ANNAMALAI UNIVERSITY

FACULTY OF ENGINEERING AND TECHNOLOGY

B. E. (Four - Year) Degree Programme (FULL - TIME)

Choice Based Credit System (CBCS)

REGULATIONS 2022

1. Condition for Admission

Candidates for admission to the first year of the four year B.E. Degree programme shall be required to have passed the final examination of the plus 2 Higher Secondary Course with Mathematics, Physics and Chemistry as courses of study and candidates who have passed the Higher Secondary Examination through vocational stream under Engineering, conducted by the Board of Secondary Education, Government of Tamilnadu or an examination of any other authority accepted by the Syndicate of this University as equivalent thereto. They shall satisfy the conditions regarding qualifying marks, age and physical fitness as may be prescribed by the Syndicate of the Annamalai University from time to time.

Candidates who have passed the Diploma programme in Engineering of the State Board of Technical Education, Tamilnadu will be eligible for admission to the second year of the four year degree programme in B.E. under the lateral entry scheme provided they satisfy other conditions.

2. Branches of Study in B.E.

BRANCH I	-	Civil Engineering
BRANCH II	-	Civil and Structural Engineering
BRANCH III	-	Mechanical Engineering
BRANCH IV	-	Mechanical Engineering (Manufacturing)
BRANCH V	-	Electrical and Electronics Engineering
BRANCH VI	-	Electronics and Instrumentation Engineering
BRANCH VII	-	Chemical Engineering
BRANCH VIII	-	Computer Science and Engineering
BRANCH IX	-	Information Technology
BRANCH X	-	Electronics and Communication Engineering
BRANCH XI	-	Computer Science and Engineering (Artificial Intelligence and Machine Learning)
BRANCH XII	-	Computer Science and Engineering (Data Science)

3. Courses of Study and Scheme of Examinations

The courses of study with respective syllabi and the scheme of Examinations are given separately.

4. Choice Based Credit System (CBCS)

The curriculum includes Humanities / Social Sciences /Management, Basic Sciences, Engineering Sciences, Professional Core, Professional/Programme Electives and Open Electives in addition to Seminar & Industrial Training and Project. Each semester curriculum shall normally have a blend of theory, practical

and theory cum practical courses. The total credits for the entire degree Programme is **173 (132** for lateral entry students).

5. Eligibility for the Degree

A candidate shall be eligible for the degree of Bachelor of Engineering if the candidate has satisfactorily undergone the prescribed courses of study for a period of four academic years and has passed the prescribed examinations in all the four academic years. For the award of the degree, a student has to earn a minimum of 173 credits (132 for lateral entry students).

Serve in any one of the Co-curricular activities such as

- National Cadet Corps (NCC)
- National Service Scheme (NSS)
- National Sports Organization (NSO) and
- Youth Red Cross (YRC)

For at least one year. The students enrolled in any one of the co-curricular activities (NCC / NSS / NSO / YRC) will undergo training for about 80 hours and attend a camp of about seven days. The training shall include classes on hygiene and health awareness and also training in first-aid. While the training activities will normally be during weekends, the camp will normally be during vacation period.

(or)

Enrol as a student member of a recognized professional society such as

- Student Chapters of Institution of Engineers (India)
- Student Chapters of other Professional bodies like ICI, ISA, IIChE, IEEE, SAE, ASHRAE, CSI and IWS

5.1 B.E (Honours) Degree

A student shall be eligible to get Under Graduate degree with Honours, if he/she completes an additional 20 credits. Thus the total credits are 193. Out of 193 credits (152 credits for lateral entry students), 20 credits must be earned by studying additional course offered by the same or allied Departments (listed in Annexure) in the fifth, sixth and seventh semesters.

5.2 B.E Degree with Minor Engineering

A student shall be eligible to get Under Graduate degree with additional Minor Engineering, if he/she completes an additional 20 credits. Out of the 193 credits, 20 credits must be earned from the courses offered by any one of the Departments (listed in Annexure) in the Faculty of Engineering and Technology in fifth, sixth and seventh semesters.

6. Assignment of Credits for Courses

Each course is normally assigned one credit per hour of lecture/tutorial per week and half credit for one hour for laboratory or practical or drawing course per week.

7. Duration of the Programme

A student is normally expected to complete the B.E. programme in four years but in any case not more than seven years from the time of admission.

8. Registration for Courses

A newly admitted student will automatically be registered for all the courses prescribed for the first, second and third semesters without any option.

Every other student shall enrol for the courses intended to be credited in the succeeding semester in the current semester itself by completing the registration form indicating the list of courses. This registration will be done a week before the last working day of the current semester.

A student is required to earn 173 (132 for lateral entry students) credits in order to be eligible for obtaining the degree. However the student is entitled to enjoy an option to earn either more or less than the total number of credits prescribed in the curriculum of a particular semester on the following guidelines:

8.1 Slow Learners

The **slow learners** may be allowed to withdraw certain courses with the approval by the Head of the Department and those courses may be completed by them in the fifth year of study and still they are eligible to be awarded with I Class. A student can withdraw a maximum of 2 courses per semester from IV semester to VII semester and take up those courses in the fifth year of study. However, courses withdrawn during odd semesters (V and VII) must be registered in the odd semester of fifth year and courses withdrawn during even semesters (IV and VI) must be registered in the even semester of fifth year.

8.2 Advanced Learners

The **advanced learners** may be allowed to take up the open elective courses of eighth semester in sixth and seventh semesters one in each to enable them to pursue industrial training/project work in the entire eighth semester period provided they should register those courses in the fifth semester itself. Such students should meet the teachers offering those elective courses themselves for clarifications. No specific slots will be allotted in the time table for such courses.

9. Project Work

The student typically registers for project at the end of seventh semester and completes it at the end of the eighth semester along with the courses prescribed for study in the eighth semester. However a student who has registered and successfully completed the courses of eighth semester by acquiring additional credits in the earlier semesters can attempt to spend his/her period of study in an industry and complete his/her project work, submit the project report and appear for viva-voce examination at the end of eighth semester.

10. Mandatory Induction Program

A 3-week long induction program for the UG students entering the institution, right at the start is proposed. Normal classes start only after the induction program is over. The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

- Physical Activity
- Creative Arts
- Imparting Universal Human Values
- Literary Activities
- Conduct of crash courses on soft skills
- Lectures by Eminent People
- Visits to Local Area
- Familiarization to Dept./Branch & Innovative practices

11. Electives

The elective courses fall under two basic categories: Professional Electives and Open Electives.

11.1 Professional Elective Courses

The Professional Elective courses are offered in the concerned branch of specialization and a student can choose the Professional Elective courses with the approval of the Head of the Department concerned.

11.2 Open Elective Courses

Apart from the various Professional elective courses, a student must study **five** open elective courses of which the student may opt to study either that offered by the Department concerned or from the open elective courses offered by any other Department in the Faculty of Engineering & Technology, with the approval of the Head of the concerned Department and the Head of the Department offering the course. In case the student opts to study an open elective offered by a neighbouring Department in the Faculty, it shall be handled by the faculty of that Department offering the chosen open elective.

A student may be required to choose Intellectual Property Rights (IPR) and Cyber Security as open electives anywhere between fifth and eighth semesters as part of the requirements of the study.

11.3 MOOC (SWAYAM) Courses

The student can be permitted to earn not more than 40 % of his/her total credits (that is 69 credits) by studying Massive Open Online Courses (MOOCs) offered through the SWAYAM Portal of UGC with the approval of the Head of the Department concerned and the Dean of the Faculty. The courses will be considered as equivalent to elective courses from the fifth to the eighth semesters and the credits earned through MOOC courses may be transferred and considered for awarding Degree to the student concerned.

A student who earns 3 or more credits from a 12 week MOOC course through SWAYAM portal (Syndicate Resolution No.:14 dated 10.05.2019) shall be exempted from studying the elective course and permitted to transfer the credits. Besides the student may be permitted to claim for the conversion to the next higher grade in accordance with the Syndicate Resolution No.: 31 dated 09.09.2020

11.4 Value Added Courses

A student can study one or more value added courses being offered by the other Departments of Study either within the Faculty or any other Faculty in the University in any semester of the B.E degree programme except First Year, with the restriction that only one Value added Course can be registered at a time.

11.5 Extra One Credit Courses

One credit courses shall be offered by a Department with the prior approval from the Dean of the Faculty.

For one credit courses, a relevant potential topic may be selected by a committee consisting of the Head of the Department concerned and the Board of Studies member from the Department and a senior faculty member from the Department concerned. An expert from industry familiar with the topic chosen may be accordingly invited to handle classes for the students. The details of the syllabus, time table and the name of the industrial expert may be sent by the above committee to the Dean for approval. The credits earned through the extra one credit courses shall be over and above the total credit requirement prescribed in the

curriculum for the award of the degree. Students can take a maximum of two extra one credit courses (one each in VI and VII semesters). They shall be allowed to take extra one credit courses offered in other Departments with the permission of Head of the Department offering the courses. A separate mark sheet shall be issued for extra one credit courses.

11.6 Skill Related /Naan Mudhalvan

A student is required to study **Three** open elective courses One each in the fifth, sixth and seventh semester of study as part of acquiring skills in the specified field. The student shall pursue the open electives listed in the Naan Mudhalvan portal against the respective semesters. However alternatively the student shall choose the open electives from the list tabled relating to the respective programmes with the approval of the Head of the Department concerned and Dean of the Faculty.

12. Assessment

12.1. Theory Courses

The break-up of Continuous Assessment for the theory courses relates to evaluating the performance under the five Course Outcomes uniformly with 5 Marks for each outcome spread over Two Mid-Semester tests and One Assignment, totaling to 25 Marks. Similarly the break-up mark for University End Semester exams involves evaluating the performance under the five Course Outcomes with 15 Marks for each Outcome, totalling to 75 Marks.

The break-up of continuous assessment and examination marks for theory courses is as follows:

First assessment (Mid-Semester Test-I Covering Units I & II)	:	8 marks
Second assessment (Mid-Semester Test-II Covering Units III, IV & V)	:	12 marks
Third Assessment (Assignment Covering Units I, II, III, IV & V)	:	5 marks
End Semester Examination	:	75 marks

The break-up of Continuous Assessment for the theory course titled Basic Engineering in the II semester that involves two disciplines requires evaluating the performance under the five Course Outcomes, with 3 for one discipline and two for the other, uniformly with 5 Marks for each outcome spread over Two Mid-Semester tests and One Assignment, totalling to 25 Marks. Similarly the break-up mark for University End Semester exams involves evaluating the performance under the five Course Outcomes with 15 Marks for each Outcome, totalling to 75 Marks.

12.2 Practical Courses

The break-up of Continuous Assessment for the practical courses involves evaluating the performance under the five Course Outcomes uniformly with 8 Marks for each outcome spread over Two tests and Record work, totalling to 40 Marks. Similarly the break-up mark for University End Semester exams relates to evaluating the performance under the five Course Outcomes with 12 Marks for each Outcome, totalling to 60 Marks

The break-up of continuous assessment and examination marks for Practical courses is as follows:

First Assessment (Test-I Relating to Cycle I)	:	15 marks
Second Assessment (Test-II Relating to Cycle II)	:	15 marks
Maintenance of Record book	:	10 marks
End Semester Examination	:	60 marks

12.3 Theory cum Practical Course

The break-up of Continuous Assessment for the theory cum practical courses necessitates to evaluating the performance as being followed for the theory and practical courses individually and requires the students to clear each component separately. The average of the marks secured by the student in the theory and practical courses and the appropriate grade relating to the average shall be assigned to the student.

12.4 Project Work

The continuous assessment marks for the project work will be 40 and to be assessed by a review committee consisting of the project guide and a minimum of two members nominated by the Head of the Department. One of the committee members will be nominated as the Chairman by the Head of the Department. The Head of the Department may be a member or the Chairman. At least two reviews should be conducted during the semester by the review committee. The student shall make presentation on the progress made before the committee. 60 marks are allotted for the project work and viva voce examination at the end of the semester.

12.5 Industrial Internship

After attending the internship during the semester vacation of II / III year for a period of 4 weeks duration in each year, the student has to submit a report and appear for the viva-voce exam along with the V/VII semester end semester examinations.

13. Substitute Assessment

A student, who has missed, for genuine reasons accepted by the Head of the Department, one or more of the assessments of a course other than the final examination, may take a substitute assessment for any one of the missed assessments. The substitute assessment must be completed before the date of the third meeting of the respective class committees.

A student who wishes to have a substitute assessment for a missed assessment must apply to the Dean / Head of the Department within a week from the date of the missed assessment.

14. Student Counsellors (Mentors)

To help the students in planning their course of study and for general advice on the academic programme, the Dean / Head of the Department will attach a certain number of students to a member of the faculty who shall function as student counsellor for those students throughout their period of study. Such student counsellors shall advise the students, give preliminary approval for the courses to be taken by the students during each semester and obtain the final approval of the Dean / Head of the Department.

15. Class Committee

For all the branches of study during the first two semesters, a common class committee will be constituted by the Dean of the faculty. From among the various teachers teaching the same common course to different classes during each semester of the first year, the Dean shall appoint one of them as course coordinator.

The composition of the class committee during first and second semesters will be as follows:

- Course coordinators of all courses.
- All the Heads of the Sections, among whom one may be nominated as Chairman by the Dean.
- The Dean may opt to be a member or the Chairman.

For each of the higher semesters, separate class committees will be constituted by the respective Head of the Departments.

The composition of the class committees from third to eighth semester will be as follows:

- Teachers of the individual courses.
- A seminar coordinator (for seventh semester only) shall be appointed by the Head of the Department
- A project coordinator (for eighth semester only) shall be appointed by the Head of the Department from among the project supervisors.
- One Professor or Associate Professor, preferably not teaching the concerned class, appointed as Chairman by the Head of the Department.
- The Head of the Department may opt to be a member or the Chairman.

The class committee shall meet three times during the semester. The first meeting will be held within two weeks from the date of class commencement in which the type of assessment like test, assignment etc. for the third assessment and the dates of completion of the assessments will be decided.

The second meeting will be held within a week after the completion of the first assessment to review the performance and for follow-up action.

The third meeting will be held after all the assessments but before the University semester examinations are completed for all the courses, and at least one week before the commencement of the examinations. During this meeting the assessment on a maximum of 25 marks for theory/40 marks for seminar/ industrial training, practical and project work will be finalized for every student and tabulated and submitted to the Head of the Department (to the Dean in the case of I & II Semester) for approval and transmission to the Controller of Examinations.

16. Attendance Requirements

The students with 75% attendance and above are permitted to appear for the University examinations. However, the Vice Chancellor may give a rebate / concession not exceeding 10% in attendance for exceptional cases only on Medical Grounds.

17. Temporary Break of Study

A student is permitted to go on break of study for a maximum period of one year either as two breaks of one semester each or a single break of one year.

If a student wishes to apply for break of study, the student shall apply to the Dean in advance, in any case, not later than the last date of the first assessment period. The application duly filled by the student shall

be submitted through the Head of the Department. In the case of short term employment/ training/ internship, the application for break of study shall be approved and forwarded by the Head of the Department concerned to the Dean.

However, the student must complete the entire programme within the maximum period of seven years.

18. Procedure for Withdrawing from the Examinations

A student can withdraw from all the examinations of the semester only once during the entire programme on valid grounds accepted by the University. Such withdrawal from the examinations of a semester will be permitted only if the candidate applies for withdrawal at least 24 hours before the commencement of the last examination. The letter grade 'W' will appear in the mark sheet for such candidates.

19. Passing and Declaration of Examination Results

All assessments of all the courses on an absolute marks basis will be considered and passed by the respective results passing boards in accordance with the rules of the University. Thereafter, the Controller of Examinations shall convert the marks for each course to the corresponding letter grade as follows, compute the Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA), and prepare the mark sheets.

90 to 100 marks	:	Grade 'S'
80 to 89 marks	:	Grade 'A'
70 to 79 marks	:	Grade 'B'
60 to 69 marks	:	Grade 'C'
55 to 59 marks	:	Grade 'D'
50 to 54 marks	:	Grade 'E'
Less than 50 marks	:	Grade 'RA'
Withdrawn from the examination	:	Grade 'W'

A student who obtains less than 30 / 24 marks out of 75 / 60 in the theory / practical examinations respectively or is absent for the examination will be awarded grade RA.

A student who earns a grade of S, A, B, C, D or E for a course, is declared to have successfully completed that course. Such a course cannot be repeated by the student.

A student who is detained for lack of attendance must re-register for and repeat the courses in the respective semester.

A student who obtains letter grade RA in the mark sheet must reappear for the examination of the courses except for Honours courses.

A student who obtains letter grade W in the mark sheet must reappear for the examination of the courses.

The following grade points are associated with each letter grade for calculating the grade point average and cumulative grade point average.

S - 10; A - 9; B - 8; C - 7; D - 6; E - 5; RA - 0

Courses with grade RA / W are not considered for calculation of grade point average or cumulative grade point average.

A student can apply for re-evaluation of one or more of his examination answer papers within a week from the date of issue of mark sheet to the student on payment of the prescribed fee per paper. The

application must be made to the Controller of Examinations with the recommendation of the Head of the Department.

After the results are declared, mark sheets will be issued to the students. The mark sheet will contain the list of courses registered during the semester, the grades scored and the grade point average for the semester.

GPA is the sum of the products of the number of credits of a course with the grade point scored in that course, taken over all the courses for the semester, divided by the sum of the number of credits for all courses taken in that semester.

OGPA/CGPA is similarly calculated considering all the courses taken from the time of admission.

20. Awarding Degree

After successful completion of the programme, the degree will be awarded based on OGPA/CGPA.

The conversion of OGPA/CGPA (from I semester to VIII Semester) to the corresponding Percentage of marks may be calculated as per the following formula:

Percentage of marks = (OGPA/CGPA - 0.25) x 10

Where $OGPA/CGPA = \frac{\sum C_i GP_i}{\sum C_i}$

C_i- Credit hours of a course

GP_i - Grade Point of that course

20.1 Honours Degree

The student requires to earn a minimum of 193 credits within four years (152 credits within three years for lateral entry students) from the time of admission, pass all the courses in the first attempt from I Semester to VIII Semester (III Semester to VIII Semester for lateral entry students) and obtain a OGPA/CGPA of 8.25 or above to obtain the Honours Degree.

The student is required to complete 6 elective courses, 2 each in the V, VI and VII semesters with a stipulation that 2 of the 6 courses need to be of 4 credits each, while the remaining 4 has to be of 3 credits each, thus totalling to 20 credits, the choice being approved by the Head of the Department concerned and the Dean of the Faculty.

However, if the student either does not clear the extra course(s) relating to become eligible for the Honours Degree or discontinues it in any of the semesters, then the student may revert to the category of the First Class with Distinction or First class, provided the student is eligible for that respective category. The student may claim for revised mark sheet, paying the stipulated fee in order that the unsuccessful appearance or discontinuity of the course(s) is not reflected in the new mark sheet.

20.2 First Class with Distinction

To obtain B.E Degree First Class with Distinction, a student must earn a minimum of 173 Credits within four years (132 credits within three years for lateral entry students) from the time of admission, by passing all the courses in the first attempt from I Semester to VIII Semester (III Semester to VIII Semester for lateral entry students) and obtain a CGPA of 8.25 or above.

20.3 First Class

To obtain B.E Degree First Class, a student must earn a minimum of 173 credits within ***five*** years (132 credits within ***four*** years for lateral entry students) from the time of admission and obtain a OGPA/CGPA of 6.75 or above for all the courses from I Semester to VIII Semester (III Semester to VIII Semester for lateral entry students).

20.4 Second Class

For Second Class, the student must earn a minimum of 173 credits within **seven** years (132 credits within **six** years for lateral entry students) from the time of admission.

20.5 B.E Degree with Minor Engineering

The student shall be given an option to earn a Minor Engineering Degree in another discipline of Engineering not related to his/her branch of study at the end of the first year provided the student clears all the subjects in the first year in the first attempt and secures a OGPA/CGPA of not less than 7.5

The student is required to earn an additional 20 credits starting from the third semester in the sense he/she requires to complete 6 elective courses, 2 each in the V, VI and VII semesters with a stipulation that 2 of the 6 courses need to be of 4 credits each, while the remaining 4 has to be of 3 credits each, thus totalling to 20 credits, the choice being approved by the Head of the Department concerned and the Dean of the Faculty.

The rules for awarding the B.E degree in First Class with Distinction or in First Class or in Second Class apply in the same manner for B.E Degree with Minor Engineering.

However the student who opts for Honours Degree is not entitled to pursue B.E Degree with Minor Engineering and vice-versa

21. Ranking of Candidates

The candidates who are eligible to get the B.E. degree with Honours will be ranked together on the basis of OGPA/CGPA for all the courses of study from I Semester to VIII Semester (III Semester to VIII Semester for lateral entry students).

The candidates who are eligible to get the B.E. degree in First Class with Distinction will be ranked next after those with Honours on the basis of OGPA/CGPA for all the courses of study from I Semester to VIII Semester (III Semester to VIII Semester for lateral entry students).

The candidates passing with First Class will be ranked next after those with distinction on the basis of OGPA/CGPA for all the courses of study from I Semester to VIII Semester (III Semester to VIII Semester for lateral entry students).

The ranking of candidates will be done separately for each branch of study.

22. Transitory Regulations

The University shall have powers to revise or change or amend the regulations, the scheme of examinations, the courses of study and the syllabi from time to time.

Wherever there had been change of syllabi, examinations based on the existing syllabi will be conducted for three consecutive times after implementation of the new syllabi in order to enable the students to clear the arrears. Beyond that the students will have to take up their examinations in equivalent courses, as per the new syllabi, on the recommendations of the Head of the Department concerned.

ANNEXURE

S.No.	Branch of Study in B.E	Honours Elective Courses from Same and Allied Departments of	Minor Engineering Courses from Other Departments of
1	Civil Engineering	1. Civil Engineering 2. Civil and Structural Engineering.	1. Mechanical Engineering 2. Electrical Engineering 3. Chemical Engineering 4. Computer Science and Engineering 5. Computer Science and Engineering (Artificial Intelligence and Machine Learning) 6. Computer Science and Engineering(Data Science) 7. Mechanical (Manufacturing) Engineering. 8. Electronics and Instrumentatio Engineering. 9. Information Technology 10. Electronics and Communication Engineering.
2	Civil and Structural Engineering		
3	Mechanical Engineering	1. Mechanical Engineering 2. Mechanical (Manufacturing) Engineering.	1. Civil Engineering 2. Civil and Structural Engineering. 3. Electrical Engineering 4. Chemical Engineering 5. Computer Science and Engineering 6. Computer Science and Engineering (Artificial Intelligence and Machine Learning) 7. Computer Science and Engineering (Data Science) 8. Electronics and Instrumentation Engineering. 9. Information Technology 10. Electronics and
4	Mechanical (Manufacturing) Engineering.		

S.No.	Branch of Study in B.E	Honours Elective Courses from Same and Allied Departments of	Minor Engineering Courses from Other Departments of
			Communication Engineering.
5	Electrical and Electronics Engineering	1. Electrical Engineering 2. Electronics and Instrumentation Engineering 3. Electronics and Communication Engineering	1. Civil Engineering 2. Civil and Structural Engineering. 3. Mechanical Engineering 4. Chemical Engineering 5. Mechanical (Manufacturing) Engineering.
6	Electronics and Instrumentation Engineering.		
7	Chemical Engineering	1. Chemical Engineering 2. Pharmacy 3. Electronics and Instrumentation Engineering	1. Civil Engineering 2. Mechanical Engineering 3. Electronics and Instrumentation Engineering. 4. Information Technology 5. Civil and Structural Engineering. 6. Electrical Engineering 7. Electronics and Communication Engineering. 8. Mechanical (Manufacturing) Engineering. 9. Computer Science and Engineering 10. Computer Science and Engineering (Artificial Intelligence and Machine Learning) 11. Computer Science and Engineering(Data Science)

S.No.	Branch of Study in B.E	Honours Elective Courses from Same and Allied Departments of	Minor Engineering Courses from Other Departments of
8	Computer Science and Engineering	1. Computer Science and Engineering. 2. Information Technology 3. Electronics and Communication Engineering 4. Computer Science and Engineering(Artificial Intelligence and Machine Learning) 5. Computer Science and Engineering(Data Science)	1. Civil Engineering 2. Mechanical Engineering 3. Mechanical (Manufacturing) Engineering. 4. Civil and Structural Engineering. 5. Chemical Engineering
9	Information Technology		
10	Electronics and Communication Engineering.	1. Electrical Engineering 2. Electronics and Instrumentation Engineering 3. Electronics and Communication Engineering	1. Civil Engineering 2. Civil and Structural Engineering. 3. Mechanical Engineering 4. Chemical Engineering 5. Mechanical (Manufacturing) Engineering.
11	Computer Science and Engineering (Artificial Intelligence and Machine Learning)	1. Computer Science and Engineering. 2. Information Technology 3. Electronics and Communication Engineering 4. Computer Science and Engineering(Artificial Intelligence and Machine Learning) 5. Computer Science and Engineering(Data Science)	1. Civil Engineering 2. Mechanical Engineering 3. Mechanical (Manufacturing) Engineering. 4. Civil and Structural Engineering. 5. Chemical Engineering
12	Computer Science and Engineering (Data Science)		

DETAILS OF COURSE CODE

S. No	Code (3rd and 4th Digits)	Details	Code (5th and 6th Digits)	Details
1	ET	Common Course for the faculty	HS	Humanities Theory
2	CE	Civil Engg. Course	HP	Humanities Practical
3	CZ	Civil and Structural Engg. course	BS	Basic Science Theory
4	ME	Mechanical Engg. Course	BP	Basic Science Practical
5	MM	Mechanical Engg (Manufacturing). Course	ES	Engineering Science Theory
6	EE	Electrical and Electronics Engg. Course	SP	Engineering Science Practical
7	EI	Electronics and Instrumentation Engg. course	PC	Professional Core Theory
8	CH	Chemical Engg. course	CP	Professional Core Practical
9	CS	Computer Science and Engg. course	PE	Professional Elective Theory
10	IT	Information Technology course	EP	Professional Elective Practical
11	EC	Electronics and Communication Engg. course	IT	Internship /Industrial Training
12	AI	Computer Science and Engineering (Artificial Intelligence and Machine Learning)	OE	Open Elective Theory
13	DS	Computer Science and Engineering (Data Science)	PV	Project and Viva-voce
14	YY	Code of the Program concerned (S. No 02 to S.No.13)		

The first two digits relate to the year from which the Regulations commence

7th digit represents the semester and 8th and 9th digits represent the serial number of courses.

ANNAMALAI UNIVERSITY

FACULTY OF ENGINEERING AND TECHNOLOGY

B.E (Four Year) Degree Program (FULL-TIME)

Choice Based Credit System (CBCS)

COURSES OF STUDY AND SCHEME OF EXAMINATIONS (REGULATIONS 2022)

Curriculum for B.E 2022-23 onwards

SEMESTER I									
Course Code	**Category**	**Course**	**L**	**T**	**P/D**	**CA**	**FE**	**Total**	**Credits**
22ETBS101	**BS-I**	Mathematics-I	3	1	-	25	75	100	4
22ETBS102	**BS-II**	Physics	3	1	-	25	75	100	4
22ETBS103	**BS-III**	Chemistry	3	1	-	25	75	100	4
22ETES104	**ES-I**	Programming for Problem Solving	2	1	-	25	75	100	3
22ETHS105	**HS-I**	Heritage of Tamils **தமிழர் மரபு**	1	-	-	25	75	100	1
22ETHP106	**HSP-I**	Communication Skills and Language Laboratory	-	-	3	40	60	100	1.5
22ETSP107	**ESP-I**	Engineering Workshop Practices	-	-	3	40	60	100	1.5
22ETSP108	**ESP-II**	Electrical Wiring and Earthing Practice Laboratory	-	-	3	40	60	100	1.5
								Total Credits	**20.5**

SEMESTER II									
Course Code	**Category**	**Course**	**L**	**T**	**P/D**	**CA**	**FE**	**Total**	**Credits**
22ETHS201	**HS-II**	English	3	1	-	25	75	100	4
22ETBS202	**BS-IV**	Mathematics-II	3	1	-	25	75	100	4
22ETES203	**ES-II**	Basic Engineering*	4	-	-	25	75	100	4
22ETHS204	**HS-III**	Tamils and Technology **தமிழரும் தொழில்நுட்பமும்**	1	-	-	25	75	100	1
22ETBP205	**BSP-I**	Physics Laboratory	-	-	3	40	60	100	1.5
22ETBP206	**BSP-II**	Chemistry Laboratory	-	-	3	40	60	100	1.5
22ETSP207	**ESP-III**	Computer Programming Laboratory	-	-	3	40	60	100	1.5
22ETSP208	**ESP-IV**	Engineering Graphics	2	-	3	40	60	100	3
								Total Credits	**20.5**

*** Basic Civil Engineering (3 Units) & Basic Mechanical Engineering (2 Units) for Circuit Branches**
*** Basic Mechanical Engineering (2 Units) & Basic Electrical and Electronics Engineering (3 Units) for Civil, C&S and Chemical Engineering Branches**
*** Basic Civil Engineering (2 Units) & Basic Electrical and Electronics Engineering (3 Units) for Mechanical & Mechanical (Manufacturing) Engineering Branches**

THIRD SEMESTER

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
22ETBS301	BS-V	Mathematics III	3	1	0	25	75	100	4
22ETES302	ES-III	Environmental Studies	3	0	0	25	75	100	3
22ETES303	ES-IV	Engineering Mechanics	3	0	0	25	75	100	3
22CHES304	ES-V	Chemistry for Chemical Engineers	3	0	0	25	75	100	3
22CHPC305	PC-I	Transport Phenomena	2	1	0	25	75	100	3
22CHPC306	PC-II	Chemical Process Calculations	2	1	0	25	75	100	3
22CHPC 307	PC - III	Chemical Technology	2	0	0	25	75	100	2
22CHSP308	ESP-V Lab	Organic & Physical Chemistry Laboratory	-	-	3	40	60	100	1.5
22CHCP309	PCP-I Lab	Technical Analysis Laboratory	-	-	3	40	60	100	1.5
			Total Credits						**24**

FOURTH SEMESTER

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
22CHBS401	BS-VI	Numerical Methods	3	0	0	25	75	100	3
22CHES402	ES-IV	Material Science	2	0	0	25	75	100	2
22CHPC403	PC-IV	Fluid Mechanics	2	1	0	25	75	100	3
22CHPC404	PC-V	Chemical Engineering Thermodynamics - I	2	1	0	25	75	100	3
22CHPC405	PC-VI	Heat Transfer	2	1	0	25	75	100	3
22CHPC406	PC-VII	Mass Transfer – I	2	1	0	25	75	100	3
22ETHS 407	HS – II	Universal Human Values	3	0	0	25	75	100	3
22CHCP408	PCP-II Lab	Fluid Mechanics Laboratory	-	-	3	40	60	100	1.5
22CHCP409	PCP-III Lab	Heat Transfer Laboratory	-	-	3	40	60	100	1.5
			Total Credits						**23**
Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming V Semester.									

