of the concerned course. Non-submission of IPE/IOE will lead to term not grant (TNG).
7. The assessment of laboratory course from the 3rd semester onwards shall be carried out in two parts.
   i. CIE of laboratory consists of IPE/IOE shall be based on turn-by-turn supervision of the student's work and the quality of his/her work as prescribed through laboratory journals and his/her performance in oral or Practical/Oral examinations uniformly distributed throughout the semester. Student must submit and secure 40% marks in the IPE/IOE of the concerned course. Non-submission of IPE/IOE will lead to term not grant (TNG).
   ii. SEE of laboratory shall be based on performing an experiment followed by an oral examination or a written examination.
   iii. The relative weightage for CIE and SEE for assessment of laboratory courses shall be 50% and 50% respectively from second year onwards and a minimum performance of 40% in both CIE and SEE separately shall be required to get the passing grade.
   iv. SEE for laboratory course shall normally be held one week before the SEE for theory courses and shall be conducted by a panel of examiners consisting of external and internal examiner. This activity shall be coordinated by Department Examination Coordinator (DEC) in consultation with Coordinator of the respective department.
8. A student failed in SEE of a laboratory course in a regular semester shall be eligible to appear for examination conducted along with SEE of laboratory courses of the subsequent semester. Such examination shall be fairly comprehensive (generally of 3 hours similar to EPE/EOE i.e. External Practical/Oral Examinations) to properly judge his/her practical skill and theoretical knowledge for that laboratory course. He or she will suffer a grade penalty as per Table 3.
9. Assessment of Seminar, Mini-project, Micro Project, Major Project etc.:
   i. The Seminar/Project report must be submitted by the prescribed date usually two weeks before the end of academic session of the semester.
   ii. It is desirable that the topics for seminar/project be assigned by the end of previous semester.

iii. The seminar report and the presentation of seminar shall be evaluated by panel of three departmental faculty members (decided by Branch Coordinator).

iv. The mini-project shall be evaluated jointly by a panel of three Internal Examiners.

v. The report on field training shall be evaluated by a panel of three Internal Examiners.

vi. The assessment of B. Tech major project work shall be carried out in two phases as shown below:

I-phase CIE (50% weightage) consists of

a) Departmental Committee (Synopsis submission seminar)

b) Project work assessment by Guide

(Departmental Committee consists of following:

Director- Chairman

Branch Coordinator from respective branch – member

Senior faculty from respective branch – member

Guide/Course Coordinator- member)

I-phase SEE (50% weightage) consists of Progress Seminar and presentation evaluated by Panel of Internal Examiners.

II-phase CIE (50% weightage) consists of

a) Project work assessment by Guide

b) Report submission seminar evaluated by Departmental Committee

II-phase SEE (50% weightage) (Final orals and presentations) evaluated by Panel of External and Internal Examiners.

10. *Semester End Examination duration will be 4 hrs.

11. In respect of CIE, and Laboratory work a target date shall be fixed for the completion of each sheet, job, Project, experiment or assignment and the same complete or incomplete shall be collected on the target date and assessed immediately at the respective departments by the concerned teachers and % marks (or grades) shall be submitted to the Co-coordinator. The Co-coordinator of the Department of Technology shall communicate this % of marks (or grades) to the University within a week after the end of each term.

R.B.T. 10 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 (≥40% minimum grade DD), 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, subject to fulfilling minimum requirement for continuation.

R.B.T. 11 CGPA Improvement Policy for award of degree:

A student getting CGPA ≤ 4.50 with grade 'DD' in any course or grade 'FF' in any course shall have the possibility to repeat one or more 'DD' graded courses along with the failed courses, /are being offered in a semester.

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 SEE of maximum two theory courses of seventh and eighth semester.

R.B.T. 12 Evaluation System:

1. **Semester Grade Point Average (SGPA)**

$$= \frac{\sum(\textbf{Course credits in passed courses} \times \textbf{Earned Credits})}{\sum(\textbf{Course credits in registered courses})}$$

2. **Cumulative Grade Point Average (CGPA)**

$$= \frac{\sum(\textbf{Course credits in passed courses} \times \textbf{Earned Credits})\textbf{of all Semesters}}{\sum(\textbf{Course credits in registered courses})}$$

   i. Cumulative Grade Point Average (CGPA) will be calculated cumulatively for Sem. I to Sem. VIII for regular students.

   ii. Cumulative Grade Point Average (CGPA) will be calculated cumulatively for Sem. III to Sem. VIII for lateral entry students.

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

Ist Division with distinction	: CGPA ≥7.5 and above
Ist Division	: CGPA ≥6.0 and <7.5
IInd Division	: CGPA ≥5.5 and < 6.0

New gradation suggested as follows.

Table 1

Grade Points	Equivalent Range
5.5	55%
6.0	60%
6.5	65%
7.0	70%
7.5	75%

Conversion of CGPA to percentage marks for CGPA **≥ 4.5** can be obtained using equation.

Percentage marks = (CGPA x 10)

An example of these calculations is given below:

Typical academic performance calculations - I semester

Sample Table 2

Course no.	Course credits (Sample)	Grade awarded	Earned credits	Grade points	Points secured
Col 1	Col 2	Col 3	Col 4	Col 5	Col 6 (col4 *col5)
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	00
TTNXXX	2	AB	2	9	18
Total	21		17	38	124

1. Total Points earned for this semester = 124

$$\textbf{Semester Grade Point Average (SGPA)} = \frac{124}{21} = 5.90$$

2. Cumulative Grade Point Average (CGPA) =

   Cumulative points earned in all passed courses = 124 (past semesters) + 124 (this semester)

   = 248

   Cumulative earned credits = 23 (past semesters) + 21 (this sem.) = 44

$$\textbf{Cumulative Grade Point Average (CGPA)} = \frac{\Sigma(124 + 124)}{\Sigma(23 + 21)} = 5.63$$

Table 3

System of Evaluation

Grade	Grade Points	Marks obtained (%)			Description of Performance
		Regular Semester	Re-examination	Repeated Examination	
AA	10	90-100	--	--	Outstanding
AB	09	80-89	90-100	--	Excellent
BB	08	70-79	80-89	90-100	Very Good
BC	07	60-69	70-79	80-89	Good
CC	06	50-59	60-69	70-79	Fair
CD	05	45-49	50-59	60-69	Average
DD	04	40-44	40-49	40-59	Poor
DD$	04	Below 40	Below 40	Below 40	Poor (Subject to Application of Ordinance 96)
FF	00	Below 40	Below 40	Below 40	Fail
XX	--	--	--	--	Detained
ABSENT	--	--	--	--	Absent
PP	--	--	--	--	Passed (Audit Course)
NP	--	--	--	--	Not Passed (Audit Course)

Note: An equivalent certificate of CGPA to percentage of marks will be provided to student on his/her demand after remitting prescribed fees by Shivaji University.

R.B.T. 13 Entry of Students from Regular Pattern to Credit Pattern

A student of Department of Technology, Shivaji University, Kolhapur admitted before academic year 2020-21, and such student shall clear back log subjects of regular pattern if any, by appearing for respective examination conducted by Department of Technology. Further they shall undergo additional academic requirements (bridge course) if required as suggested by Department committee, so as to have turning with credit pattern.

R.B.T. 14 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 are not contributed to SGPA or CGPA of the concerned student.

R.B.T. 15 Awards of Grades for Re-Examination:

- A student who has obtained grade 'FF' in regular semester shall be eligible to appear for re-examination conducted before the commencement of the next regular semester.
- In such cases Continuous Internal Evaluation performance of a student shall not be wiped out.
- A student shall apply for re-examination before the last date of such application and shall appear for re-examination.
- 70% weightage similar to SEE shall be given to re-examination.
- A student who is eligible for re-examination, but remains absent for reexamination shall be given grade 'Absent'.
- A student shall be awarded a grade between 'AB' to 'DD', or 'FF' or 'XX' as given in Table 3 depending upon the cumulative marks obtained by him/her in CIE and Re-examination of SEE. Here a student has to suffer a grade penalty by accepting one grade lower as compared with the regular grades.

R.B.T. 16 Showing Evaluated Semester End Examination Answer Paper, Re-Evaluation, and applying for revaluation:

The evaluated answer book will be shown to the student as per the time table prepared by the exam cell of Department of Technology after the declaration of result. The grievances regarding the incorrect total and assessment of the not assessed questions will be done by the respective faculty on submission of grievance form. A student having doubt regarding the grade declared in a course can apply for the photocopy of the answer book by remitting the prescribed fee as specified; a student can also apply for rechecking of his/her SEE answer book as per Shivaji University norms. There is no provision for showing of evaluated answer book, photocopy and rechecking for revaluation of the reexamination.

R.B.T. 17 Change of Branch:

Students shall be eligible to apply for Change of Branch after completing the first two semesters. The change of branch shall be permitted strictly on merit basis subject to the rules and regulations prescribed by Directorate of Technical Education, Maharashtra State/Admission Regulatory authority, Maharashtra State time to time.

R.B.T. 18 Disciplines and Conduct:

i. Every student shall be required to observe discipline and decorous behavior both inside and outside the campus and not to indulge in any activity, which shall tend to bring down the prestige of the Department.

ii. Any act of indiscipline of a student reported to the Department, shall be referred as per Shivaji University norms.

iii. If a student while studying in the institute is found indulging in anti-national activities contrary to the provisions of acts and laws enforced by Government he/she shall be liable to be expelled from the Department without any notice.

iv. If a student is involved in any kind of ragging, the student shall be liable for strict action as per Maharashtra anti-ragging act 1999, which is in effect from 15th May 1999.

v. If any statement/information supplied by the student in connection with his/her admission is found to be false/ incorrect at any time, his/ her admission shall be cancelled and he/she shall be expelled from the institute and fees paid shall be forfeited.

vi. Student once admitted in the Department of Technology shall follow instructions issued from time to time.

vii. If a student is found guilty of malpractice in examinations then he/she shall be punished as per the recommendations of the Shivaji University, Kolhapur.

viii. Every admitted student shall be issued photo identification (ID) card which must be retained by the student while he/she is registered at Department of Technology. The student must have valid ID card with him/her while in the Department of Technology.

ix. Any student who alters or intentionally mutilates an ID card or who uses the ID card of another student or allows his/her ID card to be used by another student shall be subjected to disciplinary action.

x. The valid ID card must be presented for identification purpose as and when demanded by authorities. Any student refusing to provide an ID card shall be subjected to disciplinary action.

Note: All other rules and regulations will be applicable as per Shivaji University, Kolhapur.

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester V**					
Course Title	**:**	**Thermal Engineering and Plant Utilities**			***Course Code***	**:**	CH311
Teaching Scheme (Hours)	**:**	Lecture	04 Hours/Week		***Total Credits***	**:**	04
		Tutorial	00 Hours/Week				
Evaluation Scheme (Marks)	**:**	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	**:**	03 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	BS-12A2, CH212, CH214, CH222 & CH224					
Course Domain	**:**	Program Core					

Course Rationale: Importance of Plant Utilities in a typical Chemical Process Plant is enormous. Without fundamental knowledge of these Utilities, it is very difficult to survive in a Chemical Plant. As Chemical Process Technology becomes more complex, Chemical Engineers will need in depth and fundamental understanding of different utilities. This course focuses on understanding the important technical fundamentals of Chemical Process Utilities. The emphasis on the fundamentals will help the student to understand the concepts and apply those accordingly.

	Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to
1.	Explain concepts for Chemical Plant Utilities with listing of the same;	1.	Understand Plant Utility Concept with need and application of each of those utilities;
2.	Discuss different thermal energy storage systems;	2.	Compare and contrast different thermal energy storage systems;
3.	Elucidate steam as a plant utility and discuss steam generation process along with boiler relevant topics;	3.	Differentiate steam types with interpretation as well as analysis of steam and boiler related numerical problems;
4.	Describe different compressors and pumps used in Chemical Plants;	4.	Distinguish between different compressors and pumps with justification for selection of the same;
5.	Outline refrigeration systems and discuss importance and types of insulation;	5.	List different refrigeration systems and choose insulation types;
6.	Illustrate industrial inerting with the relevant topics' discussion.	6.	Make sense of industrial inerting and compare various techniques.

Curriculum Content	**Hours**
Unit I: **Process Utilities:** 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.	07
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,	10

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.	
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.	08
Unit V: Refrigeration Systems and Insulation: Refrigeration systems, humidification and dehumidification equipment, drying and cooling tower, air blending, exhaust, ventilation, cryogenics, Importance of insulation for the process equipment, insulation materials and their effect on various materials of equipment, piping, fitting and valves, insulation for high, intermediate, low and subzero temperatures including cryogenic insulation, determination of optimum insulation thickness.:	11
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

Suggested 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.
Suggested 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, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester V**					
Course Title	**:**	**Chemical Reaction Engineering-I**			***Course Code***	**:**	CH312
Teaching Scheme (Hours)	**:**	Lecture	03Hours/Week		***Total Credits***	**:**	04
		Tutorial	01 Hours/Week				
Evaluation Scheme (Marks)	**:**	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	**:**	03 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	BS-11B1, BS-12B1, BS-12A2, CH211, CH213 and CH221					
Course Domain	**:**	Program Core					

Course Rationale: The purpose of this course is to introduce and make aware the students about concepts and implementation of the reaction rate, derivation of rate expressions from reaction mechanism, reactor types, integral and differential method of analysis, principles of chemical reactor analysis and design, experimental determination of rate equations, design of batch and continuous reactors, selection of the most appropriate reactor for a given feed.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain basic concepts of chemical reaction engineering and classification of reaction;	1.	Understand basic concepts of chemical reaction engineering and classification of reaction;
2.	Discuss kinetics of homogeneous reaction, concentration and temperature dependent term of rate of equation;	2.	Recognize kinetics of homogeneous reaction and calculate the value of rate constant;
3.	Explain overall concept of batch reactor and catalytic and autocatalytic reaction;	3.	Remember and analyze batch reactor and catalytic and autocatalytic reactions;
4.	Impart knowledge of flow reactors, space time and holding time;	4.	Derive a design equation for reactors and calculate size of reactors, space time and holding time;
5.	Elaborate size comparison of various single and multiple ideal reactor system along with recycle reactor;	5.	Identify good reactor system/ set-up after comparing the size of reactor;
6.	Illustrate types of multiple reactions, namely parallel and series.	6.	Differentiate between desired and undesired reactions and understand the types of multiple reactions.