FIFTH SEMESTER

Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
22CHPC501	PC-VIII	Chemical Reaction Engineering - I	2	1	0	25	75	100	3
22CHPC502	PC-IX	Mass Transfer – II	2	1	0	25	75	100	3
22CHPC503	PC-X	Particle & Fluid-particle processing	2	1	0	25	75	100	3
22CHPC504	PC-XI	Chemical Engineering Thermodynamics II	2	1	0	25	75	100	3
22CHPE505	PE-I	Professional Elective –I	3	0	0	25	75	100	3
22CHPE506	PE-II	Professional Elective –II	3	0	0	25	75	100	3
22CHPE 507	OE – I	Open Elective – I	3	0	0	25	75	100	3
22CHCP508	PCP-IV Lab	Particle & Fluid particle processing Laboratory	-	-	3	40	60	100	1.5
22CHCP509	PCP-V Lab	Mass Transfer Laboratory	-	-	3	40	60	100	1.5
22ETIT510	**IT-I**	Industrial Training / Rural Internship/Innovation/ Entrepreneurship	***Four** weeks during the summer vacation at the end of **IV Semester***				100	100	**4.0**
						Total Credits			**28**

SIXTH SEMESTER

Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
22CHPC601	PC-XII	Chemical Reaction Engineering – II	2	1	0	25	75	100	3
22CHPC602	PC-XIII	Process Dynamics & Control	2	1	0	25	75	100	3
22CHPE603	PE-III	Professional Elective –III	3	0	0	25	75	100	3
22CHPE 604	PE-IV	Professional Elective –IV	3	-	-	25	75	100	3
22CHPE 605	PE-V	Professional Elective –V	3	-	-	25	75	100	3
22CHOE606	OE-II	Open Elective-II	3	0	0	25	75	100	3
22CHCP607	PCP-VI Lab	Chemical Reaction Engineering & Thermodynamics Laboratory	-	-	3	40	60	100	1.5
22CHCP608	PCP-VII Lab	Process Instrumentation & Control Laboratory	-	-	3	40	60	100	1.5
						Total Credits			**21**
Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming VII Semester.									

SEVENTH SEMESTER

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
22ETHS701	HS-III	Engineering Ethics	2	0	0	25	75	100	2
22CHPC702	PC-XIV	Process Engineering Economics	2	1	-	25	75	100	3
22CHPC 703	PC-XV	Process Modeling & Simulation	2	1	-	25	75	100	3
22CHPE704	PE-VI	Professional Elective –VI	3	-	-	25	75	100	3
22CHPE705	PE-VII	Professional Elective –VII	3	-	-	25	75	100	3
22CHOE706	OE-III	Open Elective-III	3	-	-	25	75	100	3
22CHCP707	PCP-VIII	Process Modeling & Simulation Laboratory	-	-	3	40	60	100	1.5
22CHCP 708	PCP-IX	Chemical Plant Equipment Design& Drawing Laboratory	-	-	3	40	60	100	1.5
22ETIT708	IT-II	Industrial Training / Rural Internship/ Innovation / Entrepreneurship	***Four*** *weeks during the summer vacation at the end of* ***VI Semester***				100	100	**4.0**
						Total Credits			**24**

EIGHTH SEMESTER

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
22CHOE801	OE-IV	Open Elective-IV	3	-	-	25	75	100	3
22CHOE802	OE-V	Open Elective-V	3	-	-	25	75	100	3
22CHPV803	PV – I	Project Work and Viva-voce	-	PR 10	S 2	40	60	100	6
						Total Credits			**12**

L	No. of Lecture Hours	**TR**	No. of Hours for Discussion on Industrial Training
T	No. of Tutorial Hours	**S**	No. of Seminar Hours on Industrial Training / Project
P	No. of Practical Hours	**PR**	No. of Hours for Discussion on Project work
CA	Continuous Assessment Marks	**FE**	Final Examination Marks
Credits	Credit points allotted to that course	**Total**	Total Marks

PROFESSIONAL ELECTIVES

Professional Elective - I

1. Petroleum Refining Engineering
2. Biochemical Engineering
3. Environmental Engineering
4. Electrochemical Engineering

Professional Elective - II

5. Nuclear Engineering
6. Polymer Engineering
7. Air Pollution & Control
8. Nanotechnology

Professional Elective – III

9. Petrochemical Technology
10. Industrial Biotechnology
11. Wastewater Treatment Technology
12. Pulp and Paper Technology

Professional Elective - IV

13. Modern Separation Processes
14. Membrane Science and Engineering
15. Food Processing Technology
16. Technology of Fine and Specialty Chemicals
17. Fertilizer Technology

Professional Elective - V

18. Fluidization Engineering
19. Distillation
20. Mixing Theory and Practice
21. Process Instrumentation

Professional Elective – VI

22. Computational Fluid Dynamics
23. Optimization of Chemical Processes
24. Operational Research
25. Process Modeling and Simulation

Professional Elective – VII

26. Total Quality Management
27. Chemical Works Organization and Management
28. Entrepreneurship
29. Industrial Relations and Organizational Development

OPEN ELECTIVES

1. Solid Waste Management
2. Materials of Construction in the Process Industries
3. Project Engineering
4. Fuel Technology
5. Renewable Energy Technology
6. Hazardous Waste Management
7. Disaster Management
8. Industrial Safety and Occupational Health
9. Bioconversion and Processing of Waste
10. Biology for Engineers
11. Intellectual Property Rights
12. Machine Learning (Naan Mudhalvan) – V semester
13. Augmented and Virtual Reality (AR VR) Development (Naan Mudhalvan) – VI semester
14. Block Chain (Naan Mudhalvan) – VII semester
15. NCC Studies (Army Wing) – I

EXTRA ONE CREDIT COURSES

S.No.	Course Code	Course Name	Credits
1.	CHOCSCN	Health, Safety and Environment	1
2.	CHOCSCN	Explosions and Industrial Fire Safety	1

HONORS ELECTIVE COURSES

S.No.	Course Code	Course Name	Credits
1.	CHHE601	Advanced Heat Transfer	4
2.	CHHE602	Advanced Thermodynamics	3
3.	CHHE701	Advanced Process Control Systems	4
4.	CHHE702	Advanced Fluidization Engineering	3
5.	CHHE801	Applications of Nanotechnology In Chemical Engineering	3
6.	CHHE802	Heterogeneous Reactor Design	3

MINOR ENGINEERING COURSES

S.No.	Course Code	Course Name	Credits
1.	CHMI601	Basic Principles of Chemical Engineering	4
2.	CHMI602	Organic & Inorganic Chemical Technology	3
3.	CHMI701	Chemical Engineering Operations	4
4.	CHMI702	Basics of Fluid Mechanics	3
5.	CHMI801	Basic Principles of Chemical Reaction Engineering	3
6.	CHMI802	Process Engineering & Economics	3

VALUE ADDED COURSES

S.No.	Course Code	Course Name
1.	ECHEVAC01	Food Preservation Technology
2.	ECHEVAC02	Personal Protective Equipment (PPE) & First Aid
3.	ECHEVAC03	Fire Engineering and Explosion Control
4.	ECHEVAC04	Dairy Technology

SEMESTER I

22ETBS101	MATHEMATICS -I	L	T	P/D	C
		3	1	0	4

COURSE OBJECTIVES

- To familiarize definite integrals and its application in finding area and volume.
- To introduce the fundamentals of functions of several variables.
- To make the student to learn infinite series and its nature.
- To impart knowledge about Vector calculus.
- To provide the concept of eigen values and eigen vectors of a real matrix and its properties of great utility in many branches of engineering.

UNIT I: INTEGRAL CALCULUS

Evaluation of definite integrals and their properties - Applications of definite integrals to evaluate surface areas and volumes of revolutions. Improper integral - Beta and Gamma functions and their properties.

UNIT II: FUNCTIONS OF SEVERAL VARIABLES

Rolle's theorem-Mean value theorem. Indeterminate forms - L'Hospital's rule, Functions of two variables: Taylor's and Maclaurin's series expansions - Maxima and minima for functions of two variables.

UNIT III: SEQUENCES AND SERIES

Convergence of sequence and series - Tests for convergence: Comparison test (only for series with positive terms) - D'Alembert's ratio test-Cauchy's root test-Integral test - Leibnitz's test (Alternating series).

UNIT IV: VECTOR CALCULUS (DIFFERENTIATION)

Gradient, divergence and curl - Directional derivative - Unit normal vector - Irrotational and solenoidal vectors - Expansion formulae for operators involving.

UNIT V: MATRICES

Rank of a matrix - Symmetric, skew - Symmetric and orthogonal matrices - Characteristic equation - Eigen values and Eigen vectors - Cayley-Hamilton Theorem - Diagonalization of symmetric matrices by Orthogonal transformation.

TEXT BOOKS

1. Veerarajan T., "Engineering Mathematics for First Year", Tata McGraw-Hill, New Delhi, 2008.
2. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 36th Edition, 2010

REFERENCE BOOKS

1. G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", 9th publishers, Reprint, 2002.
2. Erwin kreyszig," Advanced Engineering Mathematics", 9th Edition, John Wiley &Sons,2006.
3. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill New Delhi,11th Reprint, 2010.
4. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, Reprint,2008.

COURSE OUTCOMES

At the end of this course, Students will able to

1. Solve improper integrals using Beta and Gamma functions.
2. Evaluate the extreme values for functions of two variables.
3. Analyze the convergence of infinite series.
4. Understand vector differentiation and Recognize solenoidal and irrotational fields.
5. Solve eigen values and eigen vectors of a real matrix and Orthogonal transformation of a matrix.

Mapping of Course Outcomes with Program Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**2**									
CO2	**3**	**3**	**2**	**2**								
CO3	**3**	**3**	**2**									
CO4	**3**	**3**										
CO5	**3**	**3**	**3**	**2**	**2**							

22ETBS102	PHYSICS	L	T	P/D	C
		3	1	0	4

COURSE OBJECTIVES

- To understand the ray of light to undergo the phenomenon of interference diffraction and polarization.
- To understand the principle and various application of laser.
- To develop knowledge in crystal structure and its properties.
- To understand the energy quantization of subatomic particles like electron.
- Rationalize the law of conservation of energy in solar water heater and solar cells.

UNIT I: WAVE OPTICS

Huygens' Principle, superposition of waves and interference of light by wave front splitting and amplitude splitting; Young's double slit experiment, Newton's rings, Michelson interferometer and Mach-Zehnder interferometer. Fraunhofer diffraction from a single slit and a circular aperture, the Rayleigh criterion for limit of resolution and its application to vision; diffraction gratings and their resolving power.

UNIT II: LASERS

Introduction - Principles of Laser - Stimulated emission, Properties of laser beams: mono-chromaticity, coherence, directionality and brightness Einstein's theory of, stimulated emission A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO_2), solid - State lasers (ruby, Neodymium), dye lasers, laser speckles, applications of lasers in science, engineering and medicine.

UNIT III: CRYSTAL PHYSICS

Introduction to solid Materials - Crystal structure - Geometry of lattice unit cell - Bravais' lattice - Crystal systems, Crystal structures of Materials - (Cordination number, Atomic radius, packing factor and packing density) - Types of crystal Lattice (Simple Cubic, Body Centered Cubic, Face Centered Cubic and Hexagonal Closed Packed) Miller Indices and their calculations - Finding Miller indices of crystal planes.

UNIT IV: QUANTUM MECHANICS

Heisenberg uncertainty Principle - CDual nature of Matter and radiation - De Broglie's Wave length - Wave Velocity and group velocity. The wave Equation, Schrödinger's time dependent and independent wave equations - The Wave function and its physical significance - The particle in a box Problem (one dimensional box) - Energy quantization - Eigen values and Eigen functions.

UNIT V: ENERGY PHYSICS

Introduction to energy sources - Energy sources and their availability (Conventional and Non-conventional energy sources) solar energy - Methods of Harvesting solar energy - Solar heat collector, solar water heater and solar cells. Wind energy - Basic principle and components of wind energy Conversion system (WECS) - Application of wind energy. Biomass - Biogas Generation - Classification of Biogas plants - Properties and application of Biogas**.**

TEXT BOOKS

1. Arumugam.M. "Engineering Physics", Anuradha agencies, 2nd Edition, 1997.
2. John Twidell& Tony Weir, "Renewable Energy Resources", Taylor & Francis, 2005.
3. Avadhanulu. M.N. and Kshirsagar P.G., "A Text Book of Engineering Physics", S. Chand & Company Ltd., 7th Enlarged Revised Ed., 2005
4. Gaur R.K. and Gupta S.L., "Engineering Physics", Dhanpat Rai Publishers, New Delhi, 2003.
5. Rai.G.D, "Solar Energy Utilization" Volume-1 & 2 by - Khanna Publishers, New Delhi
6. Pajput. R. K. Non -Conventional energy sources and Utilization - S. Chand Publication -2013.

REFERENCE BOOKS

1. Rajendran.V , "Engineering Physics", Tata McGraw Hill publishers, 2009.
2. Rai G.D., "Non-conventional Energy sources", Khauna Publications, 1993.
3. Mani. P. "Engineering Physics", Dhanam Publication, Chennai, 2011.
4. Agarwal.M.P, "Solar Energy", S.Chand& Co., I Edn, New Delhi, 1983.

COURSE OUTCOMES

At the end of this course, student will be able to

1. Gain knowledge on the construction of different types of interferometer.
2. Description on different types of laser and its application.
3. Analyze the importance of packing factor in different crystal system.
4. Evaluate the quantum mechanical concept of wave velocity and group velocity.
5. Compared the different energy resource and their availability.

Mapping of Course Outcomes with Program Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**2**	**2**		**3**	**2**						**1**
CO2	**3**	**2**			**2**	**1**	**1**					
CO3	**3**	**1**	**1**			**1**						
CO4	**2**	**1**	**2**	**2**	**1**	**1**						
CO5	**3**	**2**			**1**	**2**	**1**			**1**		**1**

22ETBS103	**CHEMISTRY**	**L**	**T**	**P/D**	**C**
		3	**1**	**0**	**4**

COURSE OBJECTIVES

- To understand water treatment techniques and basic knowledge on surface chemistry.
- To provide knowledge on electrochemical cells and chemistry involved in corrosion.
- To learn various processes involved in fuel refining and mechanism involved in energy storage devices.
- To develop knowledge about synthesis of various types of polymers and nano materials.
- To get basic knowledge on refractories, lubricants and spectroscopical techniques.

UNIT I: WATER CHEMISTRY AND SURFACE CHEMISTRY

Hardness of water - Softening of hard water by ion exchange method - Boiler feed water - Boiler troubles - Internal treatment methods - Estimation of hardness by EDTA method - Desalination of brackish water - Reverse Osmosis. Disinfection of water - Break point chlorination -Adsorption - Types of Adsorption - Freundlich and Langmuir adsorption isotherms - Applications of adsorption.

UNIT II: ELECTROCHEMISTRY AND CORROSION

Electrode potential - Electrochemical cell - Measurement of EMF - Nernst equation for cell EMF - Concentration cells - Electrochemical series - Conductometry - Conductance, Cell constant - Types of conductometric titrations. Potentiometry - Principle of acid base titration. Corrosion - Dry and wet corrosion - Galvanic, concentration cell and pitting corrosion - Control of corrosion by Cathodic protection method.

UNIT III: FUELS AND STORAGE DEVICES

Fuels - Classification - Calorific values - HCV and LCV - Analysis of coal - Proximate and ultimate analysis - Refining of petroleum. Cracking - Fixed bed - Synthetic petrol - Fischer -

Tropsch process - Flue gas analysis by Orsat apparatus. Batteries - Primary and secondary - Dry cell - Lead acid storage battery - Ni-Cd battery - Lithium battery - H2-O2 fuel cell.

UNIT IV: POLYMERS AND NANO MATERIALS

Polymers -Types of polymerization - Addition, condensation and copolymerisation - Mechanism of addition polymerization (Free radical). Plastics - Thermoplastics and thermosetting plastics -Preparation, properties and uses of polyethylene, polyvinyl chloride, polystyrene, Nylon and bakelite. Nano chemistry -Introduction to nano materials. Synthesis - Precipitation, sol- Gel process, electro deposition and chemical vapour deposition methods. Carbon nano tubes, fullerenes, nano wires and nano rods.

UNIT V: ENGINEERING MATERIALS AND SPECTROSCOPIC TECHNIQUES

Refractories - Classification, characteristics (Refractoriness, RUL, Thermal spalling, porosity) and uses, Lubricants - Classification, properties (cloud and pour point, flash and fire point, viscosity index) and applications. Principles of spectroscopy - Beer - Lambert's Law - UV - Visible and IR spectroscopy - Basic principles and instrumentation (block diagram) - Fluorescence and its applications in medicine.

TEXT BOOKS

1. Jain, P.C. and Monica Jain (2010) "Engineering Chemistry" DhanpatRai& Sons, New Delhi.
2. Dara, S.S. and Umare, S.S. (2014) "Text Book of Engineering Chemistry" S. Chand & Co. Ltd., New Delhi.
3. Gopalan, R., Venkappaya, D. and Nagarajan, S. (2008) "Engineering Chemistry" Tata McGraw Publications Ltd., New Delhi.
4. Puri, B.R., Sharma, L.R. and Pathania, M.S. (2013) "Principles of Physical Chemistry" Vishal Publication Company, New Delhi.
5. Sharma, Y.R. (2010) "Elementary Organic Spectroscopy, Principle and Chemical Applications" , S. Chand Publishers, New Delhi.
6. Asim K Das and Mahua Das (2017) "An Introduction to Nanomaterials and Nanoscience" CBS Publishers & Distributors Pvt. Ltd., New Delhi.

COURSE OUTCOMES

At the end of this course work, student will be able to

1. Develop innovative methods in soft water production for industrial uses and about adsorption analysis.
2. Describe the concept of electrochemistry and its applications; corrosion and its controlling methods.

3. Understand the properties of fuels and applications of energy storage devices.
4. Synthesis various polymers and understand about nanomaterials.
5. Gain knowledge on refractories, lubricants and understand the concepts of certain spectroscopical techniques

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**3**	**2**					**2**			
CO2				**2**	**1**							
CO3	**3**		**3**									
CO4	**3**				**1**							
CO5		**2**	**3**	**2**					**2**			

22ETES104	**PROGRAMMING FOR PROBLEM SOLVING**	**L**	**T**	**P/D**	**C**
		2	**1**	**0**	**3**

COURSE OBJECTIVES

- To understand the fundamentals of C programming
- To provide students with understanding of code organization and functional hierarchical decomposition using complex data types.
- To understand how to break a large problem into smaller parts, writing each part as a module or function
- To effectively utilize structures and pointers in problem solving
- To enable students to take up Systems programming or Advanced C programming course.

UNIT I: FUNDAMENTALS OF PROGRAMMING

Introduction to Programming, Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.), Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

UNIT II: EXPRESSIONS AND CONTROL STRUCTURES

Arithmetic Expressions and Precedence, Conditional Branching and Loops, Writing and evaluation of Conditionals and consequent Branching, Iteration and Loops.

UNIT III: ARRAYS

Arrays: Arrays (1-D, 2-D), Character arrays and Strings, Basic Algorithms: Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required).

UNIT IV: FUNCTIONS

Function: Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference, Recursion: Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

UNIT V: FILES AND STRUCTURES

Structure: Structures, Defining structures and Array of Structures, Pointers: Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation). File handling (only if time is available, otherwise should be done as part of the lab).

TEXT BOOKS

1. Byron Gottfried, “Schaum's Outline of Programming with C”,McGraw-Hill.
2. E. Balaguruswamy, “Programming in ANSI C”, TataMcGraw-Hill.

REFERENCE BOOKS

1. Brian W. Kernighan and Dennis M. Ritchie, “The C Programming Language”, Prentice Hall of India.

COURSE OUTCOMES

At the end of this course, the students will be able to

1. Formulate algorithms, draw flowcharts and write pseudocode for solving arithmetic and logical problems.
2. Develop C programs using branching and looping statements.
3. Implement searching and sorting algorithms and analyze the order of complexities.
4. Define and call simple functions by value and by reference and also to write recursive functions.
5. Utilize structures, pointers and files in C programming.

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**2**										
CO2	**2**	**2**	**3**	**2**								
CO3	**2**	**2**	**3**	**2**								
CO4	**1**	**1**										
CO5	**2**	**1**	**1**									

22ETHS105	**HERITAGE OF TAMILS** **தமிழர் மரபு**	**L**	**T**	**P/D**	**C**
		1	**0**	**0**	**1**

அலகு I: **மொழி மற்றும் இலக்கியம்:** **3**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் –சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II: **மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை:** **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை \ ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III: **நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்:** **3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV: **தமிழர்களின் திணைக் கோட்பாடுகள்:** **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V: **இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு:** **3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் – தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

1. Language and Literature: Language Families in India - Dravidian Languages -Tamil as a Classical Language - Classical Literature in Tamil -Secular Nature of Sangam Literature –

Distributive Just icein Sangam Literature –Management Principles inThirukural –Tamil Epics andImpact of Buddhism&Jainismin TamilLand –Bakthi Literature Azhwars and Nayanmars.- Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

2. Heritage - Rock art paintings to modern art - Sculpture: Hero stone to modern sculpture – Bronzeicons –Tribes and their handicrafts-Art of templecar making –Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

3. Folk and Martial arts - Therukoothu, Karagattam, VilluPattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

4. Thinai concept of Tamils -Flora and Fauna of Tamils &Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

5. Contribution of Tamils to Indian National Movement and Indian Culture: Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India -Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine -Inscriptions & Manuscripts -Print History of Tamil Books.

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல்
2. மற்றும் கல்வியியல் பணிகள் கழகம்).
3. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
4.. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
6. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL - (in print)
7. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of TamilStudies.
8. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
9. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of TamilStudies.)
10. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, TamilNadu)

10. StudiesintheHistoryofIndiawithSpecialReferencetoTamilNadu(Dr.K.K.Pillay)(Published by: The Author)
11. PorunaiCivilization(JointlyPublishedbyDepartmentofArchaeology&TamilNaduText Bookand Educational Services Corporation, TamilNadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) - Reference Book.

22ETHP106	COMMUNICATION SKILLS AND LANGUAGE LABORATORY	L	T	P/D	C
		0	0	3	1.5

COURSE OBJECTIVES

- To facilitate computer assisted multimedia instruction enabling individualized and independent language learning.
- To sensitize the students to the nuances of English speech sounds, word accent, intonation and rhythm.
- To bring about a consistent accent and intelligibility in student pronunciation of English by providing an opportunity for practice in speaking.
- To improve the fluency of students in spoken English
- To train students to use Language appropriately for public speaking, group discussion and interviews.

LIST OF TOPICS

1. Listening Comprehension
2. Pronunciation, Intonation, Stress and Rhythm
3. Common Everyday Situations: Conversations and Dialogues
4. Communication at Workplace
5. Interviews
6. Formal Presentations

Suggested Software Package: Globarena Package for communicative English The Globarena Package consists of the following exercises

1. Reading comprehension
2. Listening comprehension
3. Vocabulary exercises
4. Phonetics
5. Role Play in dialogues
6. Auto Speak

TEXT BOOKS

1. Daniel Jones Current," English Pronouncing Dictionary", Edition with CD.
2. R. K. Bansal and J. B. Harrison, "Spoken English ",Orient Longman 2006 Edn.
3. J. Sethi, Kamlesh Sadanand& D.V. Jindal, "A Practical course in English Pronunciation, (with two Audio cassettes)", Prentice-Hall of India Pvt. Ltd., New Delhi.
4. T.Balasubramanian," A text book of English Phonetics for Indian Students", (Macmillan).
5. "English Skills for Technical Students", WBSCTE with British Council, OL.

COURSE OUTCOMES

At the end of this course work, Students will be able to

1. Student will heighten their awareness of correct usage of English Grammar in writing and speaking.
2. Acquire speaking ability in English both in terms of fluency and comprehensibility.
3. Enhance competence in the four modes of literacy; Writing, Speaking, Reading and Listening.
4. Ensure student to improve their accuracy and fluency in producing and understanding spoken and written English
5. Exposure of the grammatical forms of English and the use of these forms in specific communicative contexts.

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1		**3**								**3**		**3**
CO2		**3**								**3**		**3**
CO3			**2**							**3**		**3**
CO4		**2**								**3**		**3**
CO5			**3**							**3**		**3**

22ETSP107	ENGINEERING WORKSHOP PRACTICE	L	T	P/D	C
		0	0	3	1.5

COURSE OBJECTIVES

- To provide the students simple hands-on-experience in the basic aspects of production engineering in fitting, carpentry and sheet metal.
- To familiarize the students in the various hand forging operations

CARPENTRY: Use of hand tools - exercises in planning and making joints namely, Lap joint, Lenthhening joint, half lap joint, dovetail joint, mortising and tenoning etc.

FITTING: Use of bench tools, vice, hammers, chisels, files, hacksaw, centre punch, twist drill, taps and dies - Simple exercises in making T, V joint and dovetail joints.

SHEET METAL WORK: Use of hand tools - Simple exercises in making objects like cone, funnel, tray, cylinder.

SMITHY: Demonstration of hand forging and drop forging.

COURSE OUTCOMES

At end of this course work, students will be able to

1. Use basic tools of fitting, carpentry and sheet metal fabrication.
2. Fabricate simple carpentry joints.
3. Develop skill to make simple fitting joints.
4. Create simple shapes of sheet material.
5. Distinguish hand forging and drop forging operation.

Mapping of Course Outcomes with Programme Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		2		2		3					3
CO2	3		2		2		3					3
CO3	3		2		2		3					3
CO4	3		2		2		3					3
CO5	3		2		2		3					3

22ETSP108	ELECTRICAL WIRING AND EARTHING PRACTICE LABORATORY	L	T	P/D	C
		0	0	3	1.5

COURSE OBJECTIVES

- To create an awareness on the electrical safety in industrial and commercial environment.
- To enable the understanding on the principles of different types of electrical wiring.
- To offer exposure on the need for earthing and earthing practices.
- To provide practical knowledge on the various types of lighting circuits.
- To introduce methods for measuring the variables in electric circuits.

LIST OF EXPERIMENTS

1. Residential Wiring
2. Fluorescent lamp wiring
3. Stair case Wiring
4. Godown Wiring
5. Ceiling fan wiring
6. Industrial Wiring
7. Series and Parallel Lamp Circuits
8. Measurement of Earth Resistance
9. Measurement of Parameters in a Single-Phase AC Circuit
10. Measurement of Voltage, Current, Power and Power factor in a Resistive Circuit
11. Soldering Practice -Components devices and circuits -using general purpose PCB
12. Corridor Wiring
13. Test the operation and control circuit for LED Flourescent Lamp (18W)
14. Study of various categories of Fuses and Insulators
15. Study and test the operation of Automatic Iron Box
16. Testing the buck/boost functions of the domestic stabilizer

COURSE OUTCOMES

At the end of this course work, Students will be able to

1. Familiarize with the electrical safety measures.
2. Identify the different types of electrical wiring.
3. Know the necessity of Earthing.
4. Gain knowledge on the different types of lighting circuits.
5. Understand the methods for measuring electrical variables.

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**			**2**			**2**					**3**
CO2	**3**			**2**			**2**		**2**			**3**
CO3	**3**			**2**			**2**		**2**			**3**
CO4	**3**			**2**			**2**		**2**			**3**
CO5	**3**			**2**			**2**		**2**			**3**

SEMESTER II

22ETHS201	**ENGLISH**	**L**	**T**	**P/D**	**C**
		3	**1**	**0**	**4**

COURSE OBJECTIVES

- To ensure the students with good vocabulary
- To make the students participate actively in writing activities
- To practice the unique qualities of professional writing style
- To develop the students the proficiency in communicative skills
- To ensure the students to face the demand of their profession

UNIT I: VOCABULARY BUILDING

The concept of Word Formation
Root words from foreign languages and their use in English
Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives, Count and uncount nouns.
Synonyms, antonyms, and standard abbreviations.
Language development - Wh questions asking and answering yes or no questions.

UNIT II: BASIC WRITING SKILLS

Sentence Structures
Use of phrases and clauses in sentences
Importance of proper punctuation
Creating coherence and Techniques for writing precisely
Organizing principles of paragraphs in writing

UNIT III: NATURE AND STYLE OF SENSIBLE WRITING

Describing and Defining
Classifying and Providing examples or evidence
Writing introduction and conclusion

Comprehension
Precise Writing

UNIT IV: WRITING PRACTICES & ORAL COMMUNICATION

Listening to lectures and making notes
Mechanics of presentation, asking and giving instruction
Essay Writing -Writing analytical essays and issue based essays
Dialogue writing and conversation
Letter writing -Formal and informal

UNIT V: GROUP DISCUSSION AND JOB APPLICATION

Characteristics and practices of group discussion
Job application
Resume preparation
Writing reports -minutes of a meeting, accident, survey E-mail -etiquette

TEXT /REFERENCE BOOKS

1. Michael Swan,"Practical English Usage", OUP, 1995.
2. F.T. Wood,"Remedial English Grammar",Macmillan,2007.
3. William Zinsser,"On Writing Well", Harper Resource Book, 2001,
4. Liz Hamp - Lyons and Ben Heasly,"Study Writing", Cambridge University Press, 2006.
5. Sanjay Kumar and PushpLata, "Communication Skills" Oxford University Press, 2011.
6. "Exercises in Spoken English. Parts. I-III", CIEFL, Hyderabad, Oxford University Press.
7. Raman, Meenakshi and Shama, Sangeetha, "Technical Communication Principles and Practice", Oxford University Press, New Delhi, 2014.

COURSE OUTCOMES

At the end of this course work, students will able to

1. Comprehension, writing and speaking skills. Get an exposure of vocabulary and gain a good glossary.
2. Get knowledge regarding use of Grammar in speech and writing.
3. Acquire knowledge of remembering, understanding, applying, analyzing, evaluating & creating.
4. Determine how to articulate their ideas effectively to a variety of listeners.
5. Acquire ability to speak and write effectively in English.

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1		**2**		**2**						**3**		**3**
CO2		**2**		**2**						**3**		**3**
CO3			**3**							**3**		**3**
CO4			**2**	**3**						**3**		**3**
CO5			**3**	**2**						**3**		**3**

22ETBS202	**MATHEMATICS -II**	**L**	**T**	**P/D**	**C**
		3	**1**	**0**	**4**

COURSE OBJECTIVES

- To familiarize multiple integrals and its application in finding area and volume.
- To make the student to learn line, surface and volume integrals.
- To solve Second order linear differential equations with constant coefficients.
- To acquaint the student with the techniques in the theory of analytic functions.
- To introduce the fundamentals of complex integrations.

UNIT I: MULTIVARIABLE CALCULUS (INTEGRATION)

Double integrals (Cartesian) - change of order of integration in double integrals - Change of variables (Cartesian to polar) - Applications: Area as a double integral. Triple integrals (Cartesian) - Applications: Volume as a triple integral.

UNIT II: VECTOR CALCULUS (INTEGRATION)

Line, Surface and Volume integrals - Gauss divergence theorem (without proof) - Green's theorem in the plane (without proof) -Stokes theorem (without proof).Verification of the above theorems and evaluation of integrals using them.

UNIT III: ORDINARY DIFFERENTIAL EQUATIONS

First order ordinary differential equations (Linear and Bernoulli's differential equations, exact differential equations). Solution of Second order ordinary linear differential equations with constant co-efficient (method of variation of parameters only).Solution of Second order ordinary linear differential equations with variable co-efficient (Euler and Legendre's linear equations).

UNIT IV: COMPLEX VARIABLE (DIFFERENTIATION)

Analytic functions and their properties - Cauchy-Riemann equations - Harmonic functions - harmonic conjugate of elementary analytic functions-Construction of an analytic function. Mobius transformations.

UNIT V: COMPLEX VARIABLE (INTEGRATION)

Cauchy theorem (without proof) - Cauchy Integral formula (without proof) - Cauchy Integral formula for higher derivatives (without proof) -zeros and poles of an analytic functions - singularities. Residues - Cauchy Residue theorem (without proof) - Evaluation of definite integral using them. Taylor's series and Laurent's series.

TEXT BOOKS

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 36thEdition,2010.
2. Erwin kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley &Sons,2006.

REFERENCE BOOKS

1. G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", 9th Edition, Pearson,Reprint,2002.
2. W. E. Boyce and R. C. DiPrima, "Elementary Differential Equations and Boundary Value Problems", 9thEdn., Wiley India, 2009.
3. S. L. Ross, "Differential Equations", 3rd Ed., Wiley India,1984.
4. J. W. Brown and R. V. Churchill, "Complex Variables and Applications", 7th Ed., Mc-Graw Hill, 2004.
5. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, Reprint, 2008.

COURSE OUTCOMES

At the end of this course, students will be able to

1. Solve double and triple integrals in finding area and volumes.
2. Apply line, surface and volume integrals in Gauss, Greens and Stoke'stheorems.
3. Solve Second order linear differential equations with constant coefficients.
4. Construct analytic function and analyze conformal mappings.
5. Evaluate the complex integrals and contour integration.