Curriculum Content	**Hours**
Unit I Review on Basics: 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.	04
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	07

their interrelation, Temperature dependency of rate Constant -Arrhenius law, Transition state theory and collision theory.	
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.	07

Suggested Text Books:	
1.	O. Levenspeil, 'Chemical Reaction Engineering', 3 rd. Edition, John Wiley & Sons (2001)
2.	H. S. Fogler, 'Elements of Chemical Reaction Engineering', 3 rd. Edition, Prentice Hall (2001)
Suggested Reference Books:	
1.	J.M. Smith, 'Chemical Engineering Kinetics', 3 rd. Edition, McGraw Hill (1984)
2.	S. M. Walas, 'Reaction Kinetics for Chemical Engineers', McGraw Hill, New York (1959)
3.	J. Rajaram and J. C. Kuriacose, 'Kinetics and Mechanics of Chemical Transformation', McMillan India Ltd., (1993)

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester V**					
Course Title	**:**	**Inorganic Chemical Technologies**			***Course Code***	**:**	CH313
Teaching Scheme (Hours)	**:**	Lecture	04 Hours/Week		***Total Credits***	**:**	04
		Tutorial	00 Hours/Week				
Evaluation Scheme (Marks)	**:**	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	**:**	03 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	BS-12A2, CH211					
Course Domain	**:**	Program Core					

Course Rationale: Chemical Industries are the prime factors to convert the raw materials into desired products that we use in daily life. This sector has brought a tremendous change in the way the things operate. It is very important for us to understand the importance of the chemical industry which has touched all our facets of life like agriculture, environment, food, hygiene, catalysis, construction etc. It has also significantly used in re-cycling industries to curb the usage of virgin products. The proposed course will cover all these aspects in relation to the developments at the international level.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Impart knowledge of sources and processes for manufacture of various fuels and fuel gases manufactured or used in industry;	1.	Identify and select various fuels and fuel gases for different applications;
2.	Explain various processes for manufacture of chlor-alkali products;	2.	Understand manufacturing of different chlor-alkali compounds and their uses;
3.	Discuss various manufacturing processes for Sulphur compounds;	3.	Identify correct process for production of Sulphur for industrial application purpose;
4.	Elaborate different methods used for manufacture of phosphorous compounds;	4.	Differentiate between different methods for phosphorous production;
5.	Describe various manufacturing processes for potassium and its compounds.;	5.	Explain manufacture of potassium compounds and their applications;
6.	Explain various manufacturing processes and applications for nitrogen-based compounds.	6.	Outline manufacturing methods for production and applications of nitrogen compounds.

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, and acetylene. Concept, types and applications of fuel cells	10
Unit II Chlor-Alkali Industries: Manufacture of Soda ash, caustic soda, chlorine, sodium sulphate and byproducts, bleaching powder, sodium bicarbonate, aluminum, chlorates and per chlorates.	10

Unit III Sulfur and Sulphuric Acid Industries: Mining of Sulphur and manufacture of sulphuric acid. Manufacture of hydrochloric acid, aluminum sulphate and alums	08
Unit IV Phosphate Industries: Study of elemental phosphorous, manufacture of phosphoric acid, Manufacture of ammonium phosphate, Super phosphate and Triple Super phosphate manufacture, baking powder	08
Unit V Potassium Industries: Manufacture of potassium, potassium chloride, potassium sulphate and potassium nitrate	08
Unit VI Nitrogen Industries: Manufacture of synthetic ammonia, nitric acid, urea, ammonium nitrate, Ammonium Sulphate	08

Suggested Text Books:	
1.	Gopal Rao M. and Sittig M., "Dryden's Outlines of Chemical Technology", 3rd Edition, East– West Press Pvt Ltd., New Delhi, 2000
2.	George T. Austin, "Shreve's Chemical Process Industries", 5th edition. , McGraw Hill Book Company, 1985
Suggested Reference Books:	
1.	Shukla S.D. and Pandey G.N., "Text book of Chemical Technology", Vikas Publishing House Private, Limited, 1977
2.	D. Venkteshwaralu, Chemical Technology, I & III manuals of Chemical Technology, Chemical Engineering. Ed. Dev. III Madras, 1977
3.	Moulijn J. K; Makkee M. and van Diepen A; "Chemical Process Technology", Wiley, 2001
4.	Perry R. H., Green D. W., Perry's chemical Engineer's Handbook, McGraw Hill, New York, 2007

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester V**					
Course Title	**:**	**Safety in Chemical Industry**			***Course Code***	**:**	CH314
Teaching Scheme (Hours)	**:**	Lecture	03 Hours/Week		***Total Credits***	**:**	03
		Tutorial	00 Hours/Week				
Evaluation Scheme (Marks)	**:**	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	**:**	03 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	CH214, CH224, CH212					
Course Domain	**:**	Ethics, Environment and Safety					

Course Rationale: The purpose of this course is to give an understanding of basic aspects related to chemical safety. It will provide an introduction to the scope of hazardous substances and the problems they pose at the places of work. The implementation of effective chemical process safety measures prevents incidents and accidents at pilot or manufacturing scale. Therefore, Chemical Engineers must be fully aware of all the safety concerns underlying their industry.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Discuss various safety programs, engineering ethics and importance of safety;	1.	Understand and explain the use of safety programs and ethics;
2.	Explain industrial laws, regulations and source models;	2.	List and explain the industrial laws, regulations and source models;
3.	Show different ways of getting fire and explosion and explain how their control is;	3.	Demonstrate different ways of getting fire and explosions and its prevention;
4.	Discuss classification of preventive methods, relief and sizing methods;	4.	Understand relief and its sizing methods;
5.	Impart knowledge of industrial hazards, its risk assessment;	5.	Analyze methods of hazard identification, preventive measures;
6.	Emphasis on taking responsibility to ensure safety in chemical industry, further will explain few case studies.	6.	Realize responsibility to ensure safety in chemical industry, further interpret case studies.

Curriculum Content	**Hours**
Unit I Safety Concepts and Necessity: Safety Programs, Engineering Ethics, Accident and Loss Statistics, Acceptable 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.	06
Unit II Industrial Hygiene: Government Laws and Regulations, OSHA: Process Safety Management**,** 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	07

or Vapors through Holes and Pipes, Flashing Liquids, Liquid Pool Evaporation or Boiling, Conservative Analysis.	
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.	09
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.	08
Unit V Hazards Identification: Process Hazards Checklists, Hazards Surveys, Hazards and Operability Studies, Safety Reviews, Other Methods, Risk Assessment: Review of Probability Theory, Event Trees, Fault Trees, QRA and LOPA.	07
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.	03

Suggested Text Books:	
1.	D.A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall, 2011.
Suggested 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 2nd editon John Wiley and Sons Inc. (1982).

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester V**					
Course Title	**:**	**Mass Transfer Operations-I**			***Course Code***	**:**	CH315
Teaching Scheme (Hours)	**:**	Lecture	04Hours/Week		***Total Credits***	**:**	05
		Tutorial	01 Hours/Week				
Evaluation Scheme (Marks)	**:**	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	**:**	03 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	CH211, CH212,CH215,CH224					
Course Domain	**:**	Program Core					

Course Rationale: This course will provide an overview of mass transfer operation at basic to an intermediate level. This course applies the concepts of diffusion and interphase mass transfer to the analysis of different mass transfer operations such as absorption and distillation. The goal is to provide students with the theoretical/analytical background to understand mass transfer operations as well as their applications and to tackle the sort of complex problems.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Impart knowledge of the fundamental principles of mass transfer and separation processes;	1.	Understand concepts of molecular diffusion, flux rate, theories of mass transfer, mass transfer coefficient;
2.	Introduce mass transfer principles and basic concepts of mass transport;	2.	Determine diffusivity coefficient in gases and liquids, Determine mass transfer coefficients;
3.	Illustrate solutions for mass transfer numerical involving molecular diffusion;	3.	Understand and apply Fick's law of diffusion and McCabe Thiele method for mass transfer operations;
4.	Explain and discuss VLE process and the vapor liquid equilibrium;	4.	Analyze implications of factors affecting distillation column operation and design like the effect of reflux ratio, feed conditions etc.;
5.	Impart basic concepts of mass transfer in distillation;	5.	Develop and apply criteria for selecting among alternative separation technologies available;
6.	Explain extraction and absorption with reference to principle, types, equilibria, equipment for the same.	6.	Apply concepts of extraction and absorption for some industrial applications through Project Work.

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
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.	12
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.	06
Unit 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.	10

Suggested 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.
Suggested 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.	Richardson & Coulson, "Chemical Engineering", Vol. 2, Pergamon Press, 1970.

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester V**					
Course Title	**:**	**Chemical Reaction Engineering- I Laboratory**			***Course Code***	**:**	CH312L
Teaching Scheme (Hours)	**:**	Practical	2 Hours/Week		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	IPE= 50	EPE =Nil	Grand Total = 50	***Duration of IPE***	**:**	02 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	CH211, CH221					
Course Domain	**:**	Program Core with Practical Skills					

Course Rationale: The purpose of this course is to provide the students hands-on experience for various topics pertaining to chemical reaction engineering. Through this course they will also acquire adequate knowledge on various type of reactors, experimental data analysis, technical report writing and work in teams.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Impart knowledge on types of chemical reactors;	1.	Identify the type of chemical reactors;
2.	Demonstrate and explain the principles of reaction kinetics through experiments;	2.	Determine the value of rate constant and activation energy of the reactions;
3.	Discuss about the performance of various types of reactors.	3.	Demonstrate various experiment for reactors connected in series.

General Instructions: Any 8 experiments to be performed from the list, any 2 experiments to be studied as demonstration.

Sr. No.	***List of Experiments***
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
Suggested Text Books/ Reference Books/Manual	
1.	H. S. Fogler, ‘Elements of Chemical Reaction Engineering’, 3 rd. Edition, Prentice Hall (2001)
2.	J.M. Smith, ‘Chemical Engineering Kinetics’, 3 rd. Edition, McGraw Hill (1984)
3.	S. M. Walas, ‘Reaction Kinetics for Chemical Engineers’, McGraw Hill, New York (1959)

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester V**					
Course Title	**:**	**Mass Transfer Operation-I Laboratory**			***Course Code***	**:**	CH315L
Teaching Scheme (Hours)	**:**	Practical	2 Hours/Week		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	IOE= 50	EPE=50	Grand Total = 100	***Duration of EPE***	**:**	2 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	CH212, CH215, CH222					
Course Domain	**:**	Program core					

Course Rationale: This laboratory course introduces to the undergraduate students, the most important separation equipment in the process industry. Also the purpose of this course is to provide the students hands-on experience in various mass transfer operations.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Provide students hand-on experiments relevant to the principles studied in the Mass Transfer Operations theory;	1.	Perform experiments in relation to the Mass Transfer fundamentals;
2.	Demonstrate methodology to find out the equilibrium data for various systems;	2.	Determine diffusivity and mass transfer coefficients;
3.	Impart knowledge for estimation of diffusivity coefficients and mass transfer coefficients.	3.	Compare equilibrium data developed with the theoretical data and Evaluate the effectiveness of different separation techniques.

General Instructions: Any 8 experiments to be performed from the list.

Sr. No.	***List of Experiments***
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 (M=2)

Suggested Text Books/ Reference Books/Manual

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

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester V**					
Course Title	**:**	**Case Studies and Seminar**			***Course Code***	**:**	CH316L
Teaching Scheme (Hours)	**:**	Lecture	00 Hours/Week		***Total Credits***	**:**	01
		Tutorial	01 Hours/Week				
Evaluation Scheme (Marks)	**:**	IOE=50	EOE = Nil	Grand Total =50	***Duration of EOE***	**:**	NA
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	HS212					
Course Domain	**:**	Presentation and Communication skills					

Course Rationale: A case study is an investigation by a single person, business, event, or group into an individual circumstance. It involves collecting in-depth data about the individual entity through the use of several collection methods. Interviews and observation are two of the most common forms of data collection used. The purpose of this course is to provide an overview of recent trends and debates on the case studies in chemical engineering through seminars delivered by students.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Promote self-study, critical thinking and independent research ability by developing student's skills in: problem solving, self-learning, decision making in critical situations and Improving research ability;	1.	Understand and analyze scientific challenges through the various case studies undergone;
2.	Encourage and assess student's case study analysis;	2.	Achieve higher level of competency for any seminar and presentation;
3.	Impart knowledge for improvement in the collection of scientific data for assigned case study;	3.	Develop their overall personality by carving their presentation, aptitude, and research skills;
4.	Encourage students to broaden their knowledge base upon their interest in studies and encourage them to present case studies confidently.	4.	Acquire skills required for working together as a team to get benefited in terms of facilitates idea generation, Motivated, moral support, and high-risk capability.

Curriculum Content	**Hours**
Unit I 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.	08
Unit II 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.	10

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester V**					
Course Title	**:**	**Industrial Safety and Hazard Management**			***Course Code***	**:**	HS317L
Teaching Scheme (Hours)	**:**	Tutorial	1 Hours/Week		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	IOE = 50	EOE=Nil	Grand Total = 50	***Duration of IOE***	**:**	02Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	Knowledge of various courses studies hitherto will prove to be fruitful for better adapting to the course.					
Course Domain	**:**	Ethics, Environment, Society and Management					

Course Rationale: The purpose of this course is to inculcate the Management principles and Techniques for good industrial practices towards Safety, Health and Environment. The course is intended to introduce the students to the knowledge of industrial safety and hazard management.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Discuss about Industrial safety programs and toxicology, Industrial laws, regulations and source models;	1.	Analyze the effect of release of toxic substances;
2.	Demonstrate and explain fire and explosion, preventive methods, relief and its sizing methods;	2.	Understand the industrial laws, regulations and source models;
3.	Describe industrial hazards and its risk assessment;	3.	Apply the methods of prevention of fire and explosions;
4.	Impart knowledge about occupational health, industrial hygiene, and accidental prevention techniques to the students;	4.	Understand the relief and its sizing method;
5.	Make students aware about safety auditing and management systems, pollution prevention techniques etc.	5.	Understand the methods of hazard identification and preventive measures.

General Instructions: While tutorial hours, any 8 study experiments from the list to be learnt with any 2 experiments to be studied as demonstration conducted at the Environmental Science Department, Shivaji University, Kolhapur.

Sr. No.	***List of Study Experiments***
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.
Suggested Text Books/ Reference Books/Manual	
1.	D.A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall, 2011.
2.	R.K. Sinnott, Coulson & Richardson's, Chemical Engineering, Vol. 6, Elsevier India, 2006.
3.	Fawcett H.H. and W.S.Wood, Safety and accident prevention in Chemical operations 2ndediton John Wiley and Sons Inc. (1982).

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester V**					
Course Title	**:**	**Internship I**			***Course Code***	**:**	CH318L
Teaching Scheme (Hours)	**:**	Practical*	5 Days/Week		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	IOE = Nil	EOE=50	Grand Total = 50	***Duration of EOE***	**:**	05Hrs. for Entire class
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	NA					
Course Domain	**:**	Core for real world experience					

Course Rationale: The purpose of this course is to expose the students for identification of knowledge and skills essential to do well in a particular profession by hands on experience in industry for a month. *The particular internship period is post IV semester and pre-V semester.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Help expose students to the 'real' working environment;	1.	Get acquainted with the organization structure, business operations and administrative functions;
2.	Promote hands-on experience to the students' in their related field;	2.	Acquire ability to utilize technical resources and use the new ways of learning and thinking;
3.	Develop synergetic collaboration between industry and the university in promoting a knowledgeable society;	3.	Prepare the technical documents and make oral presentations related to the task assigned;
4.	Assist in providing the opportunity for students to test their interest in a particular career before permanent commitments are made.	4.	Develop attitude of a team player and aptitude for lifelong learning.

Course Description	**Hours (4 Weeks)**
Internship I which is a part of Semester V evaluation is the activity performed after the SEE of semester IV. It was mandatory for all the students to undergo the same and report to the institute for the semester V along with the completion certificate by the concerned organization. The students are bound to submit a hard as well as soft copy of the activity report to the institute.	