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**2**								
CO2	**3**	**3**	**2**									
CO3	**3**	**3**	**3**	**3**	**3**							
CO4	**3**	**3**	**2**									
CO5	**3**	**3**	**3**	**2**								

22ETES203	**BASIC ENGINEERING {Civil (2 Units), Civil (3 Units), Mechanical (2 Units), Electrical and Electronics (3 Units)}**	**L**	**T**	**P/D**	**C**
		4	**0**	**0**	**4**

BASIC CIVIL ENGINEERING (2 Units)

COURSE OBJECTIVES

- To inculcate a knowledge on essentials of Civil Engineering and to expose on the role of significance and contributions
- To satisfying societal needs and illustrate the concepts of various construction techniques

UNIT I

Introduction to Civil Engineering - Various disciplines of Civil Engineering - Introduction to various building materials Stone, Bricks, Steel, Cement, Concrete – its characteristics, types and uses. Surveying - Principles and objectives of surveying; Types, Classifications of surveying, measurement of areas and distances – chain – compass: Introduction to Leveling, Total station, Remote sensing.

UNIT II

Building construction – foundations; Bearing capacity of soil, functions of foundations, Types - Shallow and Deep. Brick masonry – Header, Stretcher, Flemish and English Bond. Columns, Lintels, Roofs – functions, types, roofing materials. Bridges – necessity - selection of site – components of a bridge: Dams – types – selection site - forces acting on a dam – Roads – uses - classification of roads – components of a road.

TEXT BOOKS

1. Ramesh babu. V, A text book of Basic Civil Engineering, Anuradha Agencies, Kumbakonam, 1995.

2. Palanichamy M.S., Basic Civil Engineering, Tata McGraw Hill Publishing Company ltd, 2000.

REFERENCE BOOKS

1. Ramamrutham V, Basic Civil Engineering, Dhanpat Rai Publishing Co. (P) Ltd., 1999.
2. Natarajan K V, Basic Civil Engineering, Dhanalakshmi Publications, Chennai, 2005.
3. SatheeshGopi, Basic Civil Engineering, Pearson Publications, 2010.

COURSE OUTCOMES

1. Understand the basic knowledge on civil engineering materials
2. Develops the skill to satisfy the social needs and suitable method of construction technique

Mapping of Course Outcomes with Programme Outcomes														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**2**	**2**									**2**	**3**	**2**	**2**
CO2	**3**	**2**	**2**									**2**	**2**	**3**	**2**
CO3															
CO4															
CO5															

BASIC CIVIL ENGINEERING (3 Units)

COURSE OBJECTIVES

- To inculcate a knowledge on essentials of Civil Engineering
- To expose the students on the role, significance and contributions of Civil Engineering in satisfying societal needs
- To illustrate the concepts of various construction techniques

UNIT I

Introduction to Civil Engineering - Relevance of Civil Engineering in the overall infrastructural development of the country. Introduction to various building materials -Stone, Bricks, Steel, Cement, Concrete, Timber -its characteristics, types and uses. Various types of buildings as per NBC; Selection of suitable site for buildings, Components of a residential building -its

functions, Orientation of a building, simple definitions - Plinth area / built up area, floor area / carpet area -floor space index.

UNIT II

Surveying - Principles and objectives of surveying; Types, Classifications of surveying, measurement of areas and distances - Chain - Compass: Introduction to Leveling, Total station, Remote sensing - Fundamental principles and applications.

Building construction - Foundations; Bearing capacity of soil, functions of foundations, Types - Shallow and Deep. Brick masonry - Header, Stretcher, Flemish and English Bond. Columns, Lintels, Roofs - Functions, types, roofing materials, Floors -functions, types, flooring materials. Decorative finishes - Plastering, interior design.

UNIT III

Bridges - Necessity - Selection of site - Components of a bridge: Dams -Types - Selection of site - Forces acting on a dam - Roads - Uses - Classification of roads - Components of a road; Railways - Basic components of permanent way -Water supply - Per capita requirement - Sources - Need for conservation of water - Rain water harvesting - Basic water treatment - Sewage and its disposal - Basic definitions - Septic tank - Components and functions.

TEXT BOOKS

1. Ramesh babu. V, A text book of Basic Civil Engineering, Anuradha Agencies, Kumbakonam, 1995.
2. Palanichamy M.S., Basic Civil Engineering, Tata McGraw Hill Publishing Company ltd, 2000.

REFERENCE BOOKS

1. Ramamrutham V, Basic Civil Engineering, DhanpatRai Publishing Co. (P) Ltd., 1999.
2. Natarajan K V, Basic Civil Engineering, Dhanalakshmi Publications, Chennai, 2005.
3. SatheeshGopi, Basic Civil Engineering, Pearson Publications, 2010.

COURSE OUTCOMES

1. Understand the basic knowledge on Civil engineering materials
2. Develops the skill to satisfy the social needs
3. Describe the suitable method of construction technique

Mapping of Course Outcomes with Programme Outcomes															
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**2**	**2**									**2**	**3**	**2**	**2**
CO2	**3**	**2**	**2**									**2**	**2**	**3**	**2**
CO3	**3**	**2**	**2**			**2**						**2**	**2**	**2**	**3**
CO4															
CO5															

BASIC MECHANICAL ENGINEERING (2 Units)

COURSE OBJECTIVES

- To familiarize the students the functioning of boilers, turbines and internal combustion engines.
- To provide knowledge about the use of various machine tools and manufacturing processes

UNIT I

Energy Conversion Devices: Boilers - Classification - Description and working of Cochran boiler - Babcock and Wilcox boiler. Steam turbines: Principles and working of Impulse and Reaction turbines. Gas turbines: Principles and working of Open cycle and Closed cycle gas turbines. Internal Combustion Engines: Classification - Principal parts - Two stroke and four stroke cycle engines - Working principle of petrol and diesel engines - Concept of CRDI and MPFI fuel injection systems - Hybrid engines. Battery electric vehicles (BEV) - key components

UNIT II

Formative Manufacturing Processes: Forging - Principle and operations; Rolling - Principle, rolling mill configurations; Extrusion - Direct versus indirect extrusion**.** Metal Casting: Principle - Green sand moulding - Injection moulding. Subtractive Manufacturing: Description of parts and operations performed: Lathe, Shaper, Universal Drilling machine, Universal Milling Machine - CNC Machining Centers. Additive Manufacturing Processes: 3 D Printing: Classification - Steps - Advantages - Disadvantages - Stereo lithography process - Gas welding -principle, Oxy-acetylene welding - Equipment, Arc welding - Principle - Equipment - Brazing: Types - Soldering - Comparison of brazing and soldering.

TEXT BOOKS

1. Prabhu T J, Jaiganesh V and Jebaraj S, Basic Mechanical Engineering, Scitech Publications Pvt. Ltd., Chennai, 2016.
2. Venugopal and Prabhuraj T J, Basic Mechanical Engineering, ARS publishers, Sirkali, 1996.

REFERENCE BOOKS

1. Hajra Choudhury S. K., Nirjhar Roy, Hajra Choudhury A. K., Elements of Workshop Technology,(Vol 1 and Vol II,) , Media Promoters, Pvt Ltd. (2008)
2. Rao P. N., Manufacturing Technology : Foundry, Forming and Welding - Vol 1,Mc Graw Hill Education, (2013)
3. Steven R. Schmid, Serope Kalpakjian, Manufacturing Processes for Engineering Materials (English) 5th Edition, Pearson India, (2009)

COURSE OUTCOMES

At end of this course work, Students will be able to

1. Demonstrate the working of various energy conversion devices such as boilers, turbines and internal combustion engines
2. Appraise the fundamental concepts of manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

BASIC ELECTRICAL AND ELECTRONICS ENGINEERING (3 Units)

COURSE OBJECTIVES

- To understand the basics of Electrical circuit laws and fundamentals of AC circuits
- To understand the working of DC Machines, transformers and AC machines
- To learn the basics of electronic devices and Communication Systems

UNIT-I BASIC CIRCUITS

Definition of current and voltage - Electrical circuit elements (R, L and C) - Ohm's Law- Kirchhoff's laws - solution for currents and voltages - AC circuits - RMS -Average values - Introduction to 3 phase systems - Advantages

UNIT-II ELECTRICAL MACHINES

Laws of Electromagnetism - Construction of DC Machines - DC Generator - EMF Equation - DC Motor - Principle of operation - Types – Characteristics

Single-phase Transformer: Construction and Working principle - EMF equation - Three-phase transformer - Working principle.

Three-phase induction motor – Construction and working principle - Single-phase induction motor - Alternators - Working principle

UNIT-III BASIC ELECTRONICS

P-N junction - VI Characteristics of PN junction diode, Zener diode - Rectifier circuits- Voltage Regulator using Zener diode - Elements of Communication Systems - Microwave, Satellite and Optical Fibre (Block Diagram Approach only).

TEXTBOOKS

1. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", McGraw Hill Education, 2014.
2. A K Theraja &B L Theraja, A Textbook of Electrical Technology, Vol.2, S. Chand Publishing, 2014.

REFERENCE BOOKS

1. Del Toro, "Electrical Engineering Fundamentals", Second edition, Pearson Education, New Delhi, 1989.
2. V.K. Mehta, Rohit Mehta, "Basic Electrical Engineering", S.Chand Publications, 2012.

COURSE OUTCOMES

At the end of the course, the students will be able to

- Understand the concepts related with electrical circuits and AC fundamentals.
- Acquire knowledge on the concepts of DC machines, Transformers and AC machines
- Enhance the knowledge about the basic electronic devices and their applications.
  Gain insight on the various elements of Communication systems.

Mapping of Course Outcomes with Programme Outcomes														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**2**	**1**									**2**			
CO2	**3**	**2**	**1**									**2**			
CO3	**3**	**2**	**1**									**2**			
CO4															
CO5															

22ETHS204	TAMILS AND TECHNOLOGY தமிழரும் தொழில்நுட்பமும்	L	T	P/D	C
		1	0	0	1

அலகு I: நெசவு மற்றும் பானைத் தொழில்நுட்பம்: 3

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II: வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: 3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு– சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் – மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ–சாரோசெனிக் கட்டிடக் கலை.

அலகு III: உற்பத்தித் தொழில் நுட்பம்: 3

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV: வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்: 3

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V: அறிவியல் தமிழ் மற்றும் கணித்தமிழ்: 3

அறிவியல் தமிழின் வளர்ச்சி -கணித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் 3 தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் V தமிழ் மின் நூலகம் 3 இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

1. **Weaving and Ceramic Technology**: Weaving Industry during Sangam Age - Ceramic technology - Black and Red Ware Potteries (BRW) - Graffiti on Potteries.
2. **Design and Construction Technology:** Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age - Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple) -Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.
3. **Manufacturing Technology**: Art of Ship Building - Metallurgical studies - Iron industry-Iron smelting, steel - Copper and gold - Coinsassource of history - Minting of Coins - Beads making - Industries Stone beads - Glass beads - Terracotta beads - Shell beads/bone beats - Archeological evidences - Gem stone types described in Silappathikaram.
4. **Agriculture and Irrigation Technology:** Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries - Pearl - Conchediving - Ancient Knowledge of Ocean - Knowledge Specific Society.
5. **Scientific Tamil & Tamil Computing**: Development of ScientificTamil - Tamil computing - Digitalization of Tamil Books - Development of Tamil Software - Tamil Virtual Academy -Tamil Digital Library - Online Tamil Dictionaries - Sorkuvai Project.

TEXT-CUM-REFERENCEBOOKS:

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL - (in print)
6. Social Life of the Tamils The Classical Period (Dr.S.Singaravelu) (Published by:International Institute of Tamil Studies).
7. Historical Heritage of theTamils (Dr.S.V.Subatamanian,Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of theTamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilizationon the bank so friver Vaigai'(Jointly Published by:Department of Archaeology&TamilNadu TextBook and Educational Service

Corporation, Tamil Nadu)

10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22ETBP205	PHYSICS LABORATORY	L	T	P/D	C
		0	0	3	1.5

COURSE OBJECTIVES

- To access the Rigidity modulus of wire.
- To assess the various properties of light.
- To assess the characterization of Metals.
- To analyses the thickness of microsized objects**.**

LIST OF EXPERIMENTS

1. Air Wedge
2. Newtons's Rings
3. Simple Pendulum
4. Dispersive power of the Prism
5. Diffraction Grating
6. Acoustic diffraction Grating
7. Compound Pendulum
8. Kunt's tube experiment
9. Young's double slit experiment
10. Laser Grating
11. Torsional Pendulum
12. Young's Modulus -Non-uniform Bending
13. Young's Modulus –Uniform Bending.

COURSE OUTCOMES

At the end of this course work, Students will be able to

1. Acquired the knowledge of torsional properties of metals wire
2. Determine the radius of curvature of the plano-convex lens.
3. Determine the dispersion power of the prism.
4. Evaluate the important characteristics of simple and compound pendulum
5. Determine the Young's Modulus of uniform and non-uniform bending.

Mapping of Course Outcomes with Programme Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**						**2**		**2**	**3**		**3**
CO2	**3**						**2**		**2**	**3**		**3**
CO3	**3**						**2**		**2**	**3**		**3**
CO4	**3**						**2**		**2**	**3**		**3**
CO5	**3**						**2**		**2**	**3**		**3**

22ETBP206	**CHEMISTRY LABORATORY**	**L**	**T**	**P/D**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To list the water quality standards.
- To assess the composition of an alloy.
- To appreciate the practical significance of acidimetry, alkalimetry, permananganometry, conductometry and potentiometry.
- To analyse quantitatively the amount of a substance present in a given sample.

LIST OF EXPERIMENTS

1. Determination of surface tension and viscosity
2. Thin layer chromatography
3. Ion exchange column for removal of hardness of water
4. Determination of chloride content of water
5. Determination of the rate constant of a reaction
6. Determination of cell constant and conductance of solutions
7. Potentiometry - determination of redox potentials and emfs
8. Saponification/acid value of an oil
9. Determination of the partition coefficient of a substance between two immiscibleliquids
10. Adsorption of acetic acid by charcoal
11. Volumetric analysis

COURSE OUTCOMES

At the end of this course work, Students will be able to

1. Determine the physical properties like surface tension and viscosity.
2. Determine rate of reactions and soapnification of oil.
3. Calculate the quantity of adsorbate adsorbed by charcoal.
4. Determine the impurity from Pharmaceutical products and hardness of water.

5. Determine exact concentration of acid and bases present in the industrial wastes.

Mapping of Course Outcomes with Program Outcomes												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**1**		**1**			**1**					
CO2	**2**	**1**				**1**						
CO3	**3**	**2**		**1**			**2**					
CO4	**3**		**1**									
CO5	**2**	**2**										

22ETSP207	**COMPUTER PROGRAMMING LABORATORY**	**L**	**T**	**P/D**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To enable students to code, compile and test C programs.
- To enable students to design algorithms using appropriate programming constructs for problem solving.
- Identify tasks in which the numerical techniques learned are applicable and apply them to write programs.
- To enable students to segregate large problems into functions using modular programming concepts.
- To enable students to apply pointer and structures in programs effectively.

[The laboratory should be preceded or followed by a tutorial to explain the approach or algorithm to be implemented for the problem given]

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment
Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions
Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures
Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series
Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation
Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations
Tutorial 7: Functions, call by value:

Lab 7: Simple functions
Tutorial 8 & 9: Numerical methods (Root finding, numerical differentiation, numerical integration):
Lab 8 and 9: Programming for solving Numerical methods problems
Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions
Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures
Tutorial 12: File handling:
Lab 12: File operations

COURSE OUTCOMES

At the end of this course work, Students will be able to

1. Analyze program requirements and develop programs using conditional and looping statements.
2. Write programs for handling arrays and strings.
3. Create C programs with user defined functions and recursive function calls.
4. Utilize pointers and structures for dynamic memory allocation in C programming.
5. Develop C programs for handling files.

Mapping of Course Outcomes with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**1**	**1**		**2**							
CO2	**2**	**1**	**1**		**2**							
CO3	**2**	**1**	**1**		**2**							
CO4	**1**	**1**	**1**		**2**							
CO5	**1**	**1**	**1**		**2**							

22ETSP208	**ENGINEERING GRAPHICS**	**L**	**T**	**P/D**	**C**
		2	**0**	**3**	**3**

TRADITIONAL ENGINEERING GRAPHICS

Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Reading a Drawing; Sectional Views; Dimensioning, True Length, Angle.

COMPUTER GRAPHICS

Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modeling; Solid Modeling; Introduction to Building Information Modeling (BIM). (Except the basic essential concepts, most of the teaching part can happen concurrently in the laboratory)

COURSE OBJECTIVES

- To develop the ability to produce simple engineering drawing and sketches based on current practice
- To develop the means for communication of ideas, thoughts and design of objects, related to engineering applications, to others though drawing
- To develop the skills to read manufacturing and construction drawings used in industry
- To develop a working knowledge of the layout of plant and equipment
- To develop skills in abstracting information from calculation sheets and schematic diagrams to produce working drawings for manufacturers, installers and fabricators

UNIT I: INTRODUCTION TO ENGINEERING DRAWING

Introduction to Engineering Drawing: Lettering, Dimensioning and use of drawing instruments. Conic sections: Eccentricity method of/for drawing ellipse, parabola and hyperbola- Tangent and Normal from a point on the curve.

UNIT II: ORTHOGRAPHIC PROJECTIONS

Orthographic projections: Introduction -Projections of points Projections of Straight lines: Determination of true length and true angle of inclinations using half cone and trapezoidal methods -drawing the projections of straight lines using half cone method from true length and true angle of inclinations.

UNIT III: PROJECTIONS OF REGULAR SOLIDS

Projections of solids in simple position: Projections of cube, Tetrahedron, prisms, Pyramids, cone and cylinder. Projections of solids: Auxiliary projections -projections of prisms, pyramids, cylinder and cone when the axis is inclined to only one plane.

UNIT IV: SECTIONS AND SECTIONAL VIEWS OF RIGHT ANGULAR SOLIDS,

Sections of solids: Sections of prisms, pyramids, cylinder and cones -true shape of section. Developments of solids: Developments of lateral surfaces of solids using parallel and radial line methods.

UNIT V: ISOMETRIC PROJECTIONS

Isometric projections: Projections of simple solids. Conversion of pictorial view of simple objects into orthographic projections (only elevation and plan)

OVERVIEW OF COMPUTER GRAPHICS COVERING

Introduction to CAD software: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars). The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.

CUSTOMIZATION & CAD DRAWING

Consisting of setup of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines and other basic geometric entities.

ANNOTATIONS, LAYERING & OTHER FUNCTIONS

Applying dimensions to objects and annotations to drawings; Setting up and use of Layers, Printing document stop a per using the print command; orthographic projection techniques Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation;

TEXT/REFERENCE BOOKS

1. BhattN.D.,Panchal V.M.& Ingle P.R.,(2014), Engineering Drawing, Charotar Publishing House.
2. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education.
3. Agrawal B. &Agrawal C. M. (2012), Engineering Graphics, TMH Publication.
4. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.
5. (Corresponding set of) CAD Software Theory and User Manuals.

COURSE OUTCOMES

At the end of this course work, Students will be able to

1. Utilize drawing instruments effectively and able to present engineering drawings and sketches.
2. Describe the concept of orthographic, isometric projections of points, lines and regular solids.
3. Visualize the images and drawings in engineering perspective.
4. Practice sectioning of bodies like machines and equipment's.
5. Develop their technical communication skills and promote life-long learning.

Mapping of Course Outcomes with Programme Outcomes												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1			**2**		**2**					**2**		**2**
CO2	**3**	**3**	**3**	**2**	**2**				**2**	**2**		**2**
CO3	**2**		**2**									
CO4	**3**	**2**	**2**	**2**								
CO5										**3**		**3**

DEPARTMENT OF CHEMICAL ENGINEERING

VISION

Our vision is to be a leading Chemical Engineering Department in the Nation, to create and develop technocrats, entrepreneurs and business leaders

MISSION

The department fosters chemical engineering as a profession that interfaces engineering and all aspects of basic sciences to disseminate knowledge in order to prepare the students to be successful leaders and practitioners and to meet the present and future needs of the society by highest degree of standards and ethics.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. To master the basic principles with ability to apply mathematics, physics, chemistry and biology and to understand and apply the same in the practice of modern technologies.

2. To excel in designing and optimization of the processes and systems by analysis and evaluation with the knowledge of basic engineering sciences of mass and energy balances: Thermodynamics of physical & chemical equilibria: heat, mass & Momentum transfer with economic principles.

3. To develop the ability to express ideas with understanding of social and cultural context of work associated with environmental, safety and economic aspects and high standards of ethical practice

4. To acquire the ability to solve problems in a broad range of career in multi-disciplinary professional team with effective management skills, moral responsibility applying critical thinking with leadership qualities at par with contemporary and global outlook.

5. The ability to cater the needs of Chemical industry, research organizations and academic institutes

PROGRAMME OUTCOMES (POs)

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Mapping of PEO with POs												
POs / PEOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
PEO1	3	3	3	3	2	3	3	2	2	1	1	3
PEO2	3	3	3	3	2	3	3	2	2	1	1	3
PEO3	3	3	3	3	2	3	3	2	2	2	1	3
PEO4	3	3	3	3	2	3	3	2	2	2	1	3
PEO5	3	3	3	3	2	3	3	2	2	1	3	3

1–Slight, 2–Moderate, 3–Substantial

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1: Apply the basics and comprehensive knowledge in chemical engineering to analyze the problems in process industries to provide pragmatic solutions.

PSO 2: Investigate and demonstrate innovative practices to develop processes and products and provide services with optimal utilization of resources with sustainability and ethics.

PSO 3: Administer professional engineering competence to analyze and interpret data in engineering, economics and management to exhibit as an individual, leader and entrepreneur with ability to efficiently communicate, work effectively in diversified environments and pursue lifelong learning for careers in industry, academics and research.

THIRD SEMESTER

22ETBS301	MATHEMATICS – III	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

The students will be trained on the

- Basics of chosen topics of mathematics, namely, partial differential equations, Fourier Series, Boundary Value Problems, Fourier Transform and Z-Transform
- Topics introduced in this course will serve the students to apply them to specialized studies in engineering.

UNIT-I: Partial differential equations

Formation of partial differential equations by eliminating arbitrary constants and arbitrary functions - Solution of standard type of first order partial differential equations - Lagrange's linear equation - Linear partial differential equations of second order with constant coefficients.

UNIT-II: Fourier series

Dirichle's conditions - General Fourier series - Odd and Even functions - Half range sine series - Half range cosine series - Complex form of Fourier series – Parseval's identity.

UNIT-III: Boundary value problems

Solutions of one-dimensional wave equation – One dimensional heat equation (without derivation) – Fourier series solutions in Cartesian co-ordinates.

UNIT-IV: Fourier transform

Fourier integral theorem (without proof) – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem - Parseval's identity

UNIT-V: Z – Transform and difference equations

Z – transform – Elementary properties – Inverse Z – transform - Convolution theorem – Solution of difference equations using Z – transform.

TEXT BOOKS:

1. Kandasamy.P, Tilagavathy.K and Gunavathy.K, Engineering Mathematics,6th ed, 2006 (Vol-I & II) S.Chand & Co Ltd., New Delhi.
2. Ventakataraman M.K., Engineering Mathematics, 2003, The National Publishing Co., Chennai.

REFERENCES:

1. Veerarajan T, Engineering Mathematics, 3rd Ed, 2005, Tata McGraw Hill.
2. Singaravelu. A, Engineering Mathematics, 2004, Meenakshi Publications, Chennai.

COURSE OUTCOMES:

On completion of the course the students will be able to

1. Relate and acquire basic understanding of the most common partial differential equations.
2. Illustrate the solution based on Fourier series and limitations.
3. Distinguish learning of methods of solving problems using Fourier Transforms.
4. Describe the boundary value problems, solve and apply to them.
5. Observe the solution-based Z-transform

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-
CO2	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-
CO3	**3**	**3**	2	2	-	-	-	-	-	-	-	-	3	-	-
CO4	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-
CO5	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-

22ETES302	**ENVIRONMENTAL STUDIES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To realize the importance of environment for engineering students.
- To understand the basis of ecosystems
- To make aware the student about global environmental problems and natural disasters.
- To give the ideas about advance technologies of Engineering that will useful to protect environment.

UNIT I

Introduction - Multidisciplinary nature of environmental studies - Definition, scope and importance - Need for public awareness.

Natural resources - Forest resources: use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.- Role of an individual in conservation of natural resources.- Equitable use of resources for sustainable lifestyles.

UNIT II

Concept of an ecosystem - Structure and function of an ecosystem - Producers, consumers and decomposers - Energy flow in the ecosystem - Ecological succession - Food chains, food webs and ecological - pyramids - Introduction, types, characteristic features, structure and function

of the following ecosystem - Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

UNIT III

Introduction – Definition: genetic, species and ecosystem diversity - Bio geographical classification of India - Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values - Biodiversity at global, National and local levels - India as a mega-diversity nation - Hot-spots of biodiversity - Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts - Endangered and endemic species of India - Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT IV

Definition - Cause, effects and control measures of Air pollution - Water pollution - Soil pollution - Marine pollution- Noise pollution - Thermal pollution - Nuclear hazards- Solid waste Management: Causes, effects and control measures of urban and industrial wastes - Role of an individual in prevention of pollution - Disaster management : floods, earthquake, cyclone and landslides.

Sustainable development - Urban problems related to energy - Water conservation, rain water harvesting, and watershed management - Resettlement and rehabilitation of people; its problems and concerns. - Environmental ethics: Issues and possible solutions - Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.

Wasteland reclamation - Consumerism and waste products - Environment Protection Act - Air (Prevention and Control of Pollution) Act - Water (Prevention and control of Pollution) Act - Wildlife Protection Act - Forest Conservation Act - Issues involved in enforcement of environmental legislation.

UNIT V

Population growth, variation among nations - Population explosion – Family Welfare Programme - Environment and human health - Human Rights - Value Education - HIV/AIDS - Women and Child Welfare - Role of Information Technology in Environment and human health -Case Studies.

TEXT BOOKS:

1. Agarwal, K.C. Environmental Biology, 2001, Nidi Publ, Ltd. Bikaner.
2. Bharucha Erach, Text book for Environmental studies,University press,UGC,Delhi
3. Environmental Studies by R Geetha Balakrishna, KG Lakshminarayana Bhatta, Sunstar Publisher, 2016.
4. Environmental Engineering by Howard S. Peavey, Donald R. Rowe, George Techobanolous, McGraw-Hill International Editions

REFERENCES:

1. Brunner R.C., Hazardous Waste Incineration, 1989, McGraw Hill Inc. 480p
2. Jadhav, H & Bhosale, V.M. Environmental Protection and Laws, 1995, Himalaya Pub. House, Delhi 284 p.

3. Wastewater Engineering – Treatment, Disposal and Reuse, METCALF AND EDDY, INC. 3rd Edition Tata McGraw-Hill Publishing Company Limited
4. Environmental Studies by Anubha Kaushik & C.P. Kaushik Second Edition, New Age International (P) Limited
5. Environmental studies by Dr. D.L.Manjunath, 1st Edition, PEARSON, 2006
6. S Rao, Environmental Pollution Control Engineering, New Age International Publisher, 2011.
7. M N. Rao, Air Pollution, Tata McGraw-Hill Publishing Company Limited,2007.
8. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB)
9. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
10. Odum, E.P.. Fundamentals of Ecology, 1971, W.B. Saunders Co. USA, 574p
11. Rao M N. & Datta, A.K. Waste Water treatment, 1987, Oxford & IBH Publ. Co. Pvt. Ltd. 345p.
12. Sharma B.K., Environmental Chemistry, 2001, Geol Publ. House, Meerut
13. Survey of the Environment, The Hindu (M)
14. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB)
15. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vol I and II, Enviro Media (R)
16. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)
17. Wanger K.D. Environmental Management, 1998, W.B. Saunders Co. Philadelphia, USA 499p

COURSE OUTCOMES:

At the end of the course students will be able to

1. Recognize and interpret the importance of the natural resources for the sustainable development.
2. Analyze the importance of ecosystem and utilize it for sustainable development.
3. Assess the value of biodiversity and develop methods to conserve it.
4. Devise suitable measures to control pollutions and waste management.
5. Appraise the population explosion and select to select suitable Information Technology Tool for standard of living

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	3	3	2	3	1	1	2	3	3	3	2	1	2	2
CO2	1	2	3	2	3	2	1	2	3	3	3	2	1	2	2
CO3	1	2	2	2	3	3	1	2	3	3	3	2	1	2	2
CO4	1	2	3	2	3	2	2	3	3	3	3	1	1	2	2
CO5	1	2	3	2	1	3	1	3	3	3	3	1	1	2	2

22ETES303	ENGINEERING MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the fundamentals of forces and their effects with their governing laws.
- To understand the definitions of particle, body forces and their equilibrium conditions.
- To understand and predict the forces and its related motions.

UNIT I: Statics of particles

Introduction-Units and Dimensions-Laws of Mechanics-Lami's Theorem-Parallelogram, Triangular and Polygon Law of Forces-Classification of Forces-Vectorial Representation of Forces-Coplanar Forces-Resolution of Forces.

Equilibrium of Particle-Vector representation of Space Force-Equilibrium of Particle in Space-Equivalent System of Forces-Principle of Transmissibility.

UNIT II: Equilibrium of rigid bodies

Free Body Diagram-Types of Supports- Types of loads- Types of beams-Action and Reaction of Forces- -Moments and Couples-Moment of a Force-Vectorial Representation of Moments and Couples.

Varignon's Theorem- Stable Equilibrium-Single Equivalent Force-Equilibrium of Rigid Bodies in Two Dimensions and Three Dimensions.

UNIT III: Geometrical properties of surfaces and solids

Centroid and Centre of Gravity-Determination of Centroid of Sections of Different Geometry-Centre of Gravity of a Body-Area Moment of Inertia-Parallel Axis Theorem-Perpendicular Axis Theorem-Determination of Moment of Inertias of Rectangular, Triangular, Circular and Semi-circular- Moment of Inertias of structural Steel Sections of Standard and Composite Sections.

Polar Moment of Inertia-Radius of Gyration-Principal Moment of Inertia-Mass Moment of Inertia- Determination of Mass Moment of Inertia of a Thin Rectangular Plate, Thin Circular Disc, Solid Cylinder, Prism, Sphere and Cone from first principles.

UNIT IV: Dynamics of particles

Introduction-Kinematics and Kinetics-Displacements, Velocity and Acceleration-Equations of Motion-Types of Motion-Rectilinear Motion-Relative Motion-Curvilinear Motion-Projectiles.

Newton's Laws of Motion-Linear Momentum-Impulse and Momentum-D'Alembert's Principle-Dynamic Equilibrium- Work Energy Equations-Law of Conservation of Energy-Principle of Work and Energy.

UNIT V: Friction and elements of rigid body dynamics

Friction Force-Laws of Sliding Friction-Equilibrium Analysis of simple systems with Sliding Friction-Wedge Friction.

Rolling Resistance-Translation and Rotation of Rigid Bodies-Velocity and Acceleration-General Plane Motion of Simple Rigid Bodies such as Cylinder, Disc/Wheel and Sphere.

TEXT BOOKS:

1. Palanichamy, M.S and Nagan, S (2010), Engineering Mechanics (Statics and Dynamics), Tata McGraw Hill Publishing Company, Ltd., New Delhi.
2. Beer, F.P and Johnson, R (2004), Vector Mechanics for Engineers (Statics), McGraw-Hill Book company, New Delhi.