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester V**								
Course Title	**:**	**Introduction to Foreign Language**						***Course Code***	**:**	LS311
Teaching Scheme (Hours)	**:**	Lecture	2 hours/week= 2 x 14 = 28 hours					***Total Credits***	**:**	Nil
Evaluation Scheme (Marks)	**:**	Assignments Viva-voce	: :	50 25	Written Test Grand Total	: :	25 100	***Duration of SEE***	**:**	NA
Revision	**:**	Fourth						***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	No								
Course Domain	**:**	Language								

Course Rationale: This course provides a competitive edge for engineering graduates in their career choices. They will be able to communicate in a second language. The course enhances listening, reading skills and memory. Our graduates may be able to participate more effectively and responsibly in a multi-cultural world if they know another foreign language in addition to the English.

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: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Help students to understand basics and deepen their knowledge in a chosen foreign language;	1.	Learn alphabets, acquire knowledge of basic grammar of the foreign language, common words and phrases therein;
2.	Guide them to communicate and translate in the chosen foreign languages;	2.	Learn to read the simple texts in foreign language;
3.	Help them describe, narrate, and ask/answer questions in the foreign language in the present time about a variety of topics related to family, daily activities, eating, and traveling;	3.	Speak a little using the greetings, well wishes etc. in Foreign Language;
4.	Comprehend the foreign language with sufficient ability to grasp the main idea and some supporting details in short conversations (spontaneous or recorded) that pertain to the topics mentioned above;	4.	Count numbers, answer to the questions like, what is your name, surname, tell age, and can initiate little communication in Foreign Language;
5.	Explain how to write sentences and short paragraphs on familiar topics relating to personal interests and practical needs;	5.	Translate both verbally and written, simple sentences in the foreign language;
6.	Narrate on how the foreign language functions with awareness and understanding of the language culture.	6.	Achieve institute's mission with respect to global education and foreign language education.

Curriculum Content	**Hours**
Unit I: General Information on Basic Grammar of the foreign language, Introduction to alphabets.	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

Suggested Reference Books:

1.	V.N.Wagner and V. G. Ovsienko, “Russian Language”, Russian, People’s Publishing House, New Delhi.
2.	S. Khavronina and A. Shirochenskaya, “Russian in Exercises”, 1991.
3.	“Genki – Japan Times”.
4.	Osamu & Nobuko Mizutani, “Aural Comprehension in Japanese”.
5.	Osamu & Nobuko Mizutani, “An Introduction to Modern Japanese”.
6.	Y. Yoshida, “Japanese for Today”.
7.	Ed Swick, “The Everything Learning German Book: Speak, Write and Understand Basic German in No Time”.
8.	Ed Swick, “Living German”.
9.	Eugene Jackson and Adolph Geiger, “German Made Simple: Learn to Speak and Understand German Quickly and Easily”.
10.	Professor Martin Durrell, “Hammer’s German Grammar and Usage” (Fifth Edition).

Class, Part & Semester	:	**Third Year B. Tech (Chemical Engineering), Part III & Semester VI**					
Course Title	:	**Chemical Reaction Engineering-II**			***Course Code***	:	CH321
Teaching Scheme (Hours)	:	Lecture	04 Hours/Week		***Total Credits***	:	05
		Tutorial	01 Hours/Week				
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	:	03 Hrs.
Revision	:	Fourth			***Month***	:	June 2022
Pre-requisites *(If any)*	:	BS-12A2, CH211, CH212, CH213 and CH221					
Course Domain	:	Program core					

Course Rationale: Multiphase catalytic and non-catalytic reactors are immanent in chemical, biochemical and petrochemical industries. Effective design of such reactors for improved productivity requires detailed understanding of the underlying principles that govern their functioning. This second level course on chemical reaction engineering extensively covers design of fluid-solid catalytic and non-catalytic reactors. Moreover, various aspects of residence time distribution, an important and often parameter used for various fault-diagnosis purposes is also covered with its applicability in designing reactors. The content of this course will build on the basic topics of the first level chemical reaction engineering course.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Impart knowledge of effect of temperature and pressure in homogeneous reactions;	1.	Evaluate reactor performance for reactors when the temperature is not uniform within the reactor;
2.	Impart knowledge of deviations in chemical reactors and to understand the parameters that influences the models of non-ideal reactors;	2.	Evaluate reactor performance under non-ideal flow situations using RTD data;
3.	Discuss rate-controlling model for heterogeneous reactions in which gas or liquid contacts a solid & reacts with it;	3.	Develop rate-controlling model for heterogeneous catalytic reactions;
4.	Illustrate rate equation for heterogeneous reactions, mass transfer and reaction;	4.	Develop rate equation for heterogeneous fluid -fluid reactions;
5.	Elaborate effects of diffusion, mass and heat transfer in catalyst pellet in reaction rates and the significance of Thiele modulus;	5.	Estimate the effects of diffusion, mass and heat transfer in catalyst pellet on reaction rates;
6.	Discuss various types of reactors and factors affecting the choice of reactor.	6.	Understand the different types of reactors and its affecting factors.

Curriculum Content	**Hours**
Unit I Temperature and pressure effects in homogeneous reactions: Heats of reaction and equilibrium constants from thermodynamic, Equilibrium Conversion, Optimum temperature progression, Adiabatic and non-adiabatic operations, Temperature and conversion profiles for exothermic and endothermic reactions, Stable operating condition in reactors.	08
Unit II Non-Ideal Flow: Non-ideal flow, Residence time distribution (Importance and interpretation of RTD curve, E, F and C curves and relationship between them in reactor, Statistical Interpretation,	10

RTD measurement, Conversion in non-ideal flow reactors, Dispersion model), Tanks-in-series model, Mixing of fluids; Degree of segregation; Laminar flow reactor; Conversion in segregated flow; Early and late mixing.	
Unit III Fluid-particle reactions: Introduction to fluid particle reactions, Kinetics- selection of a model, shrinking core model for spherical particles of unchanging size, rate of reaction for shrinking spherical particles, determination of rate controlling. Fluid particle reactor design for non-catalytic heterogeneous reactions.	09
Unit IV Fluid-fluid reactions: Introduction to fluid-fluid reaction systems, Rate equations, Reactor design with and without mass transfer considerations.	07
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, Deactivating catalysts mechanisms of catalyst deactivation, the rate and performance equations.	10
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.	08

Suggested Text Books:	
1.	O. Levenspeil, 'Chemical Reaction Engineering', 3 rd. Edition, John Wiley & Sons (2001)
2.	H. S. Fogler, 'Elements of Chemical Reaction Engineering', 3 rd. Edition, Prentice Hall (2001)
3.	S. M. Walas, 'Reaction Kinetics for Chemical Engineers', McGraw Hill, New York (1959)
Suggested Reference Books:	
1.	J.M. Smith, '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.	J.J.Carberry, 'Chemical & Catalytic Reaction Engineering', McGraw Hill (1976)
4.	Julian R.H. Ross, 'Homogeneous Catalysis-Fundamentals and Applications', Elsevier (2011)
5.	I. Chorkendroff, J.W., Niemounts Verdriet, 'Concepts of Modern Catalysis and Kinetics', John Wiley and Sons (2006)

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester VI**					
Course Title	**:**	**Industrial Pollution Control**			***Course Code***	**:**	CH322
Teaching Scheme (Hours)	**:**	Lecture	03Hours/Week		***Total Credits***	**:**	03
		Tutorial	Nil				
Evaluation Scheme (Marks)	**:**	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	**:**	03 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites	**:**	HS211, CH211L, CH221L, CH217L, CH214, CH224 and CH225					
Course Domain	**:**	Ethics, Society and Environment					

Course Rationale: The course is designed to learn a variety of chemical, physical, biological treatment processes related to industrial pollution control, the main concepts of pollution prevention which minimize wastes and prevent pollution. This course also deals with risk assessment, environmental standards, and regulatory loading limits and helps the Students learn key treatment processes that are central to industrial pollution control. The course presents pollution prevention and waste minimization concepts, terminologies, life cycle impacts, and management strategies.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain pollution, its type, effects and control, also related laws, regulations and standards;	1.	Identify sources, types of pollutants and determine their impact on the environment, related laws and standards;
2.	Discuss air pollution sources, properties, measurements, control methods with control devices and efficiency analysis, as well as their applications;	2.	Understand causes and preventive measures against air pollution;
3.	Discuss basics of water pollution sources, properties, measurement and control techniques;	3.	Follow sampling, measurement of various water pollutants, natural purification process, design various wastewater treatments methods;
4.	Explain sources, effects and control of noise and odor pollution and describe the details about waste management in chemical industries;	4.	Implement the methods and techniques for solid waste, noise and odor control;
5.	Discuss pollution prevention strategies in industrial processes;	5.	Identify and Select the technologies for specific effluents removal from the process industries;
6.	Describe how to select appropriate treatment processes for specific effluents emerging from different process industries.	6.	Acquaint with the pollution control in different process industries.

Curriculum Content	**Hours**
Unit I Environmental Pollution: 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 (CDM), Kyoto protocol.	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	08

chamber, solid traps, cyclone separator fabric filters, liquids scrubbers and ESP., Numerical problems based on theory. Gaseous pollution control- absorption, adsorption, combustion, removal of SOx, NOx, air pollution control standards: WHO, BIS, MPCB, CPCB.	
Unit III Water pollution control in industries: sources, effects of water pollutants, wastewater characteristics- DO, BOD, COD, TOC, total suspended solids, color and odor, determination of BOD and BOD constants, Water quality standards: ICMR, WHO, MPCB and CPCB, wastewater treatment- activated sludge process, trickling filters, waste stabilization ponds etc. Advanced wastewater treatment UASB, photo catalytic reactors. Removal of heavy metals- methods of removal of mercury, chromium, Removal of nitrogen, phosphorous. Numerical problems based on the theory.	07
Unit IV Industrial odor and noise control and Solid Waste Management: sources and solutions, odor control by adsorption and wet scrubbing. Industrial noise pollution: measurement & control, effect on man & environment. Solid Waste Management**:** 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 the 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

Suggested Text Books:	
1.	Rao, C.S., Environmental Pollution Control Engineering, New Age International (P) Ltd
2.	Peavy, H. S., Rowe, D.R., Tchobanoglous, G., Environmental Engineering, McGraw-Hill Book Company Limited
3.	Metcalf et al., Waste Water Treatment, Disposal & Reuse, Tata McGraw Hill Publishing Company Limited
4.	Mahajan, S.P., Pollution Control in Process Industries, Tata McGraw Hill Publishing Company Limited.
5.	Davis, M. L. And Cornwell, D. A., Introduction to Environmental Engineering, McGraw-Hill Series in Water Resources and E
Suggested Reference Books:	
1.	Hilary Theisen and Samuel A, Vigil, George Tchobanoglous, “Integrated Solid Waste Management”, McGraw-Hill, New York, 1993
2.	Frank Woodard, Industrial waste treatment Handbook, Butterworth Heinemann, New Delhi, 2001.

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester VI**					
Course Title	**:**	**Mass Transfer Operations-II**			***Course Code***	**:**	CH323
Teaching Scheme (Hours)	**:**	Lecture	03Hours/Week		***Total Credits***	**:**	04
		Tutorial	01Hours/Week				
Evaluation Scheme (Marks)	**:**	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	**:**	03 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites	**:**	CH212, CH215, CH222					
Course Domain	**:**	Program Core					

Course Rationale: Chemical engineers have to supervise the preliminary purification of raw materials or final separation of products from by-products. They have to deal with changes in composition of solutions known as the mass-transfer operations. A substantial number of the unit operations of chemical engineering are concerned with the problem of changing the compositions of solutions and mixtures through methods involving chemical reactions. The course has been designed to develop these competencies and its associated cognitive, practical and effective domain learning out comes. This second course covers those mass transfer operations that have not been covered in the first course.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain the principle and fundamental concepts of mass transfer operations;	1.	Apply this fundamental knowledge in the area of chemical engineering;
2.	Classify various operations of mass transfer;	2.	Understand various mass transfer operations used in chemical industry;
3.	Discuss material and energy balance of mass transfer operations;	3.	Carry out material and energy balance for different operations in chemical industry;
4.	Demonstrate engineering problems related to mass transfer operations;	4.	Solve the engineering problems of drying, humidification, crystallization, adsorption and evaporation operations etc.;
5.	Explain the role of membrane separation operation in the field of chemical engineering.	5.	Understand the significance, role and selection of membrane separations operations and handling.

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, Equipment 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

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

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester VI**					
Course Title	**:**	**Organic Chemical Technologies**			***Course Code***	**:**	CH324
Teaching Scheme (Hours)	**:**	Lecture	03 Hours/Week		***Total Credits***	**:**	03
		Tutorial	00 Hours/Week				
Evaluation Scheme (Marks)	**:**	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	**:**	03 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	BS-12A2, CH211, CH221					
Course Domain	**:**	Program Core					

Course Rationale: Chemical process industry sector has been playing important role in the development of a country in order to meet the basic needs of mankind. There has been continuous upgradation in technologies for improving the overall economy of the process. The purpose of this course is to improve knowledge of the chemical processes along with emphasis on recent technological development. The course primarily covers studies of process technologies, availability of raw materials, production trends, preparation of flow sheets, engineering and environmental problems of various organic based chemical industries

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Impart knowledge about sources and processes pertaining to Food Industry;	1.	Identify various components of food industry and its quality concern;
2.	Explain various processes for manufacture of oils and surfactants;	2.	Classify different oils and surfactants and understand related manufacturing;
3.	Discuss various manufacturing processes for pharmaceutical compounds;	3.	Understand correct processes for production of pharma compounds for industrial application;
4.	Elaborate different methods used for paper manufacture;	4.	Remember different methods for paper and pulp production;
5.	Describe various processes for plastic and explosives;	5.	Recognize various manufacture of plastic and explosives;
6.	State the processes and application for petroleum-based compounds.	6.	Visualize various methods and applications for petroleum and its compounds.

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	06
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	06
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

Suggested Text Books:	
1.	Gopal Rao M. and Sittig M., "Dryden's Outlines of Chemical Technology", 3rd Edition, East– West Press Pvt Ltd., New Delhi, 2000
2.	George T. Austin, "Shreve's Chemical Process Industries", 5th edition. , McGraw Hill Book Company, 1985
Suggested Reference Books:	
1.	Shukla S.D. and Pandey G.N., "Text book of Chemical Technology", Vikas Publishing House Private, Limited, 1977
2.	D. Venkteshwaralu, Chemical Technology, I & III manuals of Chemical Technology, Chemical Engineering. Ed. Dev. III Madras, 1977
3.	Moulijn J. K; Makkee M. and Van Diepen A; "Chemical Process Technology", Wiley, 2001
4.	Perry R. H., Green D. W., Perry's chemical Engineer's Handbook, McGraw Hill, New York, 2007

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester VI**					
Course Title	**:**	**Process Instrumentation and Control**			***Course Code***	**:**	CH325
Teaching Scheme (Hours)	**:**	Lecture	04 Hours/Week		***Total Credits***	**:**	04
		Tutorial	00 Hours/Week				
Evaluation Scheme (Marks)	**:**	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	**:**	03 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	CH-213, CH-215					
Course Domain	**:**	Program Core					

Course Rationale: This purpose of this course is to impart knowledge of various instruments used to measure various process parameters. It also covers content on working principle, construction, repair and use of these instrument and basics of process control.

	Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to
1.	Impart knowledge about working principles of basic instruments available for flow, pressure, level and temperature measurement;	1.	Explain working principles of basic instruments available for flow, pressure, level and temperature measurement;
2.	Explain dynamic behavior and modeling of process systems and equipment;	2.	Model dynamical system and describe the use and measurement of transfer functions;
3.	Revise Laplace and Inverse Laplace Transforms in order to obtain transfer functions and dynamic responses;	3.	Apply knowledge of Laplace Transforms to model and solve those describing dynamics of chemical processes;
4.	Explain stability characteristics of dynamic systems and its analysis;	4.	Analyze stability of control loops;
5.	Demonstrate working of P, PI and PID controllers in chemical and process industries.	5.	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 nonlinear 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.	10

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.	
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

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

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester VI**					
Course Title	**:**	**Chemical Reaction Engineering- II Laboratory**			***Course Code***	**:**	CH321L
Teaching Scheme (Hours)	**:**	Practical	2 Hours/Week		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	IPE= Nil	EPE=50	Grand Total = 50	***Duration of EPE***	**:**	02Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	CH211, CH221					
Course Domain	**:**	Program Core with Practical Skills					

Course Rationale: The purpose of this course is to provide the students hands-on experience in chemical reaction, RTD in different reactors, experimental data analysis, technical report writing.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Introduce students with main prototype chemical reactors and demonstrate reactor performance;	1.	Visualize different types of chemical reactors and practically handle the same;
2.	Demonstrate concept of residence time distribution in reactor systems;	2.	Characterize laboratory reactors through residence time distributions;
3.	Discuss about the non-catalytic homogeneous reaction in different reactors.	3.	Design and scale up the reactor on the basis of kinetic data obtained at lab scale.

General Instructions: Any 8 experiments to be performed from the list, any 2 experiments to be studied as demonstration.

Sr. No.	***List of Experiments***
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.

Suggested Text Books/ Reference Books/Manual

1.	H. S. Fogler, 'Elements of Chemical Reaction Engineering', 3 rd. Edition, Prentice Hall (2001)
2.	J.M. Smith, 'Chemical Engineering Kinetics', 3 rd. Edition, McGraw Hill (1984)
3.	S. M. Walas, 'Reaction Kinetics for Chemical Engineers', McGraw Hill, New York (1959)

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester VI**					
Course Title	**:**	**Mass Transfer Operation- II Laboratory**			***Course Code***	**:**	CH323L
Teaching Scheme (Hours)	**:**	Practical	2 Hours/Week		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	IPE = Nil	EPE=50	Grand Total = 50	***Duration of EPE***	**:**	02Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	CH212, CH215 and CH222					
Course Domain	**:**	Program Core with Practical Skills					

Course Rationale: The purpose of this course is to provide the students hands-on experience in Mass Transfer Operations, experimental data analysis, technical report writing.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Train the students for practical through experiments to understand and appreciate the concepts learnt in mass transfer operations;	1.	Apply practical knowledge to industrial applications and for developing or modifying methods;
2.	Demonstrate adsorption, evaporation mechanism, crystallization method through experiments;	2.	Understand the preparations of solid crystals using crystallization operation and evaporation of solution using different heating media;
3.	Explain simple techniques of mass transfer without chemical reactions;	3.	Understand the difference between mass transfer operations with and without chemical reaction;
4.	Discuss and explain the kinetics of adsorption operation.	4.	Understand and explain adsorption kinetics.

General Instructions: Any 8 experiments to be performed from the list, any 2 experiments to be studied as demonstration.

Sr. No.	***List of Experiments***
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.

Suggested Text Books/ Reference Books/Manual	
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.
3.	Coulson J.M., Richardson J.F., Backhurst J. R., Harker J.H. "Coulson & Richardson's Chemical Engineering", Vol. 1, 6th Ed., Elsevier, New Delhi, 2004

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester VI**					
Course Title	**:**	**Organic Chemical Technologies Laboratory**			***Course Code***	**:**	CH324L
Teaching Scheme (Hours)	**:**	Practical	2 Hours/Week		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	IPE = 50	EOE= Nil	Grand Total = 50	***Duration of IPE***	**:**	02Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	BS12A2, CH211L, CH217L, CH221L					
Course Domain	**:**	Program Core with Practical Skills					

Course Rationale: The purpose of this course is to acquaint the students with practical knowledge of the terms like acid value, iodine value, and saponification value. It also covers various preparation methods for organic compounds in the industry/engineering and experimental skills for building technical competence.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Demonstrate good laboratory practices & standard operating procedures;	1.	Understand and follow to good laboratory practices & standard operating procedures;
2.	Illustrate preparation of standard solutions and use appropriate calibration methods;	2.	Formulate and solve problems in the laboratory;
3.	Demonstrate uses and operations of various preparation methods for chemical compound;	3.	Use standard laboratory equipment, methods and classical techniques to carry out experiments;
4.	Explain procedures to prepare various compounds and its analysis;	4.	Perform the experiments and analysis for different compounds;
5.	Demonstrate presentation of results of laboratory experiments through effective writing and verbal communication skills.	5.	Communicate the concepts and results of their laboratory experiments through effective writing and oral communication skills.

General Instructions: Any 8 experiments to be performed from the list, any 2 experiments to be studied as demonstration.

Sr. No.	***List of Experiments***
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.
Suggested Text Books/ Reference Books/Manual	
1.	Gopal Rao M. and Sittig M., "Dryden's Outlines of Chemical Technology", 3rd Edition, East– West Press Pvt Ltd., New Delhi, 2000
2.	George T. Austin, "Shreve's Chemical Process Industries", 5th edition. , McGraw Hill Book Company, 1985
3.	Shukla S.D. and Pandey G.N., "Text book of Chemical Technology", Vikas Publishing House Private, Limited, 1977

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester VI**					
Course Title	**:**	**Process Instrumentation and Control Laboratory**			***Course Code***	**:**	CH325L
Teaching Scheme (Hours)	**:**	Practical	2 Hours/Week		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	IOE = 50	EPE=Nil	Grand Total = 50	***Duration of IOE***	**:**	02Hrs.
Revision	**:**	Fourth			***Month***	**:**	June2022
Pre-requisites *(If any)*	**:**	CH-213, CH-215, CH217L					
Course Domain	**:**	Program Core with Practical Skills					

Course Rationale: The purpose of this course is to apply the key concepts of automatic control and instrumentation to process plants.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain practical aspects of dynamic behavior of the systems;	1.	Understand the modern hardware and instrumentation needed to implement process control;
2.	Discuss and evaluate effect of controller on the control system;	2.	Analyze practical issues in control engineering and the benefits of control engineering;
3.	Demonstrate and explain the basic components of feedback control system.	3.	Explain effect of P, PI and PID controllers in process control.

General Instructions: Any 8 experiments to be performed from the list, any 2 experiments to be studied as demonstration.

Sr. No.	***List of Experiments***
1.	Dynamic behavior of first order system: Mercury Thermometer;
2.	Dynamic behavior of first order system: Single tank system;
3.	Dynamic behavior of first order system: C.S.T.R;
4.	Dynamic behavior of first order system in series: Two tank non-interacting system;
5.	Dynamic behavior of first order system in series: Two tank interacting system;
6.	Dynamic behavior of second order system: Mercury Manometer;
7.	Dynamic behavior of final control Element: Pneumatic control valve. Study of Pneumatic controllers;
8.	Dynamic behavior of final control Element: Proportional Controller;
9.	Dynamic behavior of final control Element: Proportional Derivative Controller;
10.	Dynamic behavior of final control Element: Proportional Integral Controller and Proportional Integral Derivative.

Suggested Text Books/ Reference Books/Manual

1. Coughanowr, D. R. and L. B. Koppel, Process systems Analysis and Control, Mc-Graw-Hill, 2nd. Ed. 1991

2.	Stephanopoulos, G., Chemical Process Control: An Introduction to Theory and Practice, Prentice-Hall, New Jersey, 1984.
3.	Luyben, W. L., Process Modelling Simulation and Control for Chemical Engineers McGraw Hill, 1990.