REFERENCES:

1. Natesan,S.C, Engineering Mechanics (Statics and Dynamics), 2002, first edition, Umesh Publications, New Delhi.
2. S.S.Bhavikatti and K.G.Rajasekarappa, Engineering Mechanics, 1999, New Agent International (P) Ltd.
3. Sadhu Sing, Engineering Mechanics, 2000, Oxford & IBH Publishing Co., New Delhi.
4. Irving H. Shames, Engineering Mechanics, 2006,prentice Hall of India ltd., New Delhi.
5. Hibbeller, R.C and Ashok Gupta, Engineering Mechanics: Statics and Dynamics, 2010, Edition, Pearson Education.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Understand the forces and its related laws of mechanics in static and dynamic conditions.
2. Calculate the actions and moments on particles, rigid bodies and structures.
3. Determine the geometrical properties of different sections and bodies.
4. Understand the concepts of motion and its effects on particles and rigid bodies.
5. Calculate the frictional forces and analyze the equilibrium of systems.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	-	2	-	-	2	-	-	-	3	2	-
CO2	3	3	-	-	2	2	-	-	2	-	-	3	3	2	-
CO3	3	3	-	-	2	2	-	-	2	-	-	-	3	2	-
CO4	3	3	-	-	-	2	-	-	2	-	-	3	3	2	-
CO5	3	3	-	-	-	2	-	-	2	-	-	3	3	2	-

22CHES304	**CHEMISTRY FOR CHEMICAL ENGINEERS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To provide the knowledge of basic chemistry to understand the fundamental principles of chemical engineering.
- To familiarize the basic terms of reaction engineering.
- To understand the basic concepts of reaction components and systems.

UNIT - I

Preparation, Physical & Chemical properties and Uses of Pyrrole, Furan, Furfural, Tetrahydro Furan, Thiophene, Indole, Pyridine, Quinoline and Isoquinoline.

Synthesis of Antimalarial drugs – isopentaquine and chloroquine Synthesis of Antibacterial drugs – Sulphaniliamide, Sulphapyridine, Sulphathiazole and Phenacetin.

UNIT - II

Carbohydrates – classification. Monosaccharides- reaction of Glucose and fructose, open chain and cyclic structures of glucose and fructose, mutarotation, epimerzation, Killiani- Fisher synthesis, Ruff degradation, conversion of aldoses to ketoses and Ketoses to aldoses. Disaccharides – properties and structure of sucrose. Polysaccharides – properties and structure of starch and cellulose.

UNIT - III

Elimination Reaction – E1,E2 elimination – Bredt's rule – Zartsev's rule – Condensation reaction – Benzoin Condensation – Aldol Condensation and Claisen Condensation – Preparation and synthetic uses of acetoacetic and malonic esters – Molecular rearrangement – Hofmann rearrangement – Schmidt rearrangement – Beckmann rearrangement.

UNIT – IV

Electrolytic conductance – Specific, Equivalent and Molar conductance – Kohlrauch's law and its applications. Electro potential, Electro chemical cell – EMF of a cell and its measurements – Reference electrodes – Hydrogen , calomel and glass electrodes. The Nernst equation and applications – Concentrations cell. Conductometry – Cell constant – Conductometric titrations – Potentiometry – Principle of acid – base – and oxidation, reduction titrations.

UNIT-V

Rate of reaction – Rate constants – Order and molecularity of reaction – First, second, third and zero order reactions – Method of determining order of reactions – Differential and integral rate expressions – Rate measurement method – Volumetry – Spectrophotometry. Complex reactions – Reverse reactions – Parallel or side reactions, chain reactions, consecutive reactions and explosive reaction. Effect of temperature and solvent on reaction rate. Theories of reaction rates – Activated complex theory of Bi-molecular reactions, the lindemann theory of unimolecular reactions.

TEXT BOOKS:

1. Advance organic Chemistry – B.S. Bahl and Arun Bahl
2. Text book of organic chemistry – P.L.Soni
3. Principles of Physical Chemistry - B. R. Puri, L.R. Sharma, M.S. Pathania

REFERENCES:

1. R.P.Singh, Handbook of Chemistry, 3rd Edition, 2015, Arihant Publications
2. Jain & Jain, Engineering Chemistry, 16th Edition, 2015, , Dhanpat Rai Pulishing Compnay

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Describe the principles of fundamental laws and reaction kinetics.
2. Illustrate models for simple systems in Chemical Engineering.
3. Apply modeling scheme for gas flow systems and reaction kinetics.
4. Design distillation column, Heat exchanger and pipe flow process.
5. Simulate simple chemical engineering systems using numerical methods.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	3	2	1	-	-	-	-	-	-	-	-	1	1	-
CO2	2	1	1	1	1	-	-	-	-	-	-	-	1	1	-
CO3	2	3	2	1	1	-	-	-	-	-	-	-	2	1	-
CO4	2	1	2	1	1	-	-	-	-	-	-	-	1	1	-
CO5	3	2	1	1	1	-	-	-	-	-	-	-	1	2	1

22CHPC305	**TRANSPORT PHENOMENA**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

COURSE OBJECTIVES:

- This course will highlight coupling between three transport phenomena with applications in various disciplines in engineering and science, and will demonstrate to the students the common mathematical structure of transport problems.
- The course will deal with flow problems involving Newtonian and non-Newtonian fluids, solid-state heat conduction, forced and free convection, binary diffusion with or without chemical reaction.

UNIT - I

Introduction to Transport Phenomena, Formulation of transport problems from nature. Basic concepts: Vector and Tensor Analysis. Scalar and vector point functions, vector operator del, del applies to scalar point functions–Gradient, del applied to vector point functions–Divergence and Curl, vector identities Cartesian and Polar coordinate system. Introduction to equation of continuity.

UNIT-II

Basics of momentum transport: Euler/Lagrangian viewpoint, laminar and turbulent flows, boundary layers, stress tensor. Shell Momentum balances, boundary conditions, velocity profiles, average velocity, momentum flux at the surfaces, of Newtonian and non-Newtonian for flow of a falling film, flow through circular tube, slits, flow through an Annulus, Adjacent flow of two Immiscible fluids . Equations of Change, equation of motion (Isothermal)

UNIT-III

Basics of energy transport: conductive, convective, Shell energy balances, boundary conditions, temperature profiles, average temperature and energy fluxes at surfaces for different types of heat sources such as electrical, viscous and chemical. Heat conduction in composite walls. Equation of energy (Isothermal and non-isothermal)

UNIT-IV

Basics of mass transport, mechanisms, and mass and molar fluxes. Shell mass balances, boundary conditions, concentration profiles, average concentration, mass flux at surfaces for Diffusion through stagnant gas film, Diffusion with homogeneous and heterogeneous chemical reaction. Equation of continuity for a binary mixture.

UNIT-V

Unsteady-state momentum, heat and mass transport: (Isothermal), Unsteady state viscous flow in suddenly moving wall, unsteady state heat conduction in finite and semi infinite wall.
Unsteady state diffusion.

TEXT BOOKS:

1. R. B. Bird, W. E. Stewart, and E. S. Lightfoot. Transport Phenomena, 2nd ed., Wiley India Pvt. Ltd., 2002.
2. Welty, C. E. Wicks, R. E. Wilson, and G. L. Rorrer. Fundamentals of Momentum, Heat, and Mass Transfer. 5th Ed., Wiley India Pvt. Ltd., 2007.

REFERENCE BOOKS :

1. W. M. Deen, Analysis of Transport Phenomena, 1998, Oxford University Press,
2. W. J. Thompson, Introduction to Transport Phenomena, 2000, Prentice Hall,

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Demonstrate the basic skills of vector and tensor analysis for cracking the transport problems.
2. Solve transport problems using shell momentum balances.
3. Predict and solve one-dimensional transport problems by using the energy conservation equations.
4. Examine simple multi-dimensional mass transport problems
5. Evaluate unsteady state basic transport problems in momentum, heat and mass and to meet out the sustainable solution.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO2	3	3	2	-	-	2	-	1	2	3	2	2	3	2	1
CO3	3	3	2	-	-	2	-	1	2	3	2	2	3	2	1
CO4	3	3	2	-	-	2	-	1	2	3	2	2	3	2	1
CO5	3	3	2	2	2	2	2	1	2	3	2	2	3	2	1

CHPC306	CHEMICAL PROCESS CALCULATIONS	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES:

- The course will serve as a basis for all further chemical engineering courses that are part of the curriculum.

Unit-I

Introductory concepts of units and dimensions, physical quantities in chemical engineering, Dimensionless groups, Basic chemical calculations – Mole, atomic and molecular weight, Composition of mixtures and solutions - problems, Gases and gaseous mixtures, ideal gas law - problems, Gas – liquid system, Vapour pressure, Clausius-Clapeyron equation, Cox chart, Duhring's plot.

UNIT-II

Humidity and Saturation, humid heat, humid volume, dew point, humidity chart and its use.
Material Balance: Introduction, Material balance without chemical reaction – Solving material balance for Distillation, Mixing, Absorption, Extraction, Evaporation, Drying, Solubility, Crystallization, Dissolution.

Unit-III

Concept of stoichiometry – Limiting and excess reactant, Material Balance with chemical reaction, Combustion – Basics and problems involving calculation of theoretical flame temperature.

Unit-IV

Material balances with Recycle, Bypass and Purging.
Energy balance: Open and Closed system, Heat capacities of solids, liquids, gases and gas mixtures.

UNIT-V

Energy balances with chemical reaction: Calculation of enthalpy changes - Heat of reaction, Heat of formation, Heat of combustion, Hess's law of heat summation. Adiabatic temperature calculations, Energy balance during phase change operations.

TEXT BOOKS:

1. Himmelblau, D. M., Riggs, J. B. "Basic Principles and Calculations in Chemical Engineering", Eighth Ed., 2015, Pearson India Education Services.
2. Bhatt, B. I., Vora, S. M., "Stoichiometry", Fourth Edition, 2004, Tata McGraw Hill Publishing Company Ltd.

REFERENCES:

1. Felder, R. M.; Rousseau, R. W., "Elementary Principles of Chemical Processes", Third Edition, 2000, John Wiley & Sons.
2. K.A.Gavhane, Introduction to Process Calculations (Stoichiometry), 2016, Nirali Publications, Pune, India
3. Hougen, O. A., Watson, K. M., Ragatz, R. A., "Chemical Process Principles, Part-I Material & Energy Balances", Second Edition, 2004, CBS Publishers & Distributors.

COURSE OUTCOMES:

After completing the course, the students will be able to

1. Appreciate the fundamentals of Stoichiometry and process calculations and their

applications to real time problems

2. Conversant in drawing the material balance for unit operations in chemical engineering and be able to apply them for design of equipment and process.
3. Understand and apply material balances derived from the governing equations for processes involving chemical reactions and combustion
4. Solve problems involving humidification, concepts of thermo-physics and heat capacities by drawing pertinent energy balances.
5. Appreciate and work on energy balances involving chemical reactions

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	-	-	1	-	-	-	-	-	-	3	2	-
CO2	3	2	1	-	-	1	-	-	-	-	-	-	3	2	-
CO3	3	2	1	-	-	1	-	-	-	-	-	-	3	2	-
CO4	3	2	1	-	-	1	-	-	-	-	-	-	3	2	-
CO5	3	2	1	-	-	1	-	-	-	-	-	-	3	2	-

22CHPC307	**CHEMICAL TECHNOLOGY**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

COURSE OBJECTIVES:

- To impart clear description of one latest process along with its Chemistry, Process parameters, Engineering Problems and Optimum Conditions.
- To understand unit operations involved in the physical separation of the products obtained during various unit processes.
- To study process technologies of various organic and inorganic process industries

UNIT -I

Industrial gases: Carbon dioxide, Hydrogen, Oxygen, Nitrogen and synthesis gas. Sulfur, Sulfuric Acid, Hydrochloric acid, Chlor-Alkali Industry: Sodium chloride, Soda ash, Sodium Bi-Carbonate, Chlorine, Caustic soda.

UNIT -II

Nitrogen Industry: Ammonia, Ammonium sulfate, Ammonium Nitrate, Ammonium Phosphate, Ammonium chloride, urea, Nitric acid, Nitro Phosphate, cyanamide. Phosphorous Industry- Phosphorus, phosphoric acid Calcium phosphate, Sodium phosphate, Di and Tri ammonium phosphate, Mixed Fertilizers and compound super phosphates.

UNIT-III

Silicate industry: Ceramics, Glass and Cement, paint, Varnish, Enamel and Lacquer, White lead, Zinc oxide, Lithophone, Titanium di oxide.

UNIT - IV

Sugar, starch, glucose, pulp, paper, leather, glue and gelatin. Oils, fats, soaps, glycerin, synthetic detergents

UNIT - V

Plastics - Phenol, vinyl, and urea formaldehydes; polypropylene and silicone. Elastomers, Natural and Synthetic fibers, Cellulose acetate, viscose rayon, Nylon, polyester.

TEXT BOOKS:

1. Austin.G.T., Shreve's Chemical Process Industries, Fifth Edn., 1984, McGraw Hill.
2. Gopal Rao,M., and M. Sittig., Dryden's Outlines of Chemical Technology, 2nd edition, 1979 Affiliated East West Press.

REFERENCES:

1. Kirk and Othmer, Encyclopedia of Chemical Technology, 5th edition, 2005, John Wiley.
2. Pandey,GN., A Text Book of Chemical Technology, 1997, Vikas Publishing Comp.,Vol. II,

COURSE OUTCOMES

On completion of the course, students would be able to

1. Understand the processes involved in manufacturing of various inorganic and organic chemicals
2. Read and interpret basic process industry drawings
3. Prepare the process flow diagrams.
4. Analyze important process parameters and engineering problems during production.
5. Suggest manufacturing process for a chemical.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	-	3	-	-

22CHSP308	ORGANIC & PHYSICAL CHEMISTRY LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

To learn basic principles involved in analysis and synthesis of different organic derivatives.

- To improve the practical knowledge on the properties and characteristics of solvents and mixtures

ORGANIC CHEMISTRY

Preparation Compounds involving in the following reaction are to be prepared:

(a) Oxidation, (b) Reduction, (c) Bromination, (d) Nitration, (e) Sulfonation, (f) Acetylation, (g) Methylation, (h) Hydrolysis and (i) Diazotisation

Qualitative Analysis The following classes of compounds are to be analysed: (a) Aldehydes, (b) Ketones, (c) Acids, (d) Esters, (e) Amides, (f) Amine, (g) Ethers, (h) Alcohol, (j) hydrocarbons and (k) sugars. Determination of Physical constants- Boiling point and Melting point.

PHYSICAL CHEMISTRY

Determination of

1. Molecular Weight - Rast's method, Freezing depression, Boiling point elevation, Transition temperature methods.
2. Phase rules - Two component system, Three component system, Phenol-water system.
3. Optical Experiments – Polarimetry, Refractometry.
4. Conductivity Experiments - Cell constant, Ostwald dilution law, Conductometric titration.
5. EMF - Single electro potentials, Concentration cells, Titrations, pH determination.
6. Surface tension
7. Viscosity

REFERENCES:

1. Alexander Findlay, Practical Physical Chemistry.
2. Daniels, Experimental Physical Chemistry.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Synthesize and analyse organic derivatives quantitatively and qualitatively.
2. Analyze the properties and characteristics of chemicals, solvents and mixtures and their reactivity.
3. Demonstrate procedures and instrumental methods in analytical and practical tasks of organic and physical chemistry.
4. Design and carry out experiments; record and analyse the results to get skilled in problem solving and analytical reasoning can
5. Communicate the scientific work in oral, written formats to explore areas of research with understanding of safe handling of chemicals and environmental issues of society.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	2	2	1	1	-	-	-	-	2	3	1	2
CO2	3	3	1	2	2	1	2	-	1	-	-	1	3	2	2
CO3	2	1	3	1	2	1	1	1	2	-	1	1	1	2	2
CO4	2	3	3	3	3	2	1	1	1	2	-	1	3	-	3
CO5	1	3	3	-	1	-	3	2	2	3	3	3	1	2	3

CHCP309	**TECHNICAL ANALYSIS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES:

- To learn the basic principles involved in characterization and estimation of industrially important materials

LIST OF EXPERIMENTS:

Experiment No. 1

Proximate and Ultimate analysis of coal

Conduct an experiment to determine the moisture, volatile matter, ash and fixed carbon in the given sample of coal by standard method.

Experiment No. 2

Analysis of Water

Conduct an experiment to find out the amount of suspended matter, total dissolved solids, temporary hardness and total hardness of the given sample water.

Experiment No. 3

Analysis of Common salt

Conduct an experiment to find the percentage of chlorides present in the given sample of common salt.

Experiment No. 4

Analysis of Bleaching powder

Conduct an experiment to determine the available chlorine in the given bleaching powder sample.

Experiment No. 5

Analysis of Copper

Conduct an experiment to estimate the percentage of copper present in the given sample of alloy

Experiment No. 6

Analysis of Mixed Acid

Conduct an experiment to find out the percentage of hydrochloric acid, sulphuric acid and nitric acid present in the mixture.

Experiment No. 7

Analysis of Tannin

Conduct an experiment to determine the total astringency due to total tannin in the given sample of myrobalan.

Experiment No. 8

Analysis of Soap

Conduct an experiment to determine the percentage of moisture content, total alkali and total fatty matter present in a given sample of soap.

Experiment No. 9

Analysis of cement

Conduct an experiment to determine loss on ignition, insoluble residue, sulfur trioxide, silica, iron, aluminum oxides, lime and magnesia in the given Portland cement.

Experiment No.10

Analysis of sugar

Conduct an experiment to determine the percentage of sucrose present in the give sample of cane sugar.

Experiment No.11

Viscosity Estimation.

Conduct an experiment to determine the kinetic viscosity of the given of using redwood viscometer.

Experiment No.12

Turbidity Meter.

Conduct an experiment to find the turbidity of the given sample of solution,

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Acquire the knowledge to employ various techniques to analyze the compounds and salts
2. Acquire the knowledge to determine the Composition of various compounds and salts
3. Acquire knowledge to infer the results.
4. Acquire hands on training to use various equipment like viscometer and measure various properties like viscosity, molecular weight.
5. Use turbidity meter and determine the turbidity of the given material.

Mapping with POs & PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	2	-	-	2	-	-	2	3	-	-
CO2	2	-	-	-	-	2	-	-	2	-	-	2	3	-	-
CO3	2	-	-	-	-	2	-	-	2	-	-	2	3	-	-
CO4	3	-	-	-	-	-	-	-	2	-	-	2	1	-	-
CO5	3	-	-	-	-	-	-	-	2	-	-	2	1	-	-

FOURTH SEMESTER

22CHBS 401	NUMERICAL METHODS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce students to numerical methods for solving chemical engineering problems based on different mathematical equations (e.g. linear/ non-linear algebraic equations, ordinary /partial differential equations)

UNIT-I
Introduction, Approximation and Concept of Error & Error Analysis, Linear Algebraic Equations: Methods like Gauss elimination, Gauss-Jordan, LU decomposition and matrix inversion, Gauss – Jacobi, Gauss-Siedel method, Chemical Engineering problems involving solution of linear algebraic equations

UNIT-II
Root finding methods for solution on non-linear algebraic equations: Bisection, Iteration, Regula Falsi, Newton-Raphson and Secant methods, Chemical Engineering problems involving solution of non-linear equations

UNIT-III
Interpolation With equal intervals: Gregory – Newton forward and backward difference, Central difference formulae: - Gauss forward and backward interpolation: Interpolation With Unequal intervals: Gregory – Newton, Lagrange's interpolation

Numerical differentiation- Newton forward and backward difference, Bessel's formula: Numerical integration: Trapezoidal rule, Simpson's rule, Chemical Engineering problems involving interpolation, numerical differentiation and integration

UNIT-IV
Ordinary Differential Equations: Taylor's methods, Euler methods, Improved and Modified Euler's method, Runge-Kutta methods, Milne's Predictor Corrector method, Chemical Engineering problems involving single, and a system of ODEs.

UNIT-V
Introduction to Partial Differential Equations: Characterization of PDEs, Elliptic equation – solution by Laplace equation; Poisson's equation, Parabolic equation – Crank Nicholson Scheme (Heat conduction/diffusion equations); Hyperbolic equation

TEXT BOOK:
1. Gupta, S. K., "Numerical Methods for Engineers, 2012, New Academic Science.
2. Venkatraman M.K. "Numerical Methods in Science and Engineering" National Publishing Company, Chennai

REFERENCES:

1. S.C. Chapra & R.P. Canale, "Numerical Methods for Engineers with Personal Computer Applications", 1985., McGraw Hill Book Company.
2. R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., 2000., Brooks Coles.
3. Atkinson, K. E., "An Introduction to Numerical Analysis", 1978., John Wiley & Sons.
4. Press, W. H. et al., "Numerical Recipes in C: The Art of Scientific Computing, 3rd Edition, 2007, Cambridge University Press.
5. Numerical Methods for Engineers, Gupta, Newage Publishers
6. Numerical Methods for Engineers with Personal Computer Applications, S.C. Chapra, McGraw

COURSE OUTCOMES:

After completion of the course, the students will be able to:

1. Perform error analysis and solve linear system of equations in chemical engineering problems
2. Solve non-linear algebraic or transcendental equations by numerical methods and to implement these methods in chemical engineering applications
3. Demonstrate a function using an appropriate numerical method, to solve chemical engineering problems and calculate a definite integral to evaluate a derivative at a value using an appropriate numerical method
4. Solve ordinary differential equations using an appropriate numerical method and apply the same to solve chemical engineering problems
5. Examine the techniques to solve partial differential equations using suitable numerical methods

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	-	2	-	-	-	-	-	-	-	3	-	-
CO2	3	3	3	-	2	-	-	-	-	-	-	-	3	-	-
CO3	3	3	3	-	2	-	-	-	-	-	-	-	3	3	-
CO4	3	3	3	-	2	-	-	-	-	-	-	-	3	3	-
CO5	3	3	3	-	2	-	-	-	-	-	-	-	3	3	-

22CHES 402	**MATERIAL SCIENCE**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

COURSE OBJECTIVES

- To impart the basic concept of material science by understanding the various properties and heat treatment of engineering materials.
- To understand the selection of materials based on their properties for various engineering applications.

UNIT – I

Introduction to materials, bonding between atoms: metallic bonding, ionic bonding, covalent bonding, Van der Waals bond, thermal expansion, elastic modulus and melting point of materials, Role of materials selection in design, structure-property-processing-performance relationships. Miller indices of directions and planes, packing of atoms inside solids, close-packed structures, structure of ceramics, ionic solids, glass and polymers, density of various materials.

UNIT-II

Imperfections in solids: vacancies, equilibrium concentration of vacancies, interstitial and substitutional impurities in solids, dislocations, types and characteristics of dislocations, interfacial defects, stacking faults. Structure of materials and Strength of Materials: Yield strength, tensile strength and ductility of materials: stress strain behaviour of metals, ceramics and polymers, tensile test, plastic deformation, necking, creep behaviour and fatigue.

UNIT-III

Semi-crystalline materials: Classification, structure and configuration of ceramics, polymers, copolymers, liquid crystals and amphiphiles.

UNIT-IV

Non-crystalline/amorphous materials: Silicates, glass transition temperature, viscoelasticity. Polymer nano-composite materials: Nanocomposites, role of reinforcement-matrix interface strength on composite behavior

UNIT-V

Corrosion, Degradation and Recycling. Biomaterials, material related to catalyst such as zeolites, silica etc. and other selected materials. Introduction to experimental techniques: XRD, NMR, PSA, etc. for material characterization highlighting links between molecular structure and macroscopic properties.

TEXT BOOKS:

1. V. Raghavan Materials Science and Engineering: A First Course, 5th Edition, 2004, prentice Hall India.
2. S. Upadhyaya and A. Upadhyaya, Material Science and Engineering, 2007, Anshan Publications.

REFERENCES:

1. R. A. L Jones, Soft Condensed Matter, 2002, Oxford University Press.
2. William D. Callister, David G. Rethwisch Materials Science and Engineering: An Introduction, Wiley Publisher.
3. B. S. Mitchell An Introduction to Materials Engineering and Science for Chemical and Materials Engineers, 2004, John Wiley & Sons.
4. Materials Science and Engineering, Raghavan, V, PHI
5. Material Science & Engineering, Upadhyaya, Anshan Publications
6. Testing of Metallic Materials, Suryanarayanan, A.V.K., Tata McGraw

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Obtain basic knowledge on materials such as bonding between atoms and packing of atoms inside solids.
2. Understand the Imperfections, structure and strength of materials.
3. Differentiate between Semi-crystalline materials, Ceramics and polymers.
4. Understand the Non-crystalline/amorphous material.
5. Possess knowledge on corrosion, biomaterials and experimental techniques for materials.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	-	-	-	-	-	-	-	-	-	2	1	-
CO2	3	-	-	2	3	2	2	-	2	-	1	2	-	-	-
CO3	3	2	3	2	-	3	3	-	3	-	-	3	3	-	2
CO4	3	3	3	3	3	3	3	-	3	-	2	3	3	3	3
CO5	2	3	-	3	3	-	3	-	-	-	-	-	3	2	-

22CHPC403	**FLUID MECHANICS**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

COURSE OBJECTIVES:

- To introduce the students to the fundamentals of the mechanics of fluids pertaining to Chemical Engineering operations.
- To introduce students to forces on fluids, mass and momentum balances and various governing equations.
- To impart the students with knowledge on types of flow, flow through conduits of varied geometry, techniques for flow measurement and instruments and equipment involved in transportation of fluids.

UNIT-I

Fundamental Concepts: Introduction to Fluid mechanics: definition of Fluid, Continuum concept of fluid, concept of Knudsen number. Shear stress field, Rheological properties of fluids. Basic equation of fluid statics; pressure variation in a static field; pressure measuring devices– manometer, U-tube, inclined tube, force on submerged bodies (straight, inclined), centre of pressure. Kinematics of fluid flow- Eulerian and Lagrangian approach, Streamline, pathline, timeline, streak line.

UNIT-II

System and control volume approaches, Reynolds transport theorem, Integral balances - mass and momentum, Euler's equation of motion, Bernoulli equation and applications. Introduction to turbulence. Viscous flow in a pipe/duct. Head loss in different flow condition: Hagen Poiseuille equation, Fanning's equation, friction factor, Moody's diagram, effect of roughness, friction from changes in velocity or direction. Losses in pipe systems: pipe entrance/exit, expansion/contraction, Fittings and valves - types, characteristics and sizing of valves.

UNIT-III

Differential analysis: mass and momentum balances, Navier-Stokes equation, Unidirectional flow, Viscous flow, Stokes law, Skin drag and pressure drag. Potential flow, Potential function, Solution of Laplace equation.

UNIT-IV

Introduction to boundary layer, boundary layer thickness under laminar and turbulent flow conditions. The principle of dimensional homogeneity - dimensional analysis, Rayleigh method and the Pi- theorem - non-dimensional action of the basic equations - similitude - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies

UNIT-V

Fluid moving machines: Introduction; Basic classification of pumps: Non-Mechanical Pump-acid egg, steam jet ejector, air lift pump, Mechanical pump: Centrifugal pumps - cavitation, NPSH, basic characteristics curves for centrifugal pumps, positive displacement pumps (rotary, piston, plunger, diaphragm pumps); pump specification; parallel operation of Centrifugal pumps; system resistance curves; fan, blower and compressor. Flow measurement: Orifice meter and Venturi meter. Concept of area meters: rotameter. Local velocity measurement: Pitot tube. Hot wire anemometer, mass flow meter

TEXT BOOKS:

1. M. White, Fluid Mechanics, 8th Edition, 2016, Tata-McGraw Hill.
2. V. Gupta and S. K. Gupta, Fundamentals of Fluid Mechanics, 2nd Edition, 2011, New Age International.
3. W. L. McCabe, J. C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, 2015, McGraw-Hill International Edition.

REFERENCES:

1. O. Wilkes, Fluid Mechanics for Chemical Engineers, 2005, Prentice Hall of India
2. R. W. Fox, P. J. Pritchard and A. T. McDonald, Introduction to Fluid Mechanics, 7th Edition, 2010, Wiley-India

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Apply pertinent concepts in fluid statics and kinematics of fluid flow to real time problems in engineering
2. Analyze the laws in fluid flow problems and provide solutions by pertinent equations to overcome the challenges combined with the knowledge on selection right kind of fittings.
3. Construct differential analysis on flow patterns and apply specific types of flow governed by equations like Navier - Stokes Equation and to be able to make decisions to enhance the performance of operations pertaining to fluid dynamics.
4. Design and develop systems by efficiently incorporating fluid dynamics concepts like Boundary layer concept, drag and lift forces on immersed bodies to draw analogies and frame prediction equations.
5. Assess and troubleshoot the pumps, compressors, blowers and valves and perform value addition to technically enhance performance of the systems which will be sensitive to society and environment.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	-	1	-	-	2	-	2	2	3	2	-
CO2	3	3	3	3	3	2	3	2	2	2	2	2	3	3	2
CO3	3	3	3	3	3	2	2	2	2	2	2	2	3	3	2
CO4	3	3	3	3	3	2	2	2	2	2	2	2	3	3	2
CO5	3	3	2	2	3	2	3	2	2	2	2	2	3	2	3

22CHPC404	**CHEMICAL ENGINEERING THERMODYNAMICS - I**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

COURSE OBJECTIVES:

To enable the students to understand the principles and application of the laws of thermodynamics, equations of state and phase equilibria for chemical engineering computations.

UNIT-I

Dimensions and Units, Temperature, Pressure, Work, Energy, Heat; Scope of thermodynamics, Energy conservation & first law of thermodynamics; State and path functions; Intensive and Extensive properties; Reversible and irreversible processes; Equilibrium; Phase Rule; Thermodynamic processes; Mass and energy balances for open systems.

UNIT-II

Phases, phase transitions, PVT behavior; Equations of state - Ideal gas law, Cubic equations of state - van der Waals, Virial, Redlich-Kwong equations; Reduced conditions & corresponding states theories; Compressibility factor; Heat effects-latent heat, sensible heat, standard heats of formation, reaction and combustion.

UNIT-III

Second law of thermodynamics; Heat engines, Carnot's theorem,; Thermodynamic Temperature Scales; Entropy; Entropy changes of an ideal gas; Mathematical statement of the second law; Entropy balance for open systems; Calculation of ideal work, Lost work. Steam and IC engines.

UNIT-IV

Thermodynamic property of fluids, Maxwell relations, 2-phase systems, graphs and tables of thermodynamic properties.

UNIT-V

Application of thermodynamics to flow processes-pumps, pipes, nozzles, compressors and turbines, Carnot refrigerator; Vapor-compression cycle; Absorption refrigeration; Heat pump, Liquefaction processes.

TEXT BOOKS

1. J.M. Smith, H.C. Van Ness and M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, 7th edition, 2005, McGraw-Hill International Edition.

REFERENCES

1. M J Moran, H N Shapiro, D D Boettner and M B Bailey, Principles of Engineering Thermodynamics, 8th Edition, Willey .
2. Chemical Engineering Thermodynamics, YVC Rao, University Press

COURSE OUTCOMES

On completion of the course, students would be able to

1. Apply mass and energy balances to closed and open systems
2. Evaluate the properties of non-ideal gases
3. Solve problems involving liquefaction, refrigeration and different power cycles.
4. Apply fundamental concepts of thermodynamics to engineering applications
5. Estimate thermodynamic properties of substances in gas and liquid states

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	-	-	-	2	-	-	-	-	-	3	2	2
CO2	3	3	3	-	-	-	2	-	-	-	-	-	3	2	2
CO3	3	3	3	-	-	-	2	-	-	-	-	-	3	2	2
CO4	3	3	3	3	-	-	2	-	-	-	-	-	3	2	2
CO5	3	3	3	-	-	-	2	-	-	-	-	2	3	2	2

22CHPC405	**HEAT TRANSFER**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

COURSE OBJECTIVES:

- To introduce the basic concepts of three modes of heat transfer in various applications
- To understand the rate of heat transfer and its calculation using various correlations for the design of various heat transfer applications
- To understand the design aspects of different heat transfer equipment's of heat exchanger, condenser, evaporator and other compact heat exchangers.

UNIT - I

Heat Transfer Fundamentals: Modes of heat transfer, thermal diffusivity and heat transfer coefficient; Differential equations of heat transfer; special forms. Conductive heat transfer - one dimensional problems, heat transfer from extended surfaces, two- and three-dimensional problems, Insulation

UNIT-II

Convective heat transfer - natural and forced convection; Dimensional analysis; Thermal boundary layer; Analogies and Correlations. Introduction to Radiation Heat Transfer

UNIT - III

Design of heat transfer equipment - double pipe heat exchanger, concept of LMTD, DPHE sizing; shell and tube heat exchanger - Kern's method for design, effectiveness-NTU method, construction aspects in brief, Bell Delaware Method

UNIT-IV

Design aspects of finned tube and other compact heat exchangers. Basics of Heat transfer with phase change - Introduction to boiling, Introduction to condensation.

UNIT-V

Design aspects of Condensers, Reboilers, Evaporators and Furnaces. Heat Transfer Agitated tanks,unsteady state heat transfer.

TEXT BOOKS:

1. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, Fundamentals of Momentum, Heat and MassTransfer, 4th Ed.,2007, Wiley.
2. W. J. McCabe, J. Smith, P. Harriot, Unit Operations of Chemical Engineering, Sixth Edition, 2005,McGraw Hill.
3. Holman, J. P., S. Bhattacharya, Heat Transfer, 10th Ed., 2011, Tata McGraw-Hill.
4. D. Q. Kern, Process Heat Transfer, 1997, Tata-McGraw Hill.

REFERENCES:

1. Bejan, A., A. D. Kraus, Heat Transfer Handbook, 2003, John Wiley.
2. Process Heat Transfer and Chemical Equipment Design, D.C.Sikdar Khanna Publishing House
3. Heat Transfer: Principles and Applications, B.K. Dutta, PHI

COURSE OUTCOMES

On completion of the course the students are expected to:

1. Remember the basic concepts of different modes of heat transfer; understand the differential equations used in conduction and apply the concepts for design in one dimensional, two and three dimensional and in extended surface heat transfer applications.
2. Remember the basic concepts of convective and radiation heat transfer; understand the mechanism of different types of convective heat transfer; apply and analyse the various analogies and correlations used in the design of the system.
3. Interpret the temperature changes in different types of heat exchanger; understand and apply the knowledge in the design of various types of heat exchanger and analyse for effective functioning of the equipments.

4. Remember and understand the importance of the compact heat exchangers, the heat transfer in boiling liquids and with phase changes; apply and analyse in the design of equipments for various applications.
5. Interpret the basic concepts in evaporation heat transfer and other un-steady state heat transfers; apply the knowledge in the design of condenser, evaporator, reboiler, furnace and agitated vessels.

Mapping with POs & PSOs															
COs	**PO 1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	-	-	-	-	-	-	-	-	3	2	-	2
CO2	3	3	3	3	-	-	-	-	-	-	-	3	2	-	2
CO3	3	3	3	3	-	-	-	-	-	-	-	3	3	2	3
CO4	3	3	3	3	-	-	-	-	-	-	-	3	3	2	3
CO5	3	2	3	-	-	-	-	-	-	-	-	3	3	2	2

22CHPC406	**MASS TRANSFER-I**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

COURSE OBJECTIVE

The course is aimed to Learn and determine mass transfer rates under laminar and turbulent conditions and apply these concepts in the design of absorption columns, humidifiers, cooling towers, dryers and crystallizers.

Unit – I:

Principles of Diffusion and Mass Transfer between phases – Theory of Diffusion – Prediction of Diffusivities – Mass Transfer Theories – Mass Transfer Coefficients

Unit – II

Gas Absorption – Packings and Packed Tower Design – Principles of Absorption – Absorption from Rich Gases – Mass Transfer Correlations - Absorption with Chemical Reaction.

Unit – III

Humidification Operation – Definitions – Humidity Chart – Wet-bulb Temperature – Cooling Tower.

Unit – IV

Drying of Solids – Principles of Drying – Cross-Circulation Drying – Through-Circulation Drying – Drying Equipments .

Unit – V

Crystallization - Crystal Geometry – Equilibria and Yields – Nucleation – Crystal Growth – Crystallization Equipment – Crystallizer Design-Crystal Size Distribution – Crystallization from Melts.

TEXT BOOKS

1. W. L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, 2014, Tata McGraw Hill, India.

REFERENCES:

1. R. E. Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983
2. S. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980.
3. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, Prentice Hall, India, 1993.

Course Outcomes:

On completion of the course, the students are expected to

1. Understand the fundamentals, types and mechanism of mass transfer operations and understand the theories of mass transfer.
2. Understand concept of theoretical stages and number of transfer units for height requirements in a gas absorption process
3. Understand the basics of humidification process and its applications
4. Understand the concept and mechanism of drying operations
5. Understand the concept of crystallization process and identification of suitable crystallizer

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	2	2	2	2	-	-	-	3	3	2	3
CO2	3	3	3	2	2	2	2	2	-	-	-	3	3	2	3
CO3	3	3	3	2	2	2	2	2	-	-	-	3	3	3	3
CO4	3	3	3	2	2	2	2	2	-	-	-	3	3	3	2
CO5	3	3	3	2	2	2	2	2	-	-	-	3	3	3	2

22ETHS 407	**UNIVERSAL HUMAN VALUES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
- Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.
- Strengthening of self-reflection.
- Development of commitment and courage to act.

UNIT-I

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

Purpose and motivation for the course, recapitulation from Universal Human Values-Self-Exploration–what is it? -Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration-Continuous Happiness and Prosperity- A look at basic Human Aspirations-Right understanding, Relationship and Physical Facility- the basic requirements for fulfillment of aspirations of every human being with their correct priority-UnderstandingHappinessandProsperitycorrectly-Acriticalappraisal of the current scenario-Method to fulfill the above human aspirations: understanding and living in harmony at various levels. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

UNIT-II

Understanding Harmony in the Human Being - Harmony in Myself!

Understanding human being as a co-existence of the sentient 'I' and the material' Body'--Understanding the needs of Self ('I') and 'Body' - happiness and physical facility-Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)-Understanding the characteristics and activities of 'I' and harmony in 'I'- Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail- Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs. dealing with disease

UNIT-III

Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness; Trust and Respect as the foundational values of relationship-Understanding the meaning of Trust; Difference between intention and competence-Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values inrelationship-Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals-Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students 'lives

UNIT-IV

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

Understanding the harmony in the Nature-Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self- regulation in nature-Understanding Existence as

Co-existence of mutually interacting units in all-pervasive space-Holistic perception of harmony at all levels of existence. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

UNIT-V

Implications of the above Holistic Understanding of Harmony on Professional Ethics

Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people- friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems- Case studies of typical holistic technologies, management models and production systems-Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations- Sumup. Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. to discuss the conduct as an engineer or scientist etc.

TEXTBOOK

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi,2010

REFERENCEBOOKS

1 Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2019.
2 The Story of Stuff (Book).
3 The Story of My Experiments with Truth- by Mohandas Karamchand Gandhi
4 Small is Beautiful - E. F Schumacher.
5 Slow is Beautiful – Cecile Andrews
6 Economy of Permanence – JC Kumarappa
7 Bharat Mein Angreji Raj -Pandit Sunderlal
8 Rediscovering India – by Dharampal
9 Hind Swaraj or Indian Home Rule - by Mohandas K.Gandhi
10 India Wins Freedom - Maulana Abdul KalamAzad
11 Vivekananda - Romain Rolland(English)
13 Gandhi - Romain Rolland (English)

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Gain more awareness of themselves, and their surroundings (family, society, nature).
2. Understand their responsibility in life, and handle problems with sustainable solutions, keeping human relationships and human nature in mind.
3. Attain better critical ability.
4. Understand their commitments on human values, human relationship and human society.

5. Apply the concepts to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	-	3	3	3	2	-	-	3	2	2	1
CO2	3	2	2	2	-	3	3	3	2	-	-	3	2	2	1
CO3	3	2	2	2	-	3	3	3	2	-	-	3	2	2	1
CO4	3	2	2	2	-	3	3	3	2	-	-	3	2	2	1
CO5	3	2	2	2	-	3	3	3	2	-	-	3	2	2	1

22CHCP408	**FLUID MECHANICS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES:

- To impart the students with the experimental knowledge to determine the flow characteristics of fluids
- To provide the students with the hands on training to analyze and assess the efficiency of the flow measuring devices and fluid transport machineries
- To inculcate practical knowledge on the measurement of Fluid Flow and their characteristics at different operating conditions.

LIST OF EXPERIMENTS

1. Experiments on Reynolds apparatus for determination of flow regime and construction of fanning's friction factor vs Reynolds number plot.
2. Experiment on Bernoulis theorem to calculate the total energy at different points and to plot the graph between total energy Vs distance.
3. Measurement of open channel flow and determination of coefficient of discharge V-notch and rectangular notch.
4. Determination of coefficient of discharge at various Reynolds number during fully developed fluid flow through orifice meter.
5. Determination of loss coefficient of pitot tube and construction of fully developed velocity profile through pipe in laminar and turbulent flow regime.
6. Determination of coefficient of discharge at various Reynolds number during fully developed fluid flow through venture meter.
7. Determine the friction factor for Darcy - Weisbach equation.
8. Determine the losses due to sudden enlargement and contraction in pipe fittings.
9. To draw the performance characteristic of the given variable speed centrifugal pump.

COURSE OUTCOMES:

On completion of the course, the students are expected to

1. Identify, name, and characterize flow patterns and regimes.
2. Utilize basic measurement techniques of fluid mechanics.
3. Measure fluid pressure and relate it to flow velocity.
4. Demonstrate the ability to write clear lab reports.
5. Demonstrate the ability to produce a working model through hands on experience in fluid mechanics design and explain its operation in terms of what was learned in the course

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	1	2	2	2	-	2	2	3	2	3	2	-
CO2	3	3	-	1	2	2	2	-	2	2	3	2	3	2	-
CO3	3	3	-	2	2	2	2	-	2	2	3	2	3	2	-
CO4	3	3	3	2	2	2	2	-	3	2	3	2	3	2	2
CO5	3	3	3	2	2	2	2	-	3	2	3	2	3	3	3

22CHCP409	**HEAT TRANSFER LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVE:

- The students should be able to perform experiments on heat conduction, convection andradiation.
- They will be able to identify the heat exchange properties of various metals

LIST OF EXPERIMENTS

1. Muffle Furnace
2. Forced convection
3. Jacketed Kettle
4. Horizontal Condenser
5. Critical Heat Flux Apparatus
6. Stefen-Boltzmann Apparatus
7. Parallel And Counter Flow Heat Exchanger
8. Natural Convection
9. Thermal Conductivity of Insulating Material
10. Emissivity Measurement
11. Drop Wise and Film Wise Condensation
12. Finned Tube Heat Exchanger

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Explain the fundamentals of heat transfer mechanisms in fluids and solids
2. Calculate heat transfer by conduction, different types of convection using classical models for these phenomena
3. Illustrate applications in various heat transfer equipment in process industries
4. Determine important data for the design and operation of the heat transfer
5. Analyze the various heat exchanger equipment and divide them based on their Operations

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	-	1	1	1	2	-	-	1	2	2	1
CO2	3	2	2	2	-	1	1	1	2	-	-	1	2	2	1
CO3	3	2	2	2	-	1	1	1	2	-	-	1	2	2	1
CO4	3	2	2	2	-	1	1	1	2	-	-	1	2	2	1
CO5	3	2	2	2	-	1	1	1	2	-	-	1	2	2	1

FIFTH SEMESTER

22CHPC501	CHEMICAL REACTION ENGINEERING – I	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES

- Basic Concepts of Kinetics and Rate Laws
- Design and performance of Ideal batch and flow Reactors
- Interpretation of Rate data
- Design the rate kinetics of multiple reactions
- Analysis of Non-ideal flow behaviour in Reactors

UNIT-I

Reactions and reaction rates - stoichiometry, extent of reactions, conversion, Selectivity Reaction rate fundamentals - elementary reaction sequences, steady state approximation and rate limiting step theory

UNIT-II

Ideal reactors - generalized material balance, design equations, graphical interpretation. Sizing and analysis of ideal batch, mixed (CSTR), plug flow and recycle reactors - solving design equations for constant and variable density systems, reactors in series and parallel.

UNIT-III

Analysis and correlation of experimental kinetic data - data collection & plotting, linearization of rate equations, differential and integral method of analysis.

UNIT-IV

Multiple reactions - conversion, selectivity, yield, series, parallel, independent and mixed series-parallel reactions.

UNIT-V

RTD theory and analysis of non-ideal reactors

TEXT BOOKS

1. Elements of Chemical Reaction Engineering by H. Scott Fogler, 2nd Edition, 2001, Prentice Hall.

REFERENCES:

1. J.M. Smith, chemical Engineering kinetics, 3rd Edition, McGraw Hill, 1981.
2. Chemical Reaction Engineering by Octave Levenspiel, 3rd Edition, 2001, John Wiley & Sons.
3. K.A. Gavhane, Chemical Reaction Engineering, volume-I, Nirali Prakashan.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Develop the kinetic rate expression by applying reaction mechanism with

Concentration and temperature dependency
2. Design of ideal batch and flow reactors for single reactions
3. Analyze and interpret the reaction kinetics of the reactor data in constant and variable volume systems
4. Develop and compose the rate kinetics of multiple Reactions
5. Adapt the concept of Residence Time Distribution (RTD) in various reactors and design parameters to analyze stability of Real Reactor.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	-	2	-	-	-	-	-	3	3	3	3
CO2	3	3	3	3	-	-	2	-	-	-	-	3	3	3	3
CO3	3	3	3	3	3	-	3	-	-	2	-	3	3	2	3
CO4	3	3	3	3	-	2	-	-	-	-	-	3	3	2	3
CO5	3	3	3	3	-	3	2	-	-	-	-	3	3	2	3

22CHPC502	**MASS TRANSFER – II**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

COURSE OBJECTIVES

- The course is aimed to remember and understand the principles and applications of conventional and less conventional separation techniques.
- To develop a sound working knowledge, ability to work and operate on different types of downstream processes and design of separation equipment.

UNIT – I

Distillation - Vapour liquid equilibria - Principle of distillation - flash distillation, differential distillation, steam distillation, molecular distillation, multi stage continuous rectification.

UNIT - II

Introduction to multi-component distillation - Number of theoretical stages by McCabe - Thiele method and Ponchan - Savarit method- Total reflux, minimum reflux ratio, optimum reflux ratio -Azeotropic and Extractive distillation

UNIT – III

Liquid - liquid extraction – Equilibria - Solvent Characteristics - Stage Wise and Continuous Contact - Design Calculations – Extraction Equipment's. Leaching – Unsteady State and Steady State operation - Equipment's for leaching.

UNIT – IV

Adsorption - Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed absorbers, break through curves.

UNIT – V

Introduction to less conventional separation process and its applications – Membrane separation and its classification - Membrane modules – Fouling –Dialysis - Osmosis - Reverse Osmosis - Ultra Filtration – Electro Dialysis – Ion Exchange.

TEXT BOOKS:

1. R.E.Treybal, Mass Transfer Operations, 3rd Edition, 1993, McGraw Hill, New Delhi.
2. W.L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, 2014, Tata McGraw Hill, India.
3. Binay K.Dutta, Principles of Mass Transfer and Separation Processes,2nd edition, Prentice Hall of India.

REFERENCE BOOKS:

1. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, 1993, Prentice Hall, India.
2. AS. Foust, Principles of Unit Operations, 2nd Edition, 1980, Wiley, New York
3. Sherwood.T.K., Pigford.R.L and Cr.Wilke., Mass Transfer. McGraw Hill.
4. Wankat, P., "Equilibrium Stage Separations", Prentice Hall, 1993.

COURSE OUTCOMES:

On completion of the course, the students are able to

1. Identify the suitable distillation techniques, determine the number of trays for stage wise contact and determine the height of the packed tower.
2. Design and determine the number of trays for multicomponent distillation.
3. Apply the ternary equilibrium diagram concepts to determine the number of stages required for separation of liquid-liquid extraction and leaching operation.
4. Apply the concept of adsorption techniques in various separation process needed in process industries.
5. Examine the concept of various less conventional separation process and its applications.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	2	-	-	-	-	2	-	3	3	2	3
CO2	3	3	3	2	2	-	-	-	-	2	-	3	3	2	3
CO3	3	3	3	2	2	-	-	-	-	2	-	3	3	2	3
CO4	3	3	3	2	2	-	-	-	-	2	-	3	3	2	3
CO5	3	3	3	2	2	-	-	-	-	2	-	3	3	2	3

22CHPC503	**PARTICLE & FLUID-PARTICLE PROCESSING**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

COURSE OBJECTIVES

- Objective of this course is to introduce students to the numerous industrial operations dealings with the particulate solids, their handling in various unit operations, and those

in which particle fluid interactions are important.

- The course addresses fundamentals of fluid-particle mechanics, such as the notion of drag, and builds on those fundamentals to develop design concepts for various industrial processes like packed bed operation, fluidized operations, sedimentation, filtration, separation of solids and fluids, etc.

UNIT-I

Introduction: Relevance of fluid and particle mechanics, and mechanical operations, in chemical engineering processes. Solid particle characterization: Particle size, shape and their distribution; Relationship among. shape factors and particle dimensions; Specific surface area; Measurement of surface area. Flow around immersed bodies: Concept of drag, boundary layer separation, skin and form drag, drag correlations

UNIT-II

Packed bed: Void fraction, superficial velocity, channeling, Ergun equation and its derivation, Kozeny Carman equation, Darcy's law and permeability, Blaine's apparatus

Fluidization: Fluidized bed, minimum fluidization velocity, pressure drop, Geldart plot etc. Types of fluidization: Particulate fluidization, Bubbling fluidization, Classical models of fluidization, Circulating fluidized beds, Applications of fluidization.

UNIT-III

Separation of solids from fluids: Introduction. Sedimentation: Free Settling, hindered settling, Richardson-Zaki equation, design of settling tanks. Filtration: Concepts, design of bag filters, design of electrostatic filters.

UNIT-IV

Centrifugal separation, design of cyclones and hydrocyclones. Size reduction, milling, laws of communition, classification of particles. Size enlargement; Nucleation and growth of particles.

UNIT-V

Transport of fluid-solid systems: pneumatic and hydraulic conveying. Colloidal particles: stabilization, flocculation. Introduction to nanoparticles: Properties, characterization, synthesis methods, applications

TEXT BOOKS

1. McCabe, W., Smith, J. and Harriott, P. Unit Operations of Chemical Engineering, 6th edition., 2014, McGraw Hill.
2. Coulson and Richardson's Chemical Engineering, Vol. 2, 2012, Butterworth-Heinemann.

REFERENCES:

1. Rhodes, M. J., Introduction to Particle Technology, 2nd edition, 2008, John Wiley, Chichester ; New York.
2. Unit Operations-I, Fluid Flow & Mechanical Operation, Gavhane, Nirali Prakashan

3. Unit Operations Vol.-I, K. A. Gavhane, Nirali Prakashan
4. Chemical Process Simulation, Husain, Wiley Eastern India
5. Allen, T., Powder Sampling and Particle Size Determination, 2003, Elsevier.
6. Masuda, H., Higashitani, K., Yoshida, H., Powder Technology Handbook, 2006, CRC, Taylor and Francis.
7. Vollath, D. Nanomaterials: An Introduction to Synthesis, Properties and Applications, 2nd Ed., 2013, Wiley.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Characterize particles and perform size reduction and size analysis of particles to meet the need of chemical industries
2. Understand the performance of packed bed reactors and fluid flow through fluidized bed reactors
3. Evaluate the parameters of various filtration equipment and sedimentation
4. Understand the size reduction of particles for need of chemical and mining industries
5. Identify the different types of fluid solid transport system and conveying of solids

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO8**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	3	-	-	2	-	-	-	-	2	3	2	3
CO2	3	3	3	3	-	-	2	-	-	-	-	2	3	2	3
CO3	3	3	3	2	-	-	2	-	-	-	-	2	3	2	3
CO4	3	2	2	3	-	-	2	-	-	-	-	-	2	3	3
CO5	3	3	3	3	-	-	2	-	-	-	-	-	3	3	3

22CHPC504	**CHEMICAL ENGINEERING THERMODYNAMICS II**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

COURSE OBJECTIVES

- To introduce the concepts of fugacity, activity coefficient, vapour-liquid equilibrium and reaction equilibrium and introduction to molecular thermodynamics.

UNIT-I

Review of first and second law of thermodynamics; Solution thermodynamics – Fundamental property relations; Phase equilibrium - Vapor-liquid equilibrium – Application of phase rule; Raoult's law - VLE computations for ideal solutions; Modified Raoult's law – Positive and negative deviations – azeotropes.

UNIT-II

Free energy and chemical potential, partial properties, Gibbs Duhem equation; Summability relation – Criterion for phase equilibrium; Excess and residual properties; Fugacity and fugacity coefficient of pure species and species in solution, Activity coefficient, VLE from K-value correlations; Flash calculations.

UNIT-III

Liquid phase properties from VLE, Lewis – Randall rule; Models for excess Gibbs energy, Margules, Van laar, , Wilson, NRTL, UNIFAC and UNIQUAC models; Henry's law; Infinite dilution activity coefficients. Heat effects and property change on mixing.

UNIT-IV

Liquid-Liquid Equilibria; Vapor-Liquid-Liquid Equilibria; Solid-Liquid Equilibria; Solid-Gas Equilibria.

UNIT-V

Chemical reaction equilibria: equilibrium criterion, equilibrium constant, evaluation of equilibrium constant at different temperatures, equilibrium conversion of single reactions, multireaction equilibria. Introduction to molecular/statistical thermodynamics.

TEXT BOOKS

1. J.M. Smith, H.C. Van Ness and M.M. Abbott, "Introduction to Chemical Engineering Thermodynamics", 7th edition, 2005, McGraw-Hill International Edition.

REFERENCES:

1. S.Sandler, "Chemical, Biochemical and Engineering Thermodynamics", 4th edition,Wiley,India.
2. Y.V.C.Rao, "Chemical Engineering Thermodynamics", 1997, University Press, Hyderabad.

COURSE OUTCOME:

On completion of the course, the students would be able to

1. Familiar with properties of solutions available in nature

2. Familiar with various reactions occurring in nature

3. Solve problems involving equilibria of different phases such as VLE, LLE, VLLE, SLE, SVE.

4. Solve problems involving reaction equilibria

5. Apply on principles of molecular thermodynamics in various field of applications

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	2	-	-	2	-	-	-	-	-	3	2	3
CO2	2	3	3	2	-	-	2	-	-	-	-	-	2	2	3
CO3	3	2	2	3	-	-	2	-	-	-	-	-	2	2	3
CO4	3	3	2	2	-	-	2	-	-	-	-	-	2	2	3
CO5	3	2	2	3	-	-	2	-	-	-	-	-	2	2	3

22CHCP508	PARTICLE & FLUID PARTICLE PROCESSING LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

- Objective of this course is to introduce students to the numerous industrial operations dealing with the particulate solids, their handling in various unit operations, and those in which particle-fluid interactions are important.
- The course addresses fundamentals of fluid-particle mechanics, such as the notion of drag, and builds on those fundamentals to develop design concepts for various industrial processes like packed bed operation, fluidized operations, sedimentation, filtration, separation of solids and fluids, etc. Industrial applications are discussed.
- The course is concluded with an introduction to colloidal systems, soft materials and nanoparticles. Applications of these novel systems are discussed.

LIST OF EXPERIMENTS

1. Settling
2. Sedimentation
3. Leaf Filter
4. Ball Mill
5. Cyclone Separator
6. Vibrating Screen
7. Double Roll Crusher
8. Jaw Crusher
9. Drop weight crusher
10. Packed bed
11. Fluidized bed

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Develop sound working knowledge on different types of crushing equipment's
2. Understand the separation characteristics of different mechanical separators
3. Assess the parameters of various filtration equipment and sedimentation
4. Understand fluid flow through packed and fluidized beds
5. Understand the industrial operations by performing the experiments

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO8**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	3	-	-	2	-	-	3	-	2	3	2	3
CO2	3	2	3	3	-	-	3	-	-	3	-	2	3	2	3
CO3	3	3	2	2	-	-	3	-	-	3	-	1	3	2	3
CO4	3	3	3	3	-	-	2	-	-	-	-	-	2	3	3
CO5	3	3	3	3	-	-	2	-	-	3	-	-	3	3	3

22CHCP509	MASS TRANSFER LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVE:

- To impart knowledge on the determination of important data for the design and operation of the process equipment's like distillation, extraction, diffusivity, drying principles which are having wide applications in various industries

LIST OF EXPERIMENTS

Experiment No 1

Conduct an experiment to leach the washing soda from the feed mixture of sand and washing soda using water as solvent by stage wise leaching and find out the maximum leaching efficiency and optimum number of stages.

Experiment No 2

Conduct an experiment to study the effect of temperature on diffusivity of volatile liquid into air.

Experiment No 3

Conduct an experiment to establish the equilibrium curve and obtain the tie line for the given Benzene -Water -Acetic acid system.

Experiment No 4

Conduct an experiment to study the drying characteristics of the given material in a current of hot air and evaluate the Heat and mass transfer coefficients and find the drying time.

Experiment No 5

Conduct an experiment to verify the Rayleigh equation by graphically and analytically.

Experiment No 6

Conduct an experiment to study the adsorption characteristics of acetic acid - water system on charcoal to find the best adsorption isotherm which represents the adsorption characteristics of acetic acid - charcoal system.

Experiment No 7

Conduct a three stage counter current extraction experiment to leach the sodium carbonate from the feed mixture of sand and washing soda using water and find the efficiency of leaching for the last two stages.

Experiment No 8

Conduct the surface evaporation experiment to evaluate the constants namely K and n in the Himus equation

$$N_A = K\,(P^*-P)^n$$

Where N_A is the flux; P* -the vapor pressure and P-partial pressure.

Experiment No 9

Conduct an experiment in Rotary Dryer to find out the holdup volume, residence time and constants a and b in the equation $X = a (N_{Fe})^b$

Experiment No 10

Conduct an experiment to determine the HETP in a packed bed distillation column by experimental and by analytical methods.

Experiment No 11

Conduct an experiment on Steam distillation experimental setup to find the theoretical steam distillation temperature, vaporization efficiency and thermal efficiency.

Experiment No 12

Conduct an experiment to leach the washing soda from the feed mixture of sand and washing soda using water as solvent by a three stage co current leaching and to find out the efficiency of individual stages and overall efficiency.

Experiment No 13

Conduct an experiment to determine the liquid phase mass transfer coefficient for the given solid-liquid [Benzoic acid (Solid) – Sodium Hydroxide (Liquid)] mass transfer operation.

TEXT BOOKS:

1. R.E.Treybal, Mass Transfer Operations, 3rd Edition, 1993, McGraw Hill, New Delhi.
2. AS. Foust, Principles of Unit Operations, 2nd Edition, 1980, Wiley, New York.
3. W.L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, 2014, Tata McGraw Hill, India.

REFERENCES:

1. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, 1993, Prentice Hall, India.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Remember and understand various fundamental concepts of mass transfer operations.
2. Describe various types of mass transfer equipment's
3. Design and operation of the process equipment's
4. Classify different types of downstream processing
5. Select the separation operations which will be economical for the process

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	2	-	2	-	3	-	-	3	3	3	3
CO2	3	3	3	2	2	-	2	-	3	-	-	3	3	3	3
CO3	3	3	3	2	2	-	2	-	3	-	-	3	3	3	3
CO4	3	3	3	2	2	-	2	-	3	-	-	3	3	3	3
CO5	3	3	3	2	2	-	2	-	3	-	-	3	3	3	3

SIXTH SEMESTER

22CHPC601	CHEMICAL REACTION ENGINEERING - II	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES

- Basic Concepts of Catalysis
- Kinetics and Mechanistic aspects of Catalysts
- Design of Catalytic Reactors for chemical reaction with mass transfer
- Design of non-Catalytic Reactors with rate controlling step
- Design Aspects of Gas-Liquid Reactors

UNIT-I

Introduction to Catalysis, homogeneous and heterogeneous catalysis. Preparation and characterization of catalysts. Physical and chemical adsorption, Adsorption isotherms, Determination of BET surface area and pore volume of the Catalyst.

UNIT-II

Kinetics of solid catalyzed gas phase reaction. Laboratory reactors for catalytic gas solid reactions. Design concepts

UNIT-III

Mass transfer, Diffusion and Chemical reactions in catalysts. Effects of external mass transfer and heat transfer, Effectiveness factor. Design aspects of catalytic reactors.

UNIT-IV

Non-catalytic gas-solid reactions, different model for gas-solid reactions

UNIT-V

Gas-liquid reactions, film and penetration theories, enhancement factor in gas-liquid reactions, gas-liquid reactors.

TEXT BOOKS:

1. Foggler H. S., Elements of Chemical Reaction Engineering, 2001, Prentice Hall.
2. Levenspiel. O, Chemical reaction engineering, 3rd Edition, 2001, John wile

REFERENCES:

1. Gilbert F. Froment, Kenneth B. Bischoff, Juray De Wilde, Chemical Reactor Analysis and Design, 2010, John Wiley & Sons.
2. Dawande S.D, Principles of Chemical Reaction Engineering, Central Techno Publications, Nagpur
3. K. A. Gavhane, Chemical Reaction Engineering Vol. - II, , Nirali Prakashan.
4. J.M. smith, Chemical Engineering Kinetics, 3rd Edition, 1981, Mc Graw Hill
5.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Develop the industrial catalyst and Characterizations studies.
2. Describe the transport process in heterogeneous reactions and predict the rate controlling steps in fluid-solid catalytic reactions.
3. Formulate the internal mass transport processes and kinetic regimes for the rate equation.
4. Create models for non-catalytic gas-solid reactions.
5. Analyze the gas-liquid reactors with mass transfer.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	3	-	3	-	-	-	-	3	3	2	3
CO2	3	3	3	3	3	-	3	-	-	-	-	3	3	2	3
CO3	3	3	3	3	3	-	3	-	-	-	-	3	3	2	3
CO4	3	3	3	3	3	-	3	-	-	-	-	3	3	2	3
CO5	3	3	3	3	3	-	3	-	-	-	-	3	3	2	3

22CHPC602	**PROCESS DYNAMICS & CONTROL**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

COURSE OBJECTIVES

- To introduce the fundamentals of process control with applications using P, PI, and PID controllers.
- The course will teach the students about mathematical models based on transfer function approach for single loop systems, how to obtain dynamic response of open loop and closed loop systems, stability analysis in transient and frequency domains, and controller tuning methods.
- The course would end with more advanced concepts like Cascade control, feed-forward control, ratio control, etc.

UNIT-I

Introductory Concepts: Characteristics of measuring elements, Need for control and automation, control logic, servo and regulatory control, block diagrams, control structures (feedback vs. feedforward), process and instrumentation diagrams. Laplace transforms, solution of ODEs using Laplace transform.

UNIT-II

Transfer function approach, response of first order systems: step, impulse and sinusoidal response, first order systems in series. Second order systems, higher order systems, transportation lag and dead time.

UNIT-III

Linear closed loop systems, development of block diagrams, classical feedback controllers. Final control element (control valves), block diagram reduction techniques. Closed loop response, servo and regulatory problems.

UNIT-IV

Stability analysis, Routh stability criterion, Root locus diagrams (rule based).
Introduction to frequency response, notion of stability. Bode diagrams, Nyquist plots, Bode and Nyquist stability criterion.

UNIT-V

Controller tuning: Ziegler-Nichols method, Cohen-Coon method. Introduction to advanced controllers: cascade control, feed forward control, ratio control. Introduction to digital control.

TEXT BOOKS:

1. Coughanowr, D. R., LeBlanc, S. Process Systems Analysis and Control, 3rd edition, 2018, McGraw-Hill.

REFERENCES:

1. Seborg, D.E., Edgar, T.F., Mellichamp, D.A. Process Dynamics and Control, 2nd
2. edition, 2003, John Wiley.
3. Stephanopoulos, G. Chemical Process Control: An Introduction to Theory and Practice, 1984 Pearson Education.
4. D.C. Sikdar , Instrumentation and Process Control, , Khanna Publishing House
5. Instrumentation, Measurement and Analysis, Nakra, TMH

COURSE OUTCOMES

On completion of the course, the students would be able to

1. Understand the concepts of working of instruments, Components and principles of a control system conversion from t domain to s domain using Laplace Transforms for solving LDE.

2. Understand the significance of the transfer functions of various forcing functions on process control systems and thus understand the concept of process dynamics

3. Develop the block diagrams and their reduction rules to obtain responses for servo and regulator problems along with the basic concepts of various modes of classical controllers and final control elements.

4. Understand the concept of stability and investigate the stability of open and closed systems using algebraic and graphical methods

5. Tune a classical feedback controller to reject disturbances or manage operating point transitions and to know the operations of advance controllers and understand the idea of digital controllers.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	-	-	-	2	-	-	-	-	3	3	2	3
CO2	3	3	2	-	1	2	2	-	-	-	-	3	3	2	3
CO3	3	3	2	-	1	2	2	3	-	-	-	3	3	2	3
CO4	3	3	2	-	-	-	2	-	-	-	-	3	3	2	3
CO5	3	3	2	-	-	-	2	-	-	-	-	3	3	2	3

22CHCP607	**CHEMICAL REACTION ENGINEERING & THERMODYNAMICS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES:

- Chemical Engineering laboratory provides students the first-hand experience of verifying various theoretical concepts learnt in theory courses.
- To determine experimentally the kinetics, rate constants and activation energy of reactions in different types of reactors.
- To enable the students to understand the behavior of fluids under PVT conditions and also apply them for practical purpose

LIST OF EXPERIMENTS:

Chemical Reaction Engineering

1. To determine the rate constant for the saponification of ethyl acetate with sodium hydroxide in a batch reactor.
2. To study the performance of the given adiabatic reactor and to find the Activation energy and Frequency factor for the second order reaction.
3. To study the performance of the given semi-batch reactor.
4. To study the performance of a given Plug Flow Reactor (PFR) for carrying out a second order saponification reaction between ethyl acetate and sodium hydroxide under isothermal conditions and to perform kinetic studies to establish rate constant using PFR.
5. To study the performance of the given semi-batch reactor (II).
6. To study the performance of CSTR by conducting a second order saponification reaction between ethyl acetate and sodium hydroxide under isothermal condition.
7. To study the performance of a Plug Flow Reactor followed by Constant Stirred Tank Reactor for carrying out a second order saponification reaction between ethyl acetate and sodium hydroxide and to determine the residence time and percentage conversion of the reaction mixture in the reactors in series at room temperature.
8. To conduct residence time distribution studies in a non-ideal packed bed reactor and to estimate the non-ideality parameter.
9. To conduct residence time distribution studies in a non-ideal stirred reactor and to estimate the non-ideality parameters.

Chemical Engineering Thermodynamics

1. To study the molecular weight of a volatile liquid using ideal gas law by measuring the mass, volume, temperature and pressure of the compound in its gaseous state.
2. To study the temperature, liquid phase composition and vapour phase composition at equilibrium and to draw the t – x – y diagram for the given ideal liquid system at 1atm.
3. To study the Azeotropic composition of a given binary liquid mixture and to generate the VLE data by Van Laar Model.
4. To study the T-x_1-y_1 diagram (generation of isobaric VLE data) for the given system at atmospheric pressure and to determine the behavior of the mixture.
5. To study the Margule's constants (or) van Laar constants for the given binary system; to subject the T-x_1-y_1 - data obtained in the laboratory for thermodynamic consistency test.
6. To study the solubility of the given solute in the given solvent at different temperatures ranging from 45ºC to 80ºC and to plot a graph of solubility against the temperatures and calculate the heat of solution, by estimating the amount of solute dissolved at various temperatures, using titration against $Na_2S_2O_3$.
7. Determine the equilibrium constant for the given reaction at atmospheric pressure and temperature.

COURSE OUTCOMES

On completion of the course, the students would be able to:

1. Describe and acquire a sound working knowledge on different types of reactors.
2. Understand the critical thinking on technical knowledge in solving problems with various types of reactors.
3. Express working knowledge on different types of reactors and design of reactors associated with Physical Parameters.
4. Develop skills to choose the right kind of reactor among single and flow reactor including reactors in combination.
5. Apply the experimental and theoretical knowledge on design of reactors and application in process industries.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	-	-	2	-	-	-	-	3	3	3	3
CO2	3	3	3	3	-	-	2	-	-	-	-	3	3	3	3
CO3	3	3	3	3	-	-	3	-	-	-	-	3	3	3	3
CO4	3	3	3	3	-	-	2	-	-	-	-	3	3	3	3
CO5	3	3	3	3	-	-	3	-	-	-	-	3	3	3	3

22CHCP608	PROCESS INSTRUMENTATION & CONTROL LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- Objective of the course is to introduce the basics of instrumentation and process control through a hands-on practical experience.
- Principles of operation of different measuring devices for temperature, level, flow, pH, will be introduced to impart knowledge of transmitters, transducers, converters, control valves, digital and analog components related to PLC, DCS, SCADA systems.

LIST OF EXPERIMENTS

1. Calibration of Thermometers
2. First Order Thermal System (Ramp Input)
3. Dynamics of I Order system
4. Hysterisis Loop in throttling Valve
5. Interacting System
6. Second Order Thermal System
7. Current to Pneumatic (I/P) converter Characteristics
8. Non Interacting System
9. Tuning of Controller Using C-C Method
10. Pneumatic Control Valve Characteristics
11. Pulse input and response of a I Order System
12. Wheel Flow Meter Characteristics
13. PID Control using LCJ Software
14. Operation and Characteristics of R7 Capacitance type LJ
15. Operation of PLC using Ladder Programming
16. Stability Analysis of Plate Heal Exchanger.

REFERENCES:

1. Seborg, D.E., Edgar, T.F., Mellichamp, D.A. "Process Dynamics and Control", 2nd edition, 2003, John Wiley.
2. Stephanopoulos, G. "Chemical Process Control: An Introduction to Theory and Practice", 1984, Pearson Education.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Calculate the process design parameters for the given first and second order system and can able to develop model equation for the given process control system.
2. Predict output values for the given disturbances and can analyse the response the response of the given process control system for different types of inputs.
3. Calculate the static and dynamic characteristics of the given instruments and select the most appropriate instruments for the given purpose.
4. Propose the right type of controllers for the given process control system and also can able to justify the selection of the controllers.
5. Develop suitable tuning parameters for the given controllers and can establish the stability criterion

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	-	-	2	-	-	-	-	3	3	2	3
CO2	3	3	2	2	-	-	2	-	-	-	-	3	3	2	3
CO3	3	3	2	2	2	-	2	-	-	-	-	3	3	2	3
CO4	3	3	2	2	-	-	2	-	-	-	-	3	3	2	3
CO5	3	3	2	2	-	-	2	-	-	-	-	3	3	2	3

SEVENTH SEMESTER

22ETHS701	ENGINEERING ETHICS	L	T	P	C
		2	0	0	2

COURSE OBJECTIVE:

- To create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to assess the rights of others.

UNIT – I

Scope and Aims of Engineering Ethics - Senses of "Engineering Ethics" - Three types of Inquiry - Kohlberg's Theory - Gilligan's Theory - Persuasive definitions of Professionalism - Robert Whitelaw's view - Samuel Florman's view - An intermediate view. Moral Reasoning ands Ethical Theories Four types of Ethical Theories 1. Virtue ethics Aristotle: Virtue and the Golden Mean Macintyre: Virtue and practices Professional Responsibility: Self-direction virtues, public – spirited virtues, teamwork virtues proficiency virtues. 2. Utilitarianism John Stuart Mill: Act- Utilitarianism and Happiness Richard Brandit: Rull- Utilitarianism and Rational Desires 3. Duty Ethics Immanuel Kant: Respect for persons John Rowl's Two principles 4. Rights Ethics John Locke: Liberty Rights A.I.Melden: Liberty and welfare Rights Uses of Ethical Theories in resolving moral dilemmas

UNIT – II

Engineering as Social Experimentation - Engineering as experimentation- Similarities and contrasts with standard experiments - Engineers as Responsible experimenters - Conscientiousness, moral autonomy, Accountability - Codes of Ethics -Codes and Experimental Nature of Engineering - Limitations of Codes

UNIT – III

The Engineer's Responsibility for Safety- Safety and Risk - The concept of safety - William W. Lowrance's definition - Modified definition - Risks – Acceptability of Risk – Risk Assessment – Risk – Benefit value function – job related risks – Magnitude and Proximity. Assessment of safety and Risk - Uncertainties in design – Probabilistic analysis - Fault – Tree analysis - Incentives to Reduce Risk.

UNIT – IV

Responsibilities to employers Professional Responsibilities: Team – Play Virtues (i)Collegiality (ii) Loyalty and (iii) Respect for authority. Collective Bargaining (i)Unionism Employer / Employee Relations (i) Confidentiality and (ii) Conflicts of interest Occupational Crime (White-Collar Crime) (i) Industrial Espionage (ii) Price Fixing and (iii) Endangering Lives

UNIT – V

Global Issues - Three senses of "relative values" - International rights (Donaldson) - Technology transfer and appropriate technology - Environmental ethics - Computer ethics. Engineers as Manager, Consultants and Leaders - Engineers as managers – Promoting an ethical climate, managing conflict - Consulting engineers - Engineers as expert witnesses & advisers - Integrity and ingenuity - – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

TEXT BOOKS:

Mike W.Martin& Roland Schinzinger, "Ethics in Engineering" 4th Edition, 2005, Tata McGraw – Hill publishing company Ltd. New Delhi,.

REFERENCES:

Jayashree Suresh & B.S. Raghavan, "Professional Ethics" 2005, S.Chand& Co, New Delhi.

COURSE OUTCOMES:

Upon completion of the course, the student should be able to

1. Justify the context for studying the course, assess the moral cognitive developments in humans, contrast between professionals from graduates of non-professional degree programmes and conversant with the four ethical theories
2. Inspect the nature of Engineering as social experimentation and able to contrast it from standard experiments, learn to be responsible experimenters and understand the roles of codes of engineering in supporting engineers to be responsible experimenters
3. Identify the responsibility of engineers towards safety and understand the definition of safety and risk and assess them to create safe process or product with safe exits
4. Assess the responsibilities as employees and develop virtues like collegiality and loyalty to create an atmosphere conducive to work, understand the concepts like conflict of interest and occupational crimes which goes against the contractual duties. To understand and be assertive to exercise the rights as engineers in organizations.
5. Understand the global issues, comprehending the working of MNCs, international rights and technology transfer. Understand the need of an engineer to play the roles of a manager, consultant, advisor and decision maker with a virtue and honesty.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	-	-	3	2	3	1	1	1	3	3	3	1
CO2	3	-	-	-	-	3	3	3	2	1	-	3	3	3	1
CO3	3	-	-	-	-	3	3	3	-	-	-	3	3	3	2
CO4	3	-	-	-	-	2	2	3	3	2	3	3	3	3	3
CO5	3	-	-	-	-	3	2	3	2	1	2	3	3	3	3

22CHPC702	**PROCESS ENGINEERING ECONOMICS**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

COURSE OBJECTIVES:

The course will

- Explain the principles of cost estimation, feasibility analysis, management, organization and quality control that will enable the students to perform as efficient managers.
- Describe the role of economic evaluation in decision making and design of processes with standard methodology.
- Estimate the value of money, worth of equipment & processes with period with different methods.
- Analyze and compare alternatives for equipment, processes and economic evaluation.
- Identify, justify and design process plants and evaluate existing facilities with budgeting and benchmarking.

UNIT - I

Value of money and equivalence - Amortization - Depreciation .

UNIT - II

Capital requirements for process plants - Balance sheet chart - earnings, profits and returns - Economic production, Break even Analysis Charts.

UNIT- III

Cost accounting -Pre construction cost estimation - allocation of cost.

UNIT - IV

Economics of selecting alternatives:

Annual cost methods, Present worth method. Replacement, rate of return method and payout time method.

UNIT - V

Economic balance:

General principles and method economic balance in single variable operation and in two variable operation.

TEXT BOOKS:

1. Schweyer, Process Engineering Economics, 1955, Me Graw Hill.
2. Peter and Timmerhaus, Plant Design and Economics for Chemical Engineers 3rd ed. 1984.

REFERENCES:

1. S.N.Maheshwari, Principles of management Accounting, 2000, sultan Chand and sons , New Delhi.
2. Dhanasekaran. S, Muralikandhan. K, Mukundhan K.S, "Engineering Economics", scitech publications(India) Pvt Limited, Chennai-600017, Tamil Nadu, India.

COURSE OUTCOMES

On completion of the course, the students would be able to

1. Calculate cost and asset accounting, time value of money, profitability, alternative investments, minimum attractive rate of return, sensitivity and risk.
2. Examine the production using economic concepts to predict and analyze the production.
3. Recommend most economical solution among alternatives in engineering problems.
4. Plan for an economical investment in process plants with fundamental knowledge encouraging them to be successful entrepreneurs.
5. Design and develop new process plant with economic evaluation.

Mapping with POs & PSOs															
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	-	-	3	-	-	-	3	3	3	2	3	-	3
CO2	2	3	3	3		-	-	-	-	-	-	-	3	2	2
CO3	-	3	2	3	2	-	-	-	-	-	-	-	3	3	3
CO4	-	3	-	3	2	-	-	-	-	-	-	-	3	2	-
CO5	2	2	-	2	2	-	-	-	-	-	-	-	3	2	3

22CHPC 703	**COMPUTING TECHNIQUES IN CHEMICAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To learn the theoretical knowledge on software techniques and applying in the design of various chemical process equipment used in different operations and to simulate the chemical process.

UNIT - I

Introduction - Material and Energy Balance – Without reaction and with reaction, Thermodynamics and Fluid – Phase Equilibrium: Introduction – Boiling Point and Dew point calculations, Vapor pressure correlations, Relative Volatility. Equation of State, Physical Properties – Liquid Density.

UNIT - II

Fluid Flow in Pipes – Laminar and Turbulent flow, Fluid Flow in Pumps – power and work required and Fluid Flow in Compressors.

UNIT - III

Introduction – Design of shell and tube heat exchanger, heat duty required, Tube selection, Shell inside diameter, number of baffles. Heat transfer coefficients - shell and tube side: Pressure drop – shell and tube side.

UNIT - IV

Introduction – Reactor Design: Continuous stirred tank reactor – Plug flow reactor – Packed bed reactor.

UNIT - V

Introduction – Distillation column – separation of binary components – Material and Energy balance around the column – Material balance – Top, Bottom section and feed tray. Column Diameter. Introduction – Packed bed absorber – number of theoretical stages - using graphical technique..Packed, Bed column diameter, Packed tower height: Estimation of height of transfer unit using Onde's and Cornell's Method – Number of theoretical trays - sizing a plant tower absorber – plate tower diameter. Liquid – Liquid Extraction.

The software packages are Polymath, MATLAB/ Simulink, Microsoft Visio, Aspen Plus, UniSim/Hysys, PRO/II, , SuperPro Designer, and Aveva Process Simulation.

TEXT BOOK:

1. Nayef Ghasem.," Computer Methods in Chemical Engineering" 2021, Edition -2, CRC Press Taylor & Francis Group.
2. Geankoplis, J. C., 1998. Transport Processes and Unit Operations, 3rd edn, McGrawHill, Boston, MA.

REFFERENCES:

1. McCabe, W. L., J. C. Smith, and P. Harriott, 1993. Unit Operations of Chemical Engineering, 5th edn, McGraw-Hill, Boston, MA.
2. Seader, J. D. and E. J. Henley, 1998. Separation Process Principles, 2nd edn, John Wiley & Sons, New York, NY.
3. Treybal, R. E., 1987. Mass-Transfer Operations, 3rd edn, McGraw-Hill, Boston, MA.
4. Seider, W. D., J. D. Seader, D. R. Lewin, S. Widagdo, 2010. Product and Process Design Principles: Synthesis, Analysis and Design, 3rd edn, Wiley, New York, NY.

COURSE OUTCOMES:

After completion of the course, the students will be able to:

1. Understand the concepts, analysis and calculate the energy and material balances of the process using the soft ware packages.
2. Understand, analyse and simulate the design and the working of flow through pipes, pumps and compressors.

3. Know the concepts of reaction kinetics, analysis and design of different reactor configurations using soft ware packages.
4. Know the concepts, analysis and design of heat exchanger systems used in process industries using computing techniques.
5. Realize the concepts, analysis and the design of mass transfer operations using the soft ware package for distillation, absorption and extraction processes.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	-	-	2	-	-	-	-	-	3	2	2
CO2	3	3	3	-	-	-	2	-	-	-	-	-	3	2	2
CO3	3	3	3	-	-	-	2	-	-	-	-	-	3	2	2
CO4	3	3	3	3	-	-	2	-	-	-	-	-	3	2	2
CO5	3	3	3	-	-	-	2	-	-	-	-	2	3	2	2

22CHCP707	**CHEMICAL PROCESS SIMULATION LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVE:

- To impart experimental knowledge of modeling using open MATLAB

LIST OF EXPRIMENTS:

1. Introduction to MATLAB: Loops, Branches and Control Flows
2. Solving a linear system using Gaussian elimination method
3. Finding Eigen vectors, Eigen values for a linear system, Curve fitting tool box
4. Solving an ordinary differential equation, PDE etc
5. Three CSTR's in series – open loop & closed loop
6. Non isothermal CSTR
7. Isothermal batch reactor – open loop
8. Non-isothermal Batch reactor
9. Plug flow reactor
10. Heat Exchanger
11. Gravity Flow tank.
12. Bubble point & Dew point calculations
13. Binary Distillation column

COURSE OUTCOME:

Upon completion of this course, the students will be able to:

1. Identify and analyze the relevance of modeling of processes
2. Analyze physical and chemical phenomena involved in various process.
3. Develop mathematical models for various chemical processes.
4. Inspect various simulation approaches.
5. Simulate a process using process simulators (MATLAB).

	Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	3	2	3	2	3	3	3	3	3	3	2
CO2	3	3	3	3	3	2	2	2	3	3	3	3	3	3	1
CO3	3	3	3	3	3	2	2	2	3	3	3	3	3	2	1
CO4	3	3	3	3	3	2	2	2	3	3	3	3	3	2	1
CO5	3	3	3	3	3	2	2	2	3	3	3	3	3	2	1

22CHCP708	**CHEMICAL PLANT DESIGN & DRAWING LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES:

- The objective of this course is to acquire basic understanding of design parameter, complete knowledge of design procedures for commonly used process equipment and their attachments

LIST OF EXPERIMENTS

1. Design of Filter Press
2. Design of Barometric Condenser
3. Design of Agitated Vessel
4. Design of Basket Centrifuge
5. Design of Distillation Column
6. Design of Heat Exchanger
7. Design of Absorption column
8. Design of Multiple Effect Evaporator
9. Design of Rotary Dryer

DESIGN - CASE STUDIES

1. Design of Cooling tower
2. Design of Crystallizer
3. Design of Venturi Meter
4. Design of Cyclone Separator
5. Design of Steam Ejector

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Determine the basics of process equipment design and important parameters of equipment design
2. Formulate the equipment fabrication and materials used
3. Design of reactors for non-catalytic and catalytic reactions.
4. Create a design for various process equipments.
5. Estimation of capital investment, total product costs, and profitability.

	Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	3	-	1	-	-	1	-	-	-	-	1	-	-
CO2	2	-	3	1	-	-	-	-	-	-	-	-	1	2	-
CO3	-	-	3	-	1	-	-	1	-	-	-	-	1	-	2
CO4	-	-	3	-	-	-	-	-	-	-	-	-	1	-	-
CO5	-	-	3	-	1	-	-	1	-	-	-	-	1	-	-

PROFESSIONAL ELECTIVES

22CHPESCN	PETROLEUM REFINERY ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide the student knowledge about origin, formation and exploration of crude oil
- To teach the students about the petroleum refining processes and its products
- To illustrate the concepts of various cracking and reforming operations
- To illustrate the various petroleum products purification processes

UNIT I

Origin, Exploration, exploitation, Production of petroleum, Composition of petroleum, Major challenges and future strategies in petroleum refining industry, Refinery economics, petroleum and petrochemical integration for value addition.

UNIT II

Crude heating, Desalting, Primary distillation, Atmospheric distillation, Vacuum distillation, Evaluation of petroleum products and their physical properties.

UNIT III

Cracking, Mechanism of cracking, Thermal cracking processes, Catalytic cracking, Catalyst used in cracking, Fluid catalytic Cracking and catalyst regeneration, Hydro cracking, Catalyst deactivation and regeneration, Recent advances in industrial catalysis.

UNIT IV

Reforming, Thermal and Catalytic reforming processes, Alkylation, Isomerization and Polymerizations processes.

UNIT V

Desulphurization processes, Solvent extraction processes, De-waxing processes, De-asphalt processes. Purification of the products, Air blowing of bitumen, recent trends lube base stock refining.

TEXT BOOKS:

1. W L Nelson Petroleum Refinery Engineering by Published by Mcgraw Hill Book Company Inc, 4th edition (1 January 1958)
2. B.K. Bhaskara Rao “Modern Petroleum Refining Processes”, 2008.

REFERENCES:

1. Dawe R.A.,”Modern Petroleum Technology part-I”, by Institute of petroleum(IP), John wiley
2. Lueas.A.G.,”Modern Petroleum Technology part-II” by Institute of petroleum(IP), John wiley.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Understand the origin, formation and exploration of crude oil
2. Gain knowledge on crude distillation processes
3. Develop suitable cracking process to convert heavy to lighter distillate
4. Understand the importance of various reforming operations
5. Gain knowledge on petroleum products purification processes

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	-	-	2	3	2	-	-	2	2	3	2	3
CO2	3	3	2	-	-	2	3	2	-	-	2	2	3	2	3
CO3	3	3	2	2	-	2	3	2	-	-	2	2	3	2	3
CO4	3	3	2	2	-	2	3	2	-	-	2	2	3	2	3
CO5	3	3	2	2	-	2	3	2	-	-	2	2	3	2	3

22CHPESCN	**BIOCHEMICAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To introduce the concepts of microbial world and its application in biochemical industries.
- To insight the significance of microbes in fermentation and its enzymatic kinetics.
- To realize the operation of large scale bioprocess and its control.

UNIT I

Introduction and characteristics of biological materials - Evaluation of modern fermentation processes - Development of Biochemical Engineering - Fermentation products future trends - Types of microorganism - Chemical composition - Requirements for growth and media fermentation Reproductive cycle variation in micro organism - strain breeding, maintenance and stock culture.

UNIT II

Fermentation - Types - Kinetics of fermentation processes – Enzyme – Kinetics - Enzyme inhibition

UNIT III

Sterilization – Liquid / Air / Surface - Media sterilization – Microbial Death Kinetics – Batch and Continuous Sterilization of media – Media for Industrial Fermentation.

UNIT - IV

Design of fermenters, Aeration and agitation -Scale up criteria - Cell separation. Downstream process, Product Recovery and Purification

UNIT - V

Equipments - operations, Measurement and Control in fermentation - Mechanical separation and Disintegration of cells for product recovery. Enzyme engineering, enzyme immobilization techniques, Immobilized enzyme columns - Effect of pH, temperature, space velocity and pressure drop on performance.

TEXT BOOKS:

1. Biochemical Engineering, Shuichi Aiba, Arthur E. Humphery & Nancy F. Millis 1965, Academic Press, Newyork.
2. Biochemical Engineering Fundamentals, James E. Bailey, David F. Ollis, 2nd Edition, 2010, Tata McGraw - Hill, New Delhi.

REFERENCES:

1. Karl Schugerl, Bioreaction Engineering (Volume 1), 1987, John Wiley.
2. T.K.Ghose (Ed)., Process Computations in Biotechnology, 1994, Tata-McGraw Hill,
3. Atkinson, B. & Mavituna. F., Biochemical Engineering and Biotechnology Handbook, 1993, McGraw Hill (2nd Edition).

COURSE OUTCOMES:

1. Gaining the interaction of microorganism and its application to mankind.
2. Explore the mechanism of fermentation process and inhibition kinetics.
3. Assess the sterilization, its application in industrial process.
4. Explore the fundamentals for bioprocess.
5. Understanding the operation and control in bioprocess engineering.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	2	-	-	1	1	1	-	-	-	1	1	3	-
CO2	2	1	1	3	2	-	1	-	-	-	-	1	3	1	1
CO3	3	1	3	3	2	1	1	1	-	-	-	1	3	2	-
CO4	3	3	3	1	2	1	1	1	-	-	-	2	3	3	1
CO5	3	2	2	2	1	1	2	1	-	-	-	1	2	3	-

22CHPESCN	ENVIRONMENTAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To familiarize the students about pollution laws.
- To provide basic knowledge about the biosphere
- To make the students to understand about the equipment and working principles of different air pollution control methods and also about wastewater treatment technologies
- To illustrate the concepts of various methods of solid waste management.

UNIT I

The biosphere; The hydrologic cycle; The nutrient cycles – Carbon, Nitrogen, Phosphorus, Sulphur; Pollution of air, water and soil; Air pollution laws and standards; Water pollution laws and standards; Water quality standards; Effects and control of noise, thermal and radioactive pollution.

UNIT II

Origin of wastewater; Types of water pollutants and their effects; Wastewater sampling and analysis; Determination of organic and inorganic matters - physical, chemical characteristics, bacteriological measurements.

UNIT III

Basic process of wastewater treatment – Primary - screening, comminution, grit removal, and sedimentation; Secondary - Trickling filter, Activated sludge process, Oxidation pond. Rotating biological contacter; Tertiary treatments – advanced wastewater treatments; recovery of materials from process effluents.

UNIT IV

Air pollution control methods: particulate emission control - gravitational settling chambers - cyclone separators, fabric filters, electrostatic precipitators, wet scrubbers, adsorbers. Control of sulfur dioxide, oxides of nitrogen, carbon monoxide and hydrocarbons. Types of air pollutant sampling and measurement, ambient air sampling, stack sampling, analysis of air pollutants. effect of air pollutants, factors affecting dispersion of air pollutants, dispersion modeling.

UNIT V

Characterization, classification of solid wastes, problems of collection and handling, solid disposal waste management such as compaction, incineration, composting, landfills and biological processing, solid waste as resource material.

TEXT BOOKS:

1. Rao, C.S. Environmental Pollution Control Engineering, 2007, New Age International, pp. 442.

2. George Tchobanoglous, Franklin L. Burton , H. David Stensel, Wastewater Engineering: Treatment and Reuse, 2002, Metcalf & Eddy, Inc., McGraw-Hill Education, pp 1848.

REFERENCES:

1. Mahajan.S.P, Pollution control in process industries, 1995, Tata-McGraw Hill, pp 273.
2. Noel de Nevers . Air Pollution and Control Engineering, 2002, McGraw Hill, pp 586.
3. Glynn Henry J. and Gary W. Heinke, Environmental Science and Engineering, 2nd Edition, 2004, Prentice Hall of India, pp 778.
4. Rao M.N. and Rao H.V.N. Air Pollution, 1993, Tata – McGraw Hill Publishing Ltd.
5. De A.K - Environmental Chemistry, 1999, Tata – McGraw Hill Publishing Ltd.
6. Sawyer, C.N., McCarty, P.L., Parkin, G.F., Chemistry for Environmental Engineering, 2000, Tata McGraw-Hill.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Understand the terminologies of biosphere, various standards and laws that forms the basis for mitigating pollution
2. Evaluate the various types of pollution abatement techniques
3. Indicate the quality and characteristics of wastewater
4. Determine various water/air quality parameters
5. Explain the solid wastes collection, handling, waste management and Disposal

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	2	3	3	2	-	-	2	3	3	3	3
CO2	3	3	3	2	2	3	3	2	-	-	2	3	3	3	3
CO3	3	3	3	2	2	3	3	2	-	-	2	3	3	3	3
CO4	3	3	3	2	2	3	3	2	-	-	2	3	3	3	3
CO5	3	3	3	2	2	3	3	2	-	-	2	3	3	3	3

22CHPESCN	**NUCLEAR ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

To gain fundamental knowledge on nuclear physics, nuclear reactor, nuclear fuels, and safe disposal of nuclear wastes.

UNIT I

Nuclear physics: Nuclear model of an atom-Equivalence of mass and energy-binding- radio activity-half life-neutron interactions-cross sections.

UNIT II

Nuclear reactor : Nuclear reactors: types of fast breeding reactors.Design and construction of fast breeding reactors-heat transfer techniques in nuclear reactors- reactor shielding. Fusion reactors.

UNIT III

Nuclear reactions and reaction materials :Mechanism of nuclear fission and fusion- radio activity- chain reactions-critical mass and composition-nuclear fuel cycles and its characteristics-uranium production and purification. Zirconium, thorium, beryllium.

UNIT IV

Properties of irradiated fuel - separation of reactor products:Uses of stable isotopes and methods of isotope separation principles of isotope separation - Separation of isotopes of light elements - separation of isotopes of heavy elements.

UNIT V

Safety and disposal: Nuclear plant safety-safety systems-changes and consequences of accident-criteriafor safety- nuclear waste-types of waste and its disposal-radiation hazards and their prevention-weapons proliferation.

TEXT BOOKS:

1. Thomas J.Cannoly, "Fundamentals of Nuclear Engineering" 1978, John Wiley.
2. Collier J.G., and Hewitt G.F, "Introduction to Nuclear power", 1987, Hemisphere publishing, New York.

REFERENCES:

1. Wakil M.M.El., "Power Plant Technology" 1984, Mc Graw-Hill International.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Explain the fundamentals of nuclear science.
2. List out nuclear reaction process and nuclear reactors.
3. Discover knowledge in nuclear fuel cycles and its characteristics.
4. Classification of nuclear reactor products.
5. Extend knowledge in safety and disposal of nuclear fuels.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3			-	-	2	2	-	2	-	2	3	2	2
CO2	3	3	3	2	2	2	2	2	-	2	-	2	3	3	2
CO3	3	3	2	2	2	2	2	2	-	-	-	2	3	3	2
CO4	3	3	2	2	2	2	2	2	-	-	-	2	3	3	2
CO5	3	3	2	2	3	3	3	2	2	2	2	2	3	3	2

22CHPESCN	POLYMER ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the characterization, structure, mechanism, various techniques of polymerization.
- To familiarize the methods of preparation, properties and applications of thermoplastic materials covering commodity, engineering and high-performance plastics.
- To understand mechanical behavior of polymeric materials under applied load for short term and long-term properties.
- To explain the flow and rheological behavior of polymer and processing operations of polymer

UNIT-I

Classification, structure and characterization of polymers - Thermal analysis, Morphological characterization, Physical testing.

UNIT-II

Kinetics of polymerization - Condensation, free radical, cationic, anionic, stereo regular polymerization - polymerization reaction engineering, Emulsion polymerization - Smith and Ewart model. Dispersion polymerization - Fitch model. Pearl and bead polymerization, Solution polymerization.

UNIT-III

Introduction to reactor design, Interpretation of batch reactor data; Rate equations, Recycle reactor, auto catalytic reactions, Design for multiple reactions: Parallel and series reactions, quantitative and qualitative treatment of product distribution and of reactor size for different types of ideal reactors.

UNIT-IV

Rheology Definitions, Simple shear flow, measurement of viscosity with various flow geometries like capillary viscometer, cone and plate viscometer, cup and bob viscometer. Viscoelasticity Mechanical models, Maxwell model, Voight model, response of models in creep, Stress, Stress relaxation dynamic experiments. Temperature dependency of viscosity. William Landel Ferry equation.

UNIT-V

Processing operations - Description of various process operations such as extrusion calendaring, moulding, block moulding, thermoforming, compounding and mixing of polymers.

TEXT BOOKS:

1. F.W.Billmeyer, Text Book of Polymer Science, 3rd Edn., 1985, Wiley - Inter Science.

2. Anil Kumar and S.K.Gupta, Fundamentals of polymer Science and Engineering, 2003, Tata McGraw Hill Publications.

REFERENCES:

1. Ferdinand Rodriguez, Principles of Polymer Systems, Tata McGraw Hill Publication
2. Crawford,R.J., Plastic Engineering, 2nd Edn, 1989, Pergamon Press
3. McCrum,N.G., Buckley,C.P. and C.B.Bucknall, Principles of Polymer Engineering, 1988, Oxford Science Publications, Oxford University Press.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Acquire knowledge on the estimation of weight average molecular masses, degree of polymerization and mass fraction of chains present in the polymer samples.
2. Understand the role of reaction engineering in improving the chemical properties of polymers.
3. Understand the key design features of a product which relate directly to the materials used in its construction
4. Discover the role of rheological properties in improving the strength of polymers
5. Examine how the process operation of various polymeric products developed

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	3	3	-	2	-	-	-	-	3	3	2	3
CO2	3	3	2	2	2	-	2	-	-	-	-	3	3	2	3
CO3	3	3	3	2	2	-	2	-	-	-	-	3	3	2	3
CO4	3	3	2	2	-	-	2	-	-	-	-	3	3	2	3
CO5	3	3	2	2	-	-	2	-	-	-	-	3	3	2	3

22CHPESCN	**ELECTROCHEMICAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the basic principles of electrochemical science and engineering
- To understand the mechanism involved in electrochemical systems.
- To familiarize the mass transfer and mechanism of corrosion.
- To aquire knowledge on concepts of electro process and design of batteries and fuel cell
- To understand the fundamental concepts of electrochemical reactor system

UNIT I

Basics of Electrochemistry-Faraday's law -Nernst potential –Galvanic cells – Polarography Electrical double layer and It's role in electrochemical processes – Electro capillary curve – Helmholtz layer –Guoy –Steven's layer –Fields at the interface.

UNIT II

Mass Transfer in Electrochemical Systems-Diffusion Controlled Electrochemical Reaction Importance of Convention and Concept of Limiting Current- Over Potential, Primary-Secondary Current Distribution – Rotating Disc Electrode

UNIT III

Introduction to Corrosion - Corrosion Theories -Derivation of Potential-Current relations of activities Controlled and Diffusion- Controlled Corrosion Process-Potential-pH Diagram-Forms of Corrosion- Definition, Factors and Control Methods of Various Forms of Corrosion-Corrosion Control Measures- Industrial Boiler Water Corrosion Control – Protective Coatings –Vapor Phase Inhibitors – Cathodic Protection, Sacrificial Anodes – Paint Removers.

UNIT IV

Electro Deposition –Electro Refining –Electroforming –Electro Polishing –Anodizing – Selective Solar Coatings, Primary and Secondary Batteries –Types of Batteries- Fuel Cells.

UNIT V

Electrodes used in different Electrochemical Industries-Metals-Graphite –Lead Dioxide Titanium Substrate Insoluble Electrodes –Iron Oxide –Semi Conducting type - Metal Finishing-Cell Design-Types of Electrochemical Reactors, Batch Cell, Fluidized Bed Electrochemical Reactor, Filter Press Cell, Swiss Roll Cell, Plug Flow Cell, Design Equation, Figures - Merits of different type of Electrochemical Reactors- Current Electrochemical practices in industries.

TEXT BOOKS

1. Picket, "Electrochemical Engineering ", Prentice Hall. 1977.
2. Newman, J. S., "Electrochemical systems ", Prentice Hall, 1973.

REFERENCES

1. Barak, M. and Stevenge, U. K., "Electrochemical Power Sources - Primary and Secondary Batteries" 1980
2. Mantell, C.," Electrochemical Engineering ", McGraw Hill, 1972.R.Subramanian, "Professional
Ethics ", Oxford University Press, Reprint, 2015.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Understand the concept of electrochemistry and electrochemical process.
2. Knowledge on mass transfer and limiting current in electrochemical engineering.
3. Evaluate the corrosion rate and control methods.
4. Understand the industrial applications of electro processing.
5. Explains the cell, Batteries and electrochemical reactions.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**		**3**	**3**	**2**	**2**	**2**	**2**	**2**	**-**	**2**	**-**	**2**	**3**	**3**
CO2	**3**		**3**	**3**	**2**	**2**	**2**	**2**	**2**	**-**	**2**	**-**	**2**	**3**	**3**
CO3	**3**		**3**	**3**	**2**	**2**	**2**	**2**	**2**	**-**	**2**	**-**	**2**	**3**	**3**
CO4	**3**		**3**	**3**	**2**	**2**	**2**	**2**	**2**	**-**	**2**	**-**	**2**	**3**	**2**
CO5	**3**		**3**	**3**	**2**	**2**	**2**	**2**	**2**	**-**	**2**	**-**	**2**	**3**	**2**

22CHPESCN	**PETROCHEMICAL TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To teach the students about the history, evolution and feature of petrochemical Industries and its economics.
- To teach the students the technological principles of organic synthesis of petrochemicals
- To teach the students about the production of polymers and petrochemicals from the petroleum products

UNIT I

Introduction – History, economics and future of petrochemicals, energy crisis and petrochemical industry, sources and classification of petrochemicals.

UNIT II

First generation petrochemicals - Alkanes – C1, C2, C3, C4 Petrochemicals, Alkenes – C2, C3, C4 Petrochemicals, Alkynes - C2, C3, C4 Petrochemicals, B-T-X aromatics, diene based petrochemicals

UNIT III

Second generation petrochemicals synthesis gas, methanol, formaldehyde chloromethanes, ethanol, acetaldehyde, acetic acid, acetic anhydride, isopropyl alcohol, ethylene oxide, propylene oxide, acetone, vinyl chloride, phenol, aniline and styrene.

UNIT IV

Third generation petrochemicals – plastics, rubbers and fibres, olefinic polymers, polyethylene, polypropylene, polyisobutylene, diene polymers – polybutadiene, neoprene, polyisopropene, SBR, synthetic fibres.

UNIT V

Production of Petrochemicals: Dimethyl Terephathalate (DMT), Ethylene Glycol, Synthetic Glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol and Acetone, Methanol, Pentaerythritol and Production of Carbon Black. Acrylic Acid, Oxo Alcohols, Acrylates, Polyols, Propylene Glycol, Ethylene Oxide/Mono Ethylene Glycol.

TEXT BOOKS:

1. S.Maiti, Introduction to petrochemical industry, 1961, Pergamon.

2. Bhaskara Rao, B. K. “A Text on Petrochemicals”, 1st Edn., 1987, Khanna Publishers, New Delhi

REFERENCES:

1. G. D. Hobson and W. Pohl., "Modern Petroleum Technology", 1990, Gulf Publishers, 2nd Edn.,
2. R. A. Meyers, "Hand book of Petroleum Refining Processes”, 1980, McGraw Hill, 1st Edn.,
3. B. K. Bhaskara Rao, "Modern Petroleum Refining Processes", 2nd Edn., 1990, Oxford and IBH Publishing Company, New Delhi
4. G.T.Austin, Shreves chemical process industries, 5th edn., 1986, Mcgraw Hill.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Understand a detailed insight of petrochemical Industries
2. Gain knowledge on the production of first generation petrochemicals.
3. Gain knowledge on the production of second generation petrochemicals.
4. Understand the production methods of rubber, plastics, fibres and their applications
5. Understand the production methods of specialty petrochemicals

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	-	-	2	2	2	-	-	2	2	3	2	2
CO2	3	2	2	-	-	2	2	2	-	-	2	2	3	2	2
CO3	3	2	2	-	-	2	2	2	-	-	2	2	3	2	2
CO4	3	2	2	-	-	2	2	2	-	-	2	2	3	2	2
CO5	3	2	2	-	-	2	2	2	-	-	2	2	3	2	2

22CHPESCN	**INDUSTRIAL BIO-TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To motivate students to excel in research and to practice the technologies in the field of Industrial biotechnology.
- To provide students with a solid understanding of Biotechnology fundamentals and applications required to solve real life problems.
- To provide students with an academic environment that is aware of professional excellence and leadership through interaction with professional bodies

UNIT-I

Overview of the cell: Cell, structure and properties, prokaryotic and eukaryotic cells, structural organization and function of intracellular organelles; Cell wall, Nucleus, Mitochondria, Golgi bodies, Lysosomes, Endoplasmic reticulum, Peroxisomes and Chloroplast.

UNIT-II

Microbial growth: pure culture techniques: Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms. The definition of growth, mathematical expression of growth, Growth curve, availability of oxygen, culture collection and maintenance of cultures.

Media formulation: principles of microbial nutrition, formulation of culture medium, selective media, factors influencing the choice of various carbon and nitrogen sources, vitamins, minerals, precursors and antifoam agents. Importance of pH.

UNIT-III

Management of waste: Management of Contaminated land**,** lake sediments and Solid Waste, Anaerobic digestion, Biostimulation, Bioaugmentation, Phytoremediation, Natural attenuation, Vermicomposting

UNIT-IV

Bioremediation: Definition, constraints and priorities of Bioremediation, Types of bioremediation, *In-situ* and *Ex-situ* bioremediation techniques, Factors affecting bioremediation. Bioremediation of Hydrocarbons. Lignocellulosic Compounds.

UNIT-V

Bioenergy & Biomining: Bio energy: Energy and Biomass Production from wastes, biofuels, bio hydrogen and biomass. **Biomining:** Bioleaching, monitoring of pollutants, microbially enhanced oil recovery, microbial fuel cells.

TEXT BOOKS:

1. Molecular Biology of cell, Alberts. B et al.Developmental Biology, SF Gilbert, Sinauer Associates Inc.
2. AVN Swamy, Industrial Pollution Control Engineering, 2006, Galgotia Publication,

REFERENCES:

1. Environmental Biotechnology - Allan Stagg.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Master about the material in cell biology.
2. Familiar about the microbial growth techniques and cultural media.

3. Know about the strategy on industrial waste management
4. Analyzinga solution for emerging contaminant problems via Bioremediation.
5. Observe the application of living biological materials for energy and extraction of metals.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1		1	-	-	-	1	1	-	-	-	1	1	2	-
CO2	2	1	1	-	-	1	1	-	-	-	-	1	2	2	-
CO3	1	1	2	1	-	2	1	1	-	1	-	1	3	1	1
CO4	2	1	1	1	-	1	3	1	-	-	-	-	3	2	-
CO5	3	2	1	1	-	1	1	1	-	-	-	1	2	2	1

22CHPESCN	**WASTEWATER TREATMENT TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To focus on the wastewater transport system and the theoretical techniques for the wastewater treatment process.

UNIT – I

Overview of waste water Engineering

Terminolgy, Wastewater characteristics, Physical characteristics, Inorganic Constituents, Organic constituents, Biological characteristics.

UNIT – II

Physical unit operations

Screening, Coarse Solids reduction, Flow equalization, Mixing and flocculation, Gravity separation, Grit removal, Sedimentation, Clarification and flotation.

Chemical unit process

Chemical coagulation, Chemical precipitation, Chemical oxidation, Chemical neutralization, Scale control and Stabilization.

UNIT – III

Biological treatment

Overview, classification, Basics and Mechanism of Aerobic and anaerobic process. Activated sludge process, Aerated lagoons, Trickling filter, Rotary biological reactor, Oxidation ponds.

UNIT – IV

Reactors in wastewater treatment

Principle, working, advantages and limitations of- Packed bed reactor, fluidized bed reactor, Inverse fluidized bed reactor, Air lift reactor, Anaerobic digestor, Sequential batch reactor, UASB reactor, Membrane reactor.

UNIT –V

Advanced wastewater treatment

Need and Techniques used for Advanced treatment, Depth Filters, Surface filtration, Membrane filtration process, Adsorption, Gas stripping, Ion exchange, Advanced oxidation process, Distillation.

TEXT BOOKS:

1. Metcalf & Eddy, Wastewater Engineering Treatment & Reuse, Tata McGraw –Hill, IV Edn, 2003.
2. Arun Kr. Jain, Ashok Kumar Jain, and B.C. Punmia, Wastewater Engineering, Laxmi Publications, New Delhi, 1998

REFERENCES:

1. George Tchobanoglous, Franklin L. Burton , H. David Stensel, Wastewater Engineering: Treatment and Reuse, 2002, Metcalf & Eddy, Inc., McGraw-Hill Education.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Characterize the various industrial effluents.
2. Perform the treatment of wastewater by physical removal and chemical degradation.
3. Articulate various aerobic and anaerobic processes for the waste water treatment and to select suitable treatment process for given situation.
4. Select and Employ different types of reactors in the waste water treatment
5. Device the adaptable treatment technology to meet out pollution control norms.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	2	2	3	3	2	-	-	-	3	3	2	3
CO2	3	3	-	2	2	3	3	2	-	-	-	3	3	2	3
CO3	3	3	2	2	2	3	3	2	-	-	-	3	3	2	3
CO4	3	3	2	2	2	3	3	2	-	-	-	3	3	2	3
CO5	3	3	2	2	2	3	3	2	-	-	-	3	3	2	3

22CHPESCN	**NANOTECHOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- The course is aimed at making the student to understand the basic principles of Nanotechnology which is a new and emerging area in Engineering.

UNIT I

Nanotechnology Basics- Optical or Particle Wave Based Nanotechnology - Crystals and Nanotechnology- Quantum Nanotechnology. Benefits of nanotechnology - Manufacturing technologies -Molecular Electronics. Medicine - Space Development.

UNIT II

Methods of Synthesis of Nanometerials. Equipment and processes needed to fabricate nanodevices and structures such as bio-chips, power devices, and opto-electronic structures. Bottom-up (building from molecular level) and top-down (breakdown of microcrystalline materials) approaches.

.**UNIT III**

Applications of nanotechnology in biotechnology: A sample list of areas covered: Biotechnology, Genomics, Genetic Engineering, Cell Biology, Stem Cells, Cloning, Prosthetics, Cybernetics.

UNIT IV

Instrumentation for Nanoscale Characterization- Instrumentation SEM, TEM, XRD, FTIR for characterization of properties. Limits of each technique.

UNIT V

Molecular motors, biological motors, artificial photosynthesis, solar energy transduction. Impact of nanotechnology on the environment.

TEXT BOOKS:

1. G. Whitesides¸ P. Alivisatos, U. California, Fundamental scientific issues for nanotechnology, 2000,
2. Novailhat, Alain, Introduction to Nano technology, 2nd Edition, 2007, Wiley Publications.

REFERENCES:

1. Jean-Marie Lehn. Supramolecular Chemistry, 1st Edition, 1995, Wiley Publications.
2. Hovnyax G., Moore J., Tibbals J., Fundamental of Nanotechnology, 1st Edition, 1997 CRC Press.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Describe the basic concepts and principles revolving around nanotechnology.
2. Explain the ability to manipulate matter at molecular scale, customizing it according to our specific needs
3. Apply the fundamentals of nanotechnology in biomedical and biological research.
4. State various synthesis and characterization techniques of Nano-materials and familiarizes about various equipment.
5. Justify the impact of nanotechnology for biology and environment.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	3	2	2	2	3	3	2	2	3	2	2
CO2	2	3	3	3	3	3	2	-	2	-	-	-	2	3	2
CO3	2	2	2	2	2	2	-	2	2	2	3	2	2	2	2
CO4	2	3	3	3	3	2	2	-	-	-	2	2	2	3	2
CO5	2	2	2	2	2	2	-	2	3	2	2	2	2	2	2

22CHPESCN	MODERN SEPARATION PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- The course is aimed at developing the skills of engineering students in novel separation processes. The learners will be enabled to appreciate the important role of modern separation processes concepts in engineering application as well as industries.

UNIT I

Thermal Diffusion: Basic Rate Law, Theory of Thermal Diffusion Phenomena for gas and liquid mixtures, Equipments design and Applications. Zone Melting: Equilibrium diagrams, Controlling factors, Apparatus and Applications.

UNIT II

Sorption Techniques - Types and choice of adsorbents, Normal Adsorption techniques, chromatographic techniques, Equipment and commercial processes, Recent advances and economics, Molecular Sieves.

.

UNIT III

Membrane Separation Processes - Types and choice of membranes, their merits, commercial, pilot plant and laboratory membrane permeators, Dialysis, Reverse Osmosis, Ultrafiltration, Membrane bioreactor, Membrane Distillation, Economics of Membrane operations.

UNIT IV

Ionic Separation - Controlling factors, Applications, Equipments for Electrophoresis, Dielectrophoresis, Electro Dialysis and Ion -Exchange, Commercial processes.

Other Techniques: Adductive Crystallization: Molecular addition compounds, Clathrate compounds and Adducts, Equipments, Applications, Economics and Commercial processes..

UNIT V

Foam Separation - Surface Adsorption, Nature of foams, Apparatus, Applications, and Controlling factors.

TEXT BOOKS:

1. Schoen H. M., "New Chemical Engineering Separation Techniques", 2nd Edition, 1972, Inter Science Publications, New York.
2. Loeb .C and Lacey R. E., "Industrial Processing with Membranes", 2nd Edition, 1972, Wiley Inter Science.

REFERENCES:

1. Perry R.H. and. Green D.W, “Perry’s Chemical Engineers Hand book”, 6th Edition., 1990, McGraw Hill, New York.
2. Coulson J. M. and Richardson J. F., "Chemical Engineering", Vol. II, 4th Edition, 1991, Butterworth, Heinemann, London.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Describe the design principle and application of thermal diffusion.
2. Explain adsorption techniques and its commercial equipments.
3. Select suitable membrane separation processes and explain applications of membrane.
4. Articulate about ionic, crystallization and its applications
5. Illustrate surface adsorption , foam separation apparatus and its application

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2		-	2	2	2	-	-	-	2	3	2	2
CO2	3	3	2	-	-	2	2	2	-	-	-	2	3	2	2
CO3	3	3	2	-	-	2	2	2	-	-	-	2	3	2	2
CO4	3	3	2	-	-	2	2	2	-	-	-	2	3	2	2
CO5	3	3	2	-	-	2	2	2	-	-	-	2	3	2	2

22CHPESCN	**MEMBRANE SCIENCE AND ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To make students understand the various types of Membrane compositions.
- To familiarize the students various Membrane configuration Units about.
- To provide knowledge about the various Membrane separations techniques.
- To illustrate the various membrane synthesis techniques and its applications

UNIT I

Synthetic Membranes - configuration, morphology, principles of permeation and separation, membrane materials.

UNIT II

Processing: Phase-inversion process, anisotropic membranes, isotropic porous membranes. Polymer blends and alloys, dynamic membranes, liquid membranes, biomimetic membranes ion exchange membranes, electro dialysis, bipolar membranes, mosaic membranes.

UNIT III

Separation processes: Electro dialysis, micro filtration, ultra filtration, reverse osmosis, hemodialysis, hem filtration.

UNIT IV

Membrane systems: Plate and frame, spiral-wound Unit, hollow fiber Units.

UNIT V
Membrane Applications: Wastewater treatment, bioseparation, biomedical.

TEXT BOOKS:
1. R.B. Kesting., Synthetic Polymeric Membranes, Second Edn., 1985, Wiley- Interscience, New York.
2. Enrico Drioli, Lidietta Giorno, Enrica Fontananova Comprehensive Membrane Science and Engineering, 2013, Elsevier, II Edn.

REFERENCES:
1. Mulder, J Basic Principles of Membrane Technology, 1996, Springer.
2. Richard W. Baker, Membrane technology and applications, II Edn., 2004 Wiley Publication.

COURSE OUTCOMES:
On completion of the course, students would be able to
1. Explain principles of permeation and separation
2. Describe Synthesis of membranes
3. Classify Membrane Separation Process
4. Differentiate membranes based on their configuration modules.
5. Discuss application of membrane

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	2	2	2	2	-	2	2	3	3	2	3
CO2	3	3	3	3		2	2	2	-	-	3	2	3	2	2
CO3	3	3	2	-	-	2	2	2	-	-	-	2	3	2	2
CO4	3	3	3	-	-	2	2	2	-	-	-	2	3	2	2
CO5	3	3	3	-	-	3	3	3	3	3	3	3	3	2	3

22CHPESCN	**FLUIDIZATION ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:
- To enable the students to learn the design aspects of fluidized beds.

UNIT-I : Basics of fluidization
Packed bed – Velocity – Pressure drop relations – Correlations of Ergun, Kozneykarman – On set of fluidization – Properties of fluidized beds –Development of fluidization from fixed bed.

UNIT-II: Fluidized bed types
Minimum fluidization conditions – Expanded bed – Elutriation – Moving solids and dilute phase – spouted bed.

UNIT-III: Design aspects

Channeling – Bed expansion in liquid – Solid and gas – Solid fluidizations. Design aspects of fluidized bed systems.

UNIT-IV: Heat and mass transfer in fluidized beds
Heat and mass transfer in fluidized bed systems – Industrial applications and case studies of fluidized bed systems.

UNIT-V: Other types of fluidization
Single stage and multistage fluidization – Collection of fines – Use of cyclones.

TEXT BOOKS:
1. Daizo Kunii, Octave Levenspiel," Fluidization Engineering" 2nd Edition, 1991, Butterworth –Heinmann.
2. Leva, M., "Fluidization", 1959, McGraw Hill Book Co

REFERENCES:
1. Rowe and Davidson, "Fluidization", 1971, Academic Press
2. Wen-Ching Yang., "Handbook of Fluidization and Fluid-Particle Systems", 20013, Marcel Dekker Inc.

COURSE OUTCOMES:
On completion of the course, the students would be able to

1. Explain the fundamentals of fluidization phenomena, correlations of Ergan and Kozney-karman equations.
2. Identify the fluidization bed types and describe minimum fluidization condition, bed expansion, elutriation and spouted bed.
3. Compare solid-liquid and solid-gas fluidizations and analyze the design aspects of fluidized bed systems
4. Describe the heat and mass transfer in fluidized beds and the industrial applications of fluidized bed reactors
5. Analyze single and multistage and the use of cyclones for the collection of fines.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	2	2	-	-	2	-	-	-	2	3	2	2
CO2	2	3	3	2	2	-	-	2	-	-	-	2	3	2	2
CO3	2	2	3	2	2		-	2	-	-	-	2	3	2	2
CO4	2	2	3	3	2		-	2	-	-	-	2	3	2	2
CO5	2	2	3	2	3		-	2	-	-	-	2	3	2	2

22CHPESCN	DISTILLATION	L	P	T	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart the fundamentals of phase diagrams and equilibria and introduce the students to boiling point and equilibrium flash vaporization curves.
- To make the students evaluate the concepts of equilibrium and simple distillation, multi component distillation ternary distillation and azeotropic distillation.
- To make the students assess the design principles of distillation process and its industrial application

UNIT I

Gibbs phase rule, phase equilibrium, ideal and non-ideal gas mixtures, Raoult's law, nonideal liquid - liquid mixtures; phase diagrams, effect of pressure on phase equilibria; Vapor Liquid Equilibria: Ideal and non-ideal binary and multi-component systems - Correlation and prediction –consistency tests; VLE of complex system-true boiling point curves-ASTM distillation, equilibrium flash vaporization curves.

UNIT II

Equilibrium and simple distillation: flash vaporization of binary and multi-component systems, differential vaporization and condensation; steam distillation; fractionation of binary systems-analytical and graphical methods of determination of number of equilibrium stages.

UNIT III

Ternary systems and multi-component systems- Sorel method, Lewis-Matheson method, Thiele-Geddes method, short cut methods, graphical evaluation of number of stages for ternary systems.

UNIT IV

Azeotropic distillation and extractive distillation: separation of homogeneous azeotropes, separation of heterogeneous azeotropes, selection of addition agents-design of azeotropic distillation process, design of extractive distillation process; Reactive Distillation and Case studies.

UNIT V

Design methods: fractionation devices, bubble cap, sieve and other types of trays-plate and column hydraulics and efficiency- plate fractionation column design methods, packed column design

TEXT BOOKS:

1. Van Winkle, M., Distillation, 2nd ed. 1967, McGraw Hill publications.
2. Doherty, M.F and Malone, M.F., Conceptual Design of Distillation systems, 2006, McGraw Hill International Edn

REFERENCES:

1. Holland, Multi-component Distillation. First Edn., 1963

2. Treybal,R.E.,Mass Transfer Operation, 3rd Edn., 1981, 3rd Edn., 1981, McGraw Hill
3. McCabe, W.L., Smith, J.C. and P. Harriot, Unit Operations in Chemical Engineering, VII Edn., 2005, McGraw Hill.
4. Sherwood,T.K.,Pigford,R.L and Cr.Wilke., Mass Transfer, McGraw Hill

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand the basic concept of thermodynamics and phase equilibria.
2. Acquire knowledge on distillation processes and determine the number of equilibrium stages.
3. Acquire knowledge on principles of ternary and multi component distillation.
4. Understand the concepts and principles of azeotropic and extractive distillation.
5. Acquire knowledge on design and develop the distillation process.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	2	2	3	3	2	2	2	2	3	2	2
CO2	3	3	3	2	2	2	2	2	2	2	2	2	3	2	2
CO3	3	3	3	2	2	2	2	2	2	2	2	2	3	2	2
CO4	3	3	3	2	2	2	2	2	2	2	2	2	3	2	2
CO5	3	3	3	2	2	2	2	2	2	2	2	2	3	2	2

22CHPESCN	**AIR POLLUTION & CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To study about the effects of air pollutants on human beings and environment, what their sources are, and their physical and chemical behavior in the atmosphere.
- To get exposed to a wide range of control technologies and future trends towards preventing air pollution.

UNIT - I : Air pollution

Air Pollution-Sources and Effects Definitions, Scope, Air Pollutants – Classifications – Natural and Artificial – Primary and Secondary, Sources of air pollution- stationary and mobile sources. Effects of Air pollutants on humans, materials and vegetation. Global effects of air pollution – Green House effect, Heat Islands, Acid Rains, Ozone Holes etc.

UNIT – II: Air quality monitoring management

Ambient Air Sampling- sampling procedures for collection of gases and particulates, High Volume Sampler. Stack monitoring- Sampling Techniques for Stack gases. Analysis of Air

Pollutants: SOx, NOx, CO, Hydrocarbons and Particulate matter. Air quality standards and Emission standards

UNIT – III:Meteorology and plume dispersion

Properties of atmosphere - Temperature, Pressure and Wind forces. Influence of Meteorological phenomena on Air Quality. Temperature lapse rates and Atmospheric Stability. Wind velocity and turbulence. Plume behaviour. Wind rose diagrams. Dispersion theories and models- stack height, plume rise.

UNIT – IV: Air pollution control methods

Source correction methods – Raw material changes, Process Changes and Equipment modifications, Particulate control equipments – Settling Chambers, Centrifugal separators, Fabric filters Wet scrubbers and Electrostatic precipitators. Collection efficiency and design problems. General Methods of Control of Gaseous emissions- Absorption, Adsorption and Combustion. Control of NOx and SOx emissions.

UNIT – V: Air pollution in industries and automobiles

Air pollution from major industrial operations: Mining and mineral processing, Cement manufacturing, Petroleum refinery, Metallurgical operations Thermal power plants. Air Pollution due to Automobiles: Emissions from automobiles, formation of photochemical smog, Combustion, Air-Fuel ratio, Control of Exhaust emissions, biological reactors for Air pollution control.

TEXT BOOKS:

1. M.N Rao and H.V.N Rao, Air Pollution, , 2007, Tata McGraw- Hill Publishing Company Limited, New Delhi.
2. R.K Trivedy and P.K Goel, An Introduction to Air Pollution, 2009, BS Publications, Hyderabad.

REFERENCES:

1. Richard W. Boubel. Fundamentals of Air Pollution, Academic Press, (Elsevier), New York
2. Noel De Nevers, Air Pollution control, McGraw – Hill publishing Co. Ltd., New York.
3. Peavy H.S, Rowe D.R. and Tchobanoglous, Environmental Engineering, Tata McGraw Hills, New Delhi
4. KVSG Murali Krishna, Air Pollution and Control, Kushal &Co, Kakinada
5. C.S Rao, Environmental Pollution Control Engineering, New Age International Publishers, New Delhi

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Identify the sources of air pollutants and analyse its effects on human and environment
2. Understand air sampling techniques and analysis of air pollutant concentration.
3. Know the meteorological properties and dispersion mechanism of pollutants in air.
4. Analyse control methods and use of industrial equipment to remove pollutants from air.
5. Apply methods of pollution control in process industries and automobiles.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	2	-	3	**3**	**2**	-	-	-	-	**3**	**2**	**2**
CO2	3	3	3	2	-	2	**2**	**2**	-	-	-	-	**3**	**2**	**2**
CO3	**3**	2	3	2	2	2	**2**	**2**	-	-	-	-	**3**	**2**	**2**
CO4	**3**	2	3	2	2	2	**2**	**2**	-	-	-	-	**3**	**3**	**2**
CO5	**3**	3	3	2	2	2	**2**	**2**	-	-	-	-	**3**	**2**	**3**

22CHPESCN	**MIXING THEORY & PRACTICE**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To teach the students about the importance of mixing in chemical process industries.
- To teach the students about the heat and mass transfer impacts in mixing.
- To enlighten the knowledge about behavior of the Newtonian and Non Newtonian Liquids.

UNIT - I

Mixing in chemical processes

Examples of processes signifying importance of mixing - Goodness of mixing: Qualification - Significance of dimensionless groups - dimensional analysis - power number correlation - Expressions for NRe, NFr, NWe, NPr from their definitions as ratios applied to resisting forces - analogy between drag coefficient and power number. Power curves with and without baffles - power reduction - Power measurement techniques - Scale - up - principle of similarity - scale-up criteria - Operating characteristics of small blade and large blade agitators

UNIT – II

Mixing operations

Mixing of solids, liquids, immiscible liquids and semisolids. Industrial mixing – Batch – Continuous. Purging of stirred tanks in series - Effect of mixing on chemical reactions - introduction -batch reactor and CSTR comparison - Residence time distribution - mixing concepts and models - RTD functions J(8) and J'(8). Imperfect mixing in Stirred tanks. Challenges in industrial mixing – lumping – clogging – air intrusions – foaming.

UNIT - III

Heat transfer and mass transfer in Mixing

Heat transfer promotion by mixing - mixing and overall heat transfer coefficient - Heat transfer correlation for helical coils and jacketed vessels - transient analysis of heat transfer - Design calculation for heat transfer in mixing vessels - Mixing and mass transfer - introduction - Interfacial phenomena - drop size distribution -coalescence - breakage - emulsion - surfactant - Mass transfer coefficient - two film concept - mass transfer modeling - Correlation for mass transfer coefficient - stage efficiency.

UNIT - I**V**

Fluid Behaviour in Mixing

Non-Newtonian liquids mixing - introduction, pseudoplastic, dilatant, Bingham plastic liquid, - thixotropic and rheopectic liquids - shear rate - shear stress behaviour - apparent viscosity - Power curve for non-Newtonian liquids - Viscometry - shear in stirred tanks -Shear in stirred tanks related to shear in pipes, apparent viscosity in pipe-line flow and stirred tanks - discussion of experimental work literature - Reynolds number modification - Practical application of Non-Newtonian mixing.

UNIT – V

Industrial Mixing Equipments

Different agitator types - appearance, characteristic features viscosity ranges, advantages, flow patterns they create and mounting specialties if any of turbines, propellers, paddles, anchors, gates, helical screws, helical ribbons. Industrial Mixers.

TEXT BOOKS:

1. Holland and Chapman, Liquid Mixing and processing in Stirred Tanks, Reinhold Publishing Co-operation, 1966, New York and London.
2. Uhl and Gray, Mixing theory and practice, Vol.1 and II, 1967, Academic Press, NewYork and London.

REFERENCES:

1. Shinji Nagata, Mixing Principles and Applications, 1975, HoltedPress , Tokyo

COURSE OUTCOMES:

After the completion of the course, the student should be able to

1. Understand the Basics of mixing in Chemical Processes.
2. Able to gain knowledge on mixing operations in the mixing equipments.
3. Understand the impact of heat transfer and mass transfer in mixing.
4. Understand the behavior of fluids in mixing.
5. Gain knowledge on the industrial mixing process and equipments.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	-	2	2	-	-	-	-	2	3	2	2
CO2	2	2	2	2	-	2	2	-	-	-	-	2	2	2	2
CO3	3	2	2	2	-	2	2	-	-	-	-	2	3	2	2
CO4	3	2	2	2	-	2	2	-	-	-	-	2	2	2	2
CO5	3	2	2	2	3	3	2	-	-	-	-	2	2	2	2

22CHPESCN	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide brief introduction of Computational Fluid Dynamics along with chemical engineering application specifically, analysis of fluid mechanics and heat transfer related problems.

UNIT I

Basics of computational fluid dynamics-Governing equations of fluid dynamics- Continuity, Momentum and Energy equations-Chemical species transport-Physical boundary conditions-Time-averaged equations for turbulent flow-Turbulent-Kinetic Energy Equations-Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

UNIT II

Derivation of finite difference equations-Simple Methods-General Methods for first and second order accuracy-solution methods for finite difference equations-Elliptic equations-Iterative solution Methods-Parabolic equations-Explicit and Implicit schemes- Example problems on elliptic and parabolic equations.

UNIT III

Finite volume formulation for steady state One, Two and Three-dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank - Nicolson and fully implicit schemes.

UNIT IV

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes-properties of discretization schemes – Conservativeness, Boundedness, Trasnportiveness, Hybrid, Power-law, QUICK Schemes.

UNIT V

Representation of the pressure gradient term and continuity equation - Staggered grid - Momentum equations - Pressure and Velocity corrections -Pressure Correction equation, SIMPLE algorithm and its variants. Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models.

TEXT BOOKS:

1. T.J. Chung, Computational Fluid Dynamics, Cambridge University, Press, 2002. 85
2. Versteeg, H.K., and Malalasekera, W., An Introduction to Computational Fluid Dynamics: The finite volume Method, Longman, 1998.
3. Ghoshdastidar , P.S., computer Simulation of flow and heat transfer, Tata McGraw Hill Publishing Company Ltd., 1998.
4. Anderson Jr J. D., “Computational Fluid Dynamics: The Basics with Applications”, 1995, McGraw Hill.

REFERENCES:

1. Muralidhar K. and Sundararajan T., "Computational Fluid Flow and Heat Transfer", 2003, Narosa Publishing House.
2. Vivek V. Ranade, Computational flow modeling for chemical reactor engineering 2002, Academic Press, San Diego.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Assess the governing equations involving continuity, momentum and energy. Analyze the effect of PDEs on CFD.
2. Investigate the use of Finite Difference equations involving simple and iterative methods.
3. Assess Finite volume formulation for steady state One, Two and Three-dimensional diffusion problems and fully implicit schemes.
4. Generate and optimize the numerical mesh for steady one-dimensional convection and diffusion
5. Justify representation of the pressure gradient term and continuity equation in context to conservativeness, boundedness, trasnportiveness, hybrid, power-law, QUICK Schemes.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	3	2	3	3	2	3	-	3	3	-	-
CO2	3	3	3	3	3	2	1	3	2	3	-	3	3	3	2
CO3	3	3	3	3	3	2	1	3	3	3	-	3	3	3	2
CO4	3	3	3	3	3	2	3	3	3	3	3	3	3	3	2
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

CHPESCN	**OPTIMIZATION OF CHEMICAL PROCESSES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- The course is aimed at developing the skills of engineering students in Optimization of chemical processes.
- The learners will be enabled to appreciate the important role of Optimization of chemical processes concepts in engineering application.

UNIT I :Objective and formulation of optimization

Objective and Introduction, Objective Function and Decision variables, Inequality and Equality Constrains in Models Formulation of the Objective Function, Lower and Upper Bounds, Selecting Functions to Fit Empirical Data, Factorial Experimental Designs, Degrees of Freedom, Economic Objective Functions, Measures of Profitability

UNIT II: Basic concepts of optimization

Continuity of Function, NLP Problem Statement, Convexity and Its Applications, Interpretation of the Objective Function in Terms of its Quadratic Approximation, Necessary and Sufficient Conditions for an Extremum of an Unconstrained Function.

UNIT III: Optimization of unconstrained functions

One-Dimensional Search Numerical Methods for Optimizing a Function of One Variable, Scanning and Bracketing Procedures, Newton and Quasi-Newton Methods of Unidimensional Search.

UNIT IV: Unconstrained multivariable optimization

Linear Programming (LP) and Applications Geometry of Linear Programs, Basic Linear Programming Definitions and Results, Simplex Algorithm, Barrier Methods, Sensitivity Analysis, Linear Mixed Integer Programs, Application of the EXCEL Solver Spreadsheet for Optimization, Formulation. Introduction to Non-linear Programming with Constraints and Mixed-Integer Programming.

UNIT V: Application of optimization in chemical engineering

Examples of Optimization in Chemical Processes like optimizing recovery of waste heat, Optimal Shell and Tube Heat Exchanger Design, Optimal Design and Operation of binary Distillation Column, Optimal pipe diameter etc. Flow sheet Optimization - Case studies.

TEXT BOOKS:

1. Edger T.F., Himmelblau D.M. and Lasdon L.S., "Optimization of Chemical Processes", 2nd Edition, 2001, McGraw- Hill.
2. Seider W.D., Seader J.D. and Lewin D.R., "Product and Process Design Principles- Synthesis, Analysis, and Evaluation", 2nd Edition, 2008, John Wiley and Sons Inc

REFERENCES:

1. Kalyan Moy Deb "Optimization for Engineering Design", 2nd Edition, 2009, Prentice Hall of India.
2. Gupta P.K, Hira D.S, Problems in Operations Research – First Edition 1991, S.Chand& Company Ltd. New Delhi.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Identify and formulate optimization problems in chemical engineering
2. Compare the constrained and unconstrained situations in the chemical reactions
3. Apply the optimization software tools in chemical engineering processes
4. Solve the various multivariable optimization problems
5. Apply the optimization concepts in chemical process equipment's.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	-	-	2	2	-	-	-	3	3	-	3
CO2	3	3	3	2	-	-	2	2	-	-	-	3	3	-	3
CO3	3	3	3	2	-	-	2	2	-	-	-	3	3	-	3
CO4	3	3	3	2	-	-	2	2	-	-	-	3	3	-	3
CO5	3	3	2	2	-	-	2	2	-	-	-	3	3	-	3

22CHPESCN	OPERATIONS RESEARCH	L	P	T	C
		3	0	0	3

COURSE OBJECTIVES:

- To teach the basic principles on operations research and optimization problem.
- To teach the basic knowledge on principles of linear programming.
- To familiarize the functioning of nonlinear programming
- To illustrate the concepts of decision making and game theory
- To teach the design of optimization by PERT and CPM

UNIT-I

Basics of operations research - Linear programming- mathematical formulation- graphical methods, theory and applications of simplex method, duality theory, revised simplex methods.

UNIT-II

Transportation models- formulation as LP problem, methods of obtaining initial solution, setting up of transportation table- performing optimality test- test for optimality

UNIT-III

Dynamic programming; Non linear programming

UNIT-IV

Decision theory and games: decision making under conditions of certainty- decision making under conditions of uncertainty- optimistic criterion- pessimistic criterion; decision making under conditions of risk. The theory of games- maximin and minimax criteria-mixed strategies for games with saddle points

UNIT-V

Programming Evaluation and Review Technique (PERT) and Critical path method (CPM)

TEXT BOOKS:

1. Gupta P.K, Hira D.S, Problems in Operations Research – First Edition 1991, S.Chand & Company Ltd. new Delhi.
2. Rudd, F., C. Watson, Strategy of Process Engineering, 19686, John Wiley.

REFERENCES:

1. Taha H.A "Operation Research" IX Edn, 2010, Prentice Hall of India, New Delhi.
2. Sharma S.K."Mathematical models in Operation Research," Tata McGraw Hill Publishing Company Ltd ,New Delhi.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand the different methods of solving problem.
2. Acquire knowledge on linear programming with limitations.
3. Acquire knowledge on principles of nonlinear programming.
4. Understand the concepts and principles of game theory and decision making.
5. Acquire knowledge on design and develop optimization using PERT and CPM.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	2	2	2	2	2	2	2	2	3	3	2
CO2	3	3	3	3	2	2	2	2	2	2	2	2	3	3	2
CO3	3	3	3	3	2	2	2	2	2	2	2	2	3	3	2
CO4	3	3	3	3	2	2	2	2	2	2	2	2	3	3	2
CO5	3	3	3	3	2	2	2	2	2	2	2	2	3	3	2

22CHPESCN	**PROCESS MODELING & SIMULATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

Course Objective:

- To understand knowledge of fundamental principles and basic laws of modeling.
- To understand the approach for mass/heat transfer & CRE.
- To apply the knowledge of differential equations.
- To understand the approach to modeling.
- Formulation of a mathematical model for various chemical Engg. System.

Unit-I: Introduction, uses of mathematical models, Scope of coverage, Principles of formulations, Introduction of Matlab and use of the language to solve modeling problems.

Unit-II: Mathematical Modeling in Chemical Reaction Engineering: CSTR, PFR, Batch reactor, semibatch reactor, Series of isothermal CSTR, constant hold-up CSTR's, CSTR's with variable hold ups, gas phase pressurized CSTR, non-isothermal CSTR, trikle bed reactor. Simulation, program development and numerical solutions of above processes.

Unit-III: Mathematical Modeling in Mass Transfer: Ideal binary distillation column, multicomponent non ideal distillation column, batch distillation with hold up, steam

distillation, Multisolute batch liquid- liquid extraction, continuous extraction, multistage countercurrent extraction, plug flow type liquid- liquid extraction, reactor with mass transfer, Absorption, Adsorption. Simulation, program development and numerical solutions of above processes.

Unit-IV: Mathematical Modeling in Heat transfer: Two heated tanks, single component vaporizer, double pipe heat exchanger, shell and tube heat exchanger, multicomponent flash drum, cooling towers. Simulation, program development and numerical solutions of above processes.

Unit-V: Mathematical Modeling in other chemical processes: Interacting and non-interacting systems with and without heaters, isothermal hydraulic system, forward and backward feed triple effect evaporator, melting, batch reverse osmosis Unit, Real CSTR modeled with an exchange volume, Real CSTR modeled using by passing and dead space.

1. Lubyen W. L., Process Modeling, Simulation and Control for Chemical Engineers, McGraw- Hill, New York, 1989.

2. Elements of Chemical Reaction Engineering by Fogler, Prentice Hall of India.

3. Mickley H. S., Sherwood T. S., Reed C. E., Application of Mathematical Modeling in Chemical Engineering, Tata-McGraw-Hill, New Delhi, 2002.

4. A. Kayode Coker, Modelling of Chemical Kinetics and Reactor Design, Gulf professional publication

COURSE OUTCOMES:

After the completion of this course, the students will be able to

1. Describe the principles of fundamental laws, reaction kinetics and uses of models.
2. Develop models for chemical processes used in industries.
3. Apply modeling scheme for gas flow systems and reaction kinetics.
4. Design distillation column, extraction process, heat exchanger and pipe flow process.
5. Simulate simple chemical processes using numerical methods.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3											**3**		
CO2	3	3		3	3	2							**3**	**1**	**2**
CO3	**3**	2	3		1								**3**	**2**	**1**
CO4	**3**	2	3	2	2	1							**3**	**2**	**1**
CO5	**3**	3	3	1	1	1							**3**	**2**	**1**

22CHPESCN	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To have a comprehensive knowledge on the evolution, principles, practices, tools and techniques of Total quality management.
- To understand the quality statements, customer focus and elements of continuous quality improvement.
- To comprehend the traditional and contemporary tools of quality control and bench marking.
- To understand the working of the quality circle and strategies for improvement and enhance performance.
- To learn the importance of ISO audits and management strategies for improved qualities.

UNIT I : Introduction

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality - Basic concepts of TQM – TQM Framework - Contributions of Quality Gurus – Barriers to TQM – Cost of Quality.

UNIT II : TQM principles

Quality statements - Customer focus –Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Continuous process improvement – PDCA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating

UNIT III : TQM tools & techniques I

The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

UNIT IV : TQM tools & techniques II

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures - BPR.

UNIT V : Quality systems

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing QS 9000 – ISO 14000 – Concepts, Requirements and Benefits –Quality Council – Leadership, Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward.

TEXT BOOKS:

1. Dale H.Besterfiled, , Carol Besterfield-Michna, Glen Besterfield , Mary Besterfield-Sacre, "Total Quality Management", Third Edition , 2006, Pearson Education Asia, , Indian Reprint
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 6th Ed., 2005, South-Western (Thomson Learning).

REFERENCES:

1. Oakland, J.S. "TQM – Text with Cases", Third Edition , 2003, Butterworth – Heinemann Ltd., Oxford.
2. Suganthi,L and Anand Samuel, "Total Quality Management", 2006, Prentice Hall (India) Pvt. Ltd.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Know prerequisites of evolution of total quality management and significance contributions of quality gurus' to the management of modern organizations.
2. Evaluate the principles of quality management and to administer how these principles can be applied within quality management systems.
3. Identify the key aspects of the quality improvement cycle and to select and use appropriate tools and techniques for controlling, improving and measuring quality.
4. Identify and prioritize customers' expectations quickly and effectively and to enlist the factors for improving the "Overall Equipment Effectiveness"
5. Describe the various elements of quality systems and Critically appraise the teamwork requirements for effective quality management.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	-	-	-	3	2	2	-	-	-	-	2	2	3	-
CO2	2	2	3	-	3	-	-	-	2	-	-	-	2	3	2
CO3	2	2	3	2	2	-	-	-	3	-	2	-	2	3	2
CO4	2	2	3	2	3	-	-	-	-	-	2	2	2	3	2
CO5	2	-	3	-	-	2	2	-	-	-	3	2	2	-	2

22CHPESCN	**CHEMICAL WORKS RGANIZATION AND MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To introduce significance of industrial relation, disputes and types of business organization
- To gain knowledge about production planning, inventory control and marking techniques
- To develop personality, communication skills and motivation of the work performance

UNIT - I

Industrial Relations – Introduction. Significance & conditions for good industrial relations- Causes of poor industrial relations & suggestions to improve it. Labour disputes in India. Industrial disputes act-1947 (only Salient Points). Types of industrial disputes – strikes – lockouts. Regulation of strikes & Lockouts.

UNIT - II

Business organization - Various forms of private, ownerships, comparison and choice. Industrial Organizations - Plant location - Factors influencing plant location - split and coupled locations- sizeof industrial units. Plant layout - Choice of equipment various types of layout - guarding of machineries - illumination, heating and ventilation.

UNIT - III

Material management - Organization - Production Planning, purchase, store - inventory control, sales and marketing. Scientific management - Rationalization - time and motion study analysis. Time management.

UNIT IV

Personality predispositions – personality and personality types, Maddi's models of personality. Perpectual process – development of perpectual skills. Motivation and work performance. Reinforcement theory – Relationship between motivation and performance.

UNIT V

Dynamics of communication – The communication process, structure of communication, Transactional Analysis, The five common communication networks in an organization. Group Dynamics – Synergy through groups, Group behaviour, group effectiveness, stages of groupdevelopment. Properties and Characteristics of Highly effective groups

T**EXT BOOKS:**

1.Sukla,M.C., Business Organization and Management, 2010.
2.Uma sekaran – "Organisational Behaviour – Text and Cases" 2004, Tata McGraw Hill NewDelhi.

REFERENCES:

1.Tripathi – "Personnel Management & Industrial Relations" 2013, Sultan Chand and SonsNew Delhi.
2.K.Aswathappa, Organization behavior - Texts and Cases, 1997Himalaya Publishing House.

Industrial disputes act-1947
3.Chakraborty S K- Managerial Development & Appraisal –Macmillan India
4.Strauss & Sayles – Personnel Management

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understanding the salient features of good relations and industrial disputes
2. Gaining knowledge about types of ownerships, plant layout and plant location
3. Developing skills in management of material, marketing, and time
4. Attaining skills to develop personality in motivating performance
5. Improving knowledge on dynamics, structure of communication, and group behavior

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	-	-	-	2	-	3	2	2	-	2	2	-	3
CO2	-	-	3	-	-	-	2	-	-	-	2	-	2	-	-
CO3	2	2	-	2	2	-	-	-	-	-	3	2	2	2	-
CO4	-	-	-	-	-	3	-	2	-	2	2	-	-	-	3
CO5	-	-	-	-	-	-	-	-	2	3	-	2	-	-	3

22CHPESCN	**ENTREPRENEURSHIP**	**L**	**P**	**0**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- Develop an entrepreneurship sprit
- Help to identify business opportunities within an organization or independently
- Initiate action on the business plan from the prospective business through EDC

UNIT – I

Meaning – Characteristics of management – Nature of management – Process of management – Functional areas of management – Management and administration – Role of management – Level of management – Evolution of management.

UNIT – II

Meaning - Nature of planning – Importance of planning – Types of planning – Steps in planning – Decision making – Meaning and definition of organizing – Steps in organizing – Nature of organization – Organization structure – Purpose of organization – Principles of organization – Delegation of authority – Nature and importance of staffing.

UNIT – III

Meaning and nature of direction – Principles of directing – Leadership and leadership style – Motivation – Communication – Need and feedback in communication – Importance of communication – Channels of communication – Types of communication – Forms of communication.

UNIT – IV

Evolution of concept of entrepreneur – Concept of entrepreneur – Characteristics of entrepreneur – Distinction between entrepreneur and manager – Technical entrepreneur – Charms of being an entrepreneur – Types of entrepreneur – Role of entrepreneurship in economic development – Barriers in entrepreneurship.

UNIT – V

Meaning of project – Project classification – Project identification – Meaning and significance of project report – Contents of a project report – Formulation of project report – Planning commission guidelines – Identification of opportunity – Project feasibility study.

TEXT BOOKS:

1. Veerabhadrappahavinal, Management and entrepreneurship, New age International, New Delhi, 2008. 2. Peter F. Drucker; Innovation and entrepreneurship, Butterworth – Heinemann, London, 1985.

REFERENCES:

1 “Creativity, innovation, entrepreneurship and enterprise in construction and development”, University of Reading, Alan Barrell – Entrepreneur in Residence Entrepreneur in Residence, University of Xiamen, Xiamen 2012.
2 “Entrepreneurship Studies”, National University Commission (Nigerian University System), 2010.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Identify the concept of management, nature, process, functional areas, roles and levels of management.
2. Assess the importance of planning, decision making, organization structure and delegation of authority
3. Examine the principles of direction, leadership styles, importance of communication, types of communications and forms of communication.
4. Assess the concept of entrepreneurship, charms, types and role of entrepreneur, role and barriers
5. Evaluate the meaning of project, identification, classification and feasibility of projects

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	-	3	-	2	3	2	3	3	3	3	2	3	3
CO2	-	3	3	3	-	2	-	3	3	3	3	3	3	3	3
CO3	-	3	3	3	3	3	-	3	3	3	3	3	3	3	2
CO4	2	3	-	3	3	3	3	3	3	2	3	2	2	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

22CHPESCN	INDUSTRIAL RELATIONS & ORGANIZATIONAL DEVELOPMENT	L	P	0	C
		3	0	0	3

COURSE OBJECTIVES:

- To inculcate the changes in the Industrial relation policies and economic policies.
- To acquaint the student with the determinants of intra -individual, inter-personnel and inter-group behaviour in organisational setting and to equip them with behavioural skills in managing people at work.
- To provide an overview of theories and practices in organizational behaviour in individual, group and organizational level.

UNIT I

Impact of Industrial Revolution – Industrial Relations: Concept – Importance of Industrial Relations – Scope and Aspects of Industrial Relations –Factors Affecting Industrial Relations – Perspectives/Approaches to Industrial Relations – Organisation of Industrial Relations – Dimensions of Industrial Relations Work – Prerequisite Successful Industrial Relations Programme.

UNIT II

Evolution of Industrial System – Anatomy of industrial conflicts - Genesis of Industrial Conflicts – Industrial Conflicts/Disputes – Concept and Essential of a Dispute – Classification of Industrial Disputes – Impact of Industrial Disputes – Cause of Industrial Conflicts –Strikes – Typology of Strikes — Lockouts.

The state and industrial relations policy - Evolution of Industrial relations policies – Industrial Relations Policy During the plan Period – The Plan Period – Recognition of Unions Machinery for solving the Dispute - Standing Orders –Grievances – Procedure for Settlement – Essence of Model Grievance Procedure.

UNIT III

The Industrial Disputes Act, 1947 - Wage Legislations - The Payment of Bonus Act, 1965 - The Factories Act, 1948. Recent Amendments.

UNIT IV

Group Behaviour: Group Dynamics, Cohesiveness and Productivity; Management of Dysfunctional groups; Group Decision Making; Organisational Politics. Leadership - Concept and Styles; Fielder's Contingency Model; House's Path - Goal Theory; Leadership Effectiveness; Sources, patterns, levels, and types of conflict; Traditional and modern approaches to conflict; Functional and dysfunctional conflicts; Resolution of conflict.

UNIT V

Organization structure – Formation – Groups in organizations – Influence – Group dynamics – Emergence of informal leaders and working norms – Group decision making techniques – Team building - Interpersonal relations – Communication – Control.

Meaning – Importance – Leadership styles – Theories – Leaders Vs Managers – Sources of power – Power centers – Power and Politics.

Organizational culture and climate – Factors affecting organizational climate – Importance. Job satisfaction – Determinants – Measurements – Influence on behavior. Organizational change – Importance – Stability Vs Change – Proactive Vs Reactive change – the change process – Resistance to change – Managing change. Stress – Work Stressors – Prevention and Management of stress – Balancing work and Life. Organizational development – Characteristics – Objectives – Organizational effectiveness Developing Gender sensitive workplace.

TEXT BOOKS:

1. Mamoria, Mamoria and Gankar, "Dynamics of Industrial Relations", Himalaya Publishing House, Sixteenth Edition, 2008.
2. Stephen P. Robins, Organisational Behavior, PHI Learning / Pearson Education, 11th edition, 2008. 11 2. Fred Luthans, Organisational Behavior, McGraw Hill, 11th Edition, 2001.

REFERENCES BOOKS:

1. Mc Shane & Von Glinov, Organisational Behaviour, 4th Edition, Tata Mc Graw Hill, 2007.
2. Nelson, Quick, Khandelwal. ORGB – An innovative approach to learning and teaching. Cengage learning. 2nd edition. 2012
3. Ivancevich, Konopaske & Maheson, Oranisational Behaviour & Management, 7th edition, Tata McGraw Hill, 2008.
4. Udai Pareek, Understanding Organisational Behaviour, 3rd Edition, Oxford Higher Education, 2011.
5. Jerald Greenberg, Behaviour in Organization, PHI Learning. 10th edition. 2011

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to:

1. Assess the industrial revolution, its effect on industrial relations, scope and aspect of industrial relations and factors affecting industrial relations
2. Identify the concept of dispute / conflict, strikes, industry relation plan, grievances and grievances models

3. Investigate the legislative aspects including the Industrial Disputes Act 1947, The Payment of Bonus Act 1965 and The Factories Act
4. Identify the nuances of Group Behaviour, Types of Leadership and dealing with conflicts.
5. Assess the organization structure, leadership styles, organizational climate, managing stress, organizational development and effectiveness.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**1**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**1**	**3**	**3**
CO2	**-**	**3**	**3**	**3**	**-**	**2**	**-**	**3**	**3**	**3**	**-**	**-**	**1**	**3**	**3**
CO3	**-**	**3**	**3**	**3**	**-**	**3**	**-**	**3**	**2**	**3**	**-**	**3**	**1**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**3**	**3**

22CHPESCN	**PROCESS INSTRUMENTATION**	**L**	**P**	**0**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To introduce the basics of process and industrial instrumentation.
- To know about the principles and operation of different measuring devices for temperature, pressure, flow, level, pH, will be introduced to impart knowledge of transmitters.

UNIT -1

Process variable and measurement - Static and dynamic characteristics of instruments - Advantages and limitations of instruments, indicating and recording mechanism, strip charts and circular charts.

UNIT - II

Different types of measuring instruments for Temperature, Pressure, Flow and Level; Description - Principles of measuring elements used and characteristic features.

UNIT - III

Measuring instruments for Viscosity, Density, Humidity, pH, Thermal conductivity, and Diffusivity, Description and principles of operations measuring elements used and characteristic features.

UNIT - IV

Instruments for Chemical Analysis: Description, operating principles, measuring elements used and method of analysis. Spectrometry, absorption, emission, and mass spectroscopy - Fluorometry, Flame photometry, NMR and ESR.

UNIT - V

Intelligent Sensors: General Structure of smart sensors & its components, Characteristic of smart sensors: Self calibration, Self-testing & self-communicating, Application of smart sensors in process industries

Text Books:

1. Eckman,D.P. Industrial Instrumentation, Wiley Eastern Ltd. 3rd ed. 1984.
2. Doebelin, E.O. and Manik, D.N., "Measurement systems Application and Design", 6th McGraw-Hill Education Pvt. Ltd, 2011.
3. Sawhney, A.K., and PuneetSawhney, "Mechanical Measurements and Instrumentation and Control", DhanpatRai & Co. (P) Limited, 2015.

Reference Books:

1. Willard, Merrit and Dean, Industrial Methods of Analysis, East West Press. 3rd ed. 1979

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to:

1. Explain the process variable, its measurement, and characteristics of measuring devices, both static and dynamic, advantages and limitations of those devices. Assess the indicating and recording mechanisms of the measured variable.
2. Assess the principles and characteristic features of measuring elements used for Temperature, pressure flow and level measurement
3. Assess the principle and characteristic features of measuring elements used for for Viscosity, density, Humidity, pH, thermal conductivity, and diffusivity measurement.
4. Understand the principles and constructional details of various electrical type flow meters.
5. Analysis and design of the level measurement, and electronics & smart transmitters.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**3**	**3**	**3**	**3**	**-**	**2**	**1**	**3**	**3**	**1**	**3**	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**3**	**3**	**1**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

22CHPESCN	FOOD PROCESSING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To familiarize the basic sciences in the fundamentals of physical, chemical and biochemical nature of food.
- To provide basic knowledge about the principles of different food preservation techniques and the simultaneous extension of shelf life of food materials.
- To demonstrate about various dairy products and beverages like carbonated and non-carbonated beverages.
- To illustrate the concepts of the processing of fruits and vegetables, meat, poultry and fishery products and packaging of food materials.

UNIT I

Introduction to food processing – nutritive values of food; types of microorganisms associated with food, its sources and behavior in food.

UNIT II

Food deterioration and its control – shelf life and dating of food – principles of food preservation – heat preservation and processing sterilization, pasteurization and blanching – cold preservation and processing freezing, refrigeration and cold storage – food irradiation, microwave heating and ohmic heating.

UNIT III

Dairy chemistry – milk as a food and its composition – quantitative analysis of milk – milk processing – pasteurization of milk – milk products – manufacturing process of milk cream, butter, evaporated milk, condensed milk, concentrated milk, ice cream, skim milk, fermented milk, butter milk, whey, dried milk products – beverages– carbonated and non carbonated beverages.

UNIT IV

Canning process of fruits and vegetables, grading, washing, peeling, coring and pitting – blanching – can filling – processing of meat and poultry – Canning of fish – preparation of raw material, salting, blanching process – filling, exhausting, sealing, can washing, thermal processing, cooling, drying and packing.

UNIT V

Principles of food packaging – introduction, types of containers, food packaging materials and forms, package testing, package with special features, safety of food packaging – method of food packaging.

TEXT BOOKS:

1 Norman N. Potter and Joseph H. Hotchkins, Food Science, V Edition, 1998, CBS Publishers & Distributors, New Delhi.

2 W.C. Frazier & D.C. Westhoff, Food Microbiology, 1986, Tata McGraw Hill.

REFERENCES:

1. Arthur W. Farrall, Engineering for Dairy and Food Products, 1967.Wiley Eastern Private Ltd,
2. G.S.Siddappa, Preservation of Fruits and Vegetables, 1986, ICAR, New Delhi.

.

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to:

1. Familiar about simple scientific information on food components and their interactions with microorganism.
2. Know about enhancing the shelf life of food by heat processing technologies.
3. Understand the chemistry of milk and technology of various dairy products.
4. Observe the preservation by canning process of fruits, vegetables, meat,poultry and fish.
5. Gain knowledge on food packaging materials and application of packaging materials.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	1	-		2	1	1	-	-	-	1	2	1	-
CO2	2	1	2	1	1	1	1	1	-	-	-	2	1	2	-
CO3	3	1	2	1	1	2	1	1	-	-	-	1	1	2	-
CO4	1	1	2	1	1	3	1	2	-	-	-	1	2	3	-
CO5	2	1	1	1-	1	3	2	1	-	-	-	2	2	3	-

22CHPESCN	**PULP & PAPER TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- Gaining Knowledge of pulp & paper industry, mill Operations, products, process variables, equipment, and terminology.
- Increasing knowledge of how the Pulp &Paper processes affect product properties, in order to improve product quality and troubleshoot variations in quality.
- To illustrate the concepts of various unit operations steps appropriately in manufacturing of paper.

UNIT I

Introduction to pulp and paper technology –Wood as a raw material – different types of wood and their uses.

UNIT II

Woodyard operation Woodyard operation - Mechanical pulping – Chemical pulping – Secondary fibre pulp processing.

UNIT III

Paper machine Paper Machine wet and addition paper machine dry and operation – Paper machine - Wet and operation.

UNIT IV

Paper and paperboard Paper and paperboard frames and products – Surface treatments – Finishing operation– End uses.

UNIT V

Properties and testing of pulp and paper Properties and Testing of pulp and paper Process control – Quality assurance – Water and air pollution control.

TEXTBOOKS:

1. Monica ER Monica, Goran Gellerstcdt Gunnar Hennksson De Gneyter, Pulp and paper chemistry and Technology, 2009.
2. Rao, M.Gopal, Sitting, Marshall, Dryden's outlines of Chemical Technology, 3rd Edition, Affilated East- West Press Pvt. Ltd.

REFERENCES:

1. Biermann, Christopher J Handbook of Pulping and Papermaking.
2. Metcalf & Eddy, Wastewater Engineering, Treatment, Dispose and Reuse, Inc. IV EDN, 2002.
3. Austin, George T., Shreves' Chemical Process Industries, 5th Edition, McGraw-Hill Education India Pvt. Ltd - New Delhi
4. Bhatia, S.C. Environmental Pollution and Control in Chemical Process Industries Second Edition 2011.
5. Trivedi, R.K., Pollution Management in Industries, Environmental Publication, Karad, India

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Describe the basic concepts of pulp and paper technology and the raw material for paper making.
2. Analyse various unit operations and reactions involved in pulp making process.
3. Explain about paper machine and its distinct operational sections.
4. Summarize various paper products and surface treatments.
5. Analyse the properties, testing of paper and the waste disposal techniques in pulp and paper industry

Mapping with POs & PSOs															
COS	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	-	-	2	3	-	-	-	-	-	-	-	-	3	-
CO3	3	-	-	-	3	-	-	-	-	-	-	-	-	3	-
CO4	3	-	2	-	3	-	-	-	-	-	-	-	-	3	-
CO5	3	-	-	-	3	2	-	-	-	-	-	-	-	3	-

22CHPESCN	FERTILIZER TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enable the students to learn the fertilizer manufacturing including new or modified fertilizer products and new techniques.

UNIT I

Nitrogenous fertilizer's

Methods of production of nitrogenous fertilizer-ammonium sulphate, nitrate, urea and calcium ammonium nitrate; ammonium chloride and their methods of production, characteristics and specifications, storage and handling.

UNIT II Phosphatic fertilizer's

Raw materials; phosphate rock, sulphur; pyrites etc., processes for the production of sulphuric and phosphoric acids; phosphates fertilizers – ground rock phosphate; bone meal-single superphosphate, triple superphosphate, triple superphosphate, thermal phosphates and their methods of production, characteristics and specifications.

UNIT III Potassic fertilizer's

Methods of production of potassium chloride, potassium schoenite, their characteristics and specifications.

UNIT IV Mixed fertilizers

Methods of production of ammonium phosphate, sulphate diammonium phosphate, nitrophosphates, urea, ammonium phosphate, mono-ammonium phosphate and various grades of NPK fertilizers produced in the country.

UNIT V Miscellaneous fertilizers

Mixed fertilizers and granulated mixtures; biofertilisers, nutrients, secondary nutrients and micro nutrients; fluid fertilizers, controlled release fertilizers, controlled release fertilizers.

TEXT BOOKS:

1. "Handbook of fertilizer technology", Association of India, 1997, New Delhi.
2. Menno, M.G.; "Fertilizer Industry - An Introductory Survey", 1973, Higginbothams Pvt. Ltd.,

REFERENCES:

1. Sauchelli, V.; "The Chemistry and Technology of Fertilizers", ACS MONOGRAPH No. 148, 1980, Reinhold Publishing Cor. New York.
2. Fertilizer Manual, "United Nations Industrial Development Organization", United Nations, New York, 