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester VI**					
Course Title	**:**	**Micro Project**			***Course Code***	**:**	CH326L
Teaching Scheme (Hours)	**:**	Tutorial	1Hour/Week		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	IOE=Nil	EOE = 50	Grand Total =50	***Duration of EOE***	**:**	02Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	The pre-requisite for this course is to have the overview of the fundamental courses of Chemical Engineering and Chemical Technology.					
Course Domain	**:**	Research skills with Project Based Learning					

Course Rationale: With this course serving purpose of project-based learning, students are motivated for active and engaged learning. The course inspires students to obtain a deeper knowledge of the subjects they're studying. Research also indicates that students are more likely to retain the knowledge gained through this approach far more readily than through traditional textbook-centered learning. In addition, students develop confidence and self-direction as they move through both team-based and independent work. It is expected that they spare at least an hour on week basis to carry out practical activity on the chosen topic.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Describe the Product Development Process including budgeting through Micro Project;	1.	Understand, plan and execute a Micro Project with team;
2.	Explain various activities of the project and distribute the work amongst team members;	2.	Understand importance of team work;
3.	Develop student 's abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Micro Project;	3.	Carry out the practical/theoretical work on the chosen topic and prepare a technical report based on their project work;
4.	Describe importance of document design by compiling Technical Report on the Micro Project work carried out.	4.	Deliver technical seminar based on the Micro Project work carried out.

Course Description:

The course introduces to the students to a project work based on a problem-based learning approach, guided by realistic and challenging customer/society/industry requirements. The course is organized as group work. Based on an idea finalized, the students in a group will follow the research steps towards conducting project work that suits requirement and design of the system to be developed. Preferably, the team members will try to develop some prototype or at least their theoretical background related to the topic chosen will be completed so as to continue the same topic for their major project in the Final Year of their studies. The course in charge will motivate and guide them in each and every stage of the project work. They will complete the task right from topic selection to the final research report writing.

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester VI**					
Course Title	**:**	**Industrial Visits**			***Course Code***	**:**	CH326L
Teaching Scheme (Hours)	**:**	L/T/P	Nil		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	IOE=50	EOE = Nil	Grand Total =50	***Duration of IOE***	**:**	02Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	The pre-requisite for this course is to have the idea of the overview of the fundamental courses of Chemical Engineering and Chemical Technology.					
Course Domain	**:**	Industry based Learning with exposure to real world.					

Course Rationale: With this course serving purpose of industry-based learning, students are motivated for active and engaged learning. The course inspires students to experience knowledge of the subjects they're studying. Because of these visits organized by the Program, students are more likely to be aware and feel affectionate of their own domain of studies. It is expected that they spare at least a couple of days through these visits to reputed chemical industries.

Course Objectives: The Course Teacher/Expert will		***Course Outcomes:*** Students will be able to	
1.	Provide an opportunity to get exposure to the real workstations, plants, machines and systems;	1.	Experience increased practical awareness of various industrial activities;
2.	Provide an opportunity to get the senior industry experts / supervisors to explain about company functions;	2.	Acquaint themselves with interesting facts and newer technologies;
3.	Make a Company tour to understand the end-to-end process at all levels;	3.	Gain interest about their own domain of studies.
4.	Brief about the functioning of machines and systems.	4.	Realize Practical application of instruments handled during course curriculum.

Course Description:

There will be at least two industrial visits to reputed chemical industry (1-2 days) preferably 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 a prescribed specific format for report writing.

Class, Part & Semester	**:**	**Third Year B. Tech (Chemical Engineering), Part III & Semester VI**								
Course Title	**:**	**Research Methodology**						***Course Code***	**:**	RM321
Teaching Scheme (Hours)	**:**	Lecture	2 Hours/week= 2 x 14 = 28 hours					***Total Credits***	**:**	Nil
Evaluation Scheme (Marks)	**:**	Assignments Viva-voce	: :	50 25	Written Test Grand Total	: :	25 100	***Duration of SEE***	**:**	NA
Revision	**:**	Fourth						***Month***	**:**	June 2022
Pre-requisites *(If any)*	**:**	No								
Course Domain	**:**	Research Skills								

Course Rationale: Having studied this course, the researchers can formulate the path to be used in conducting any research and reporting its findings. The course helps in the search of literature, development of research questions and the creation of the most suitable study design. In a way research methodology is the constitution for research.

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: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Introduce research phenomenon and its key components to the students;	1.	Understand some basic concepts of research and its methodologies;
2.	Discuss the role and importance of research in the engineering sciences;	2.	Explain key research concepts and issues;
3.	Identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project;	3.	Read, comprehend, and explain research articles in their academic discipline;
4.	Help identify various sources of information for literature review and data collection;	4.	Select and define appropriate research problem and parameters
5.	Identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.	5.	Follow research procedures of sampling, data collection, analysis and finally reporting of research work.

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: Introduction to Descriptive Statistics, Statistical data, Variable, Classification of data, exploratory data analysis, Measures of central tendency, Dispersion-Standard deviation, Correlation and regression analysis.	06
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.	06
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

Suggested 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 Engineering) Semester V and VI

The above syllabus structure and 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 2022, (Academic year 2022-23).

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. The **major change is in the name of the Program as B.Tech (Chemical Engineering) at the place of B.Tech (Chemical Technology).**

Third Year B.Tech Semester V (Chemical Engineering)

Sr. No	Third Year B.Tech(Chemical Technology) Semester V Pre-revised syllabus	Third Year B.Tech (Chemical Engineering) Semester V Revised syllabus	Remark
1.	Thermal Engineering and Plant Utilities	Thermal Engineering and Plant Utilities	Course objective statements and course outcome statements are revised, contents are revised wherever necessary.
2.	Inorganic Chemical Technologies	Inorganic Chemical Technologies	
3.	Safety in Chemical Industry	Safety in Chemical Industry	
4.	Mass Transfer Operations-I	Mass Transfer Operations-I	
5.	Mass Transfer Operations-I Laboratory	Mass Transfer Operations-I Laboratory	
6.	Case Studies and Seminar	Case Studies and Seminar	
7.	Chemical Reaction Engineering-I	Chemical Reaction Engineering-I	
8.	Chemical Reaction Engineering-I Laboratory	Chemical Reaction Engineering-I Laboratory	
9.	Industrial Safety and Hazard Management (Laboratory)	Industrial Safety and Hazard Management (Tutorial)	
10.	Internship I	Internship I	

Third Year B.Tech Semester VI (Chemical Engineering)

Sr. No	Third Year B Tech (Chemical Technology) Semester VI Pre-revised syllabus	Third Year B.Tech (Chemical Engineering) Semester VI Revised syllabus	Remark
1.	Chemical Reaction Engineering-II	Chemical Reaction Engineering-II	Course objective statements and course outcome statements are revised also, contents are revised wherever necessary.
2.	Organic Chemical Technologies	Organic Chemical Technologies	
3.	Industrial Pollution Control	Industrial Pollution Control	
4.	Mass Transfer Operations-II	Mass Transfer Operations-II	
5.	Chemical Reaction Engineering-II Laboratory	Chemical Reaction Engineering-II Laboratory	
6.	Organic Chemical Technologies Laboratory	Organic Chemical Technologies Laboratory	
7.	Mass Transfer Operations-II Laboratory	Mass Transfer Operations-II Laboratory	
8.	Mini Project	Micro Project	Title is changed and content is defined notionally.
9.	Industrial Visits	Industrial Visits	Course objective statements and course outcome statements are revised, also contents are revised wherever necessary.
10.	Process Instrumentation and Control	Process Instrumentation and Control	
11.	Process Instrumentation and Control Laboratory	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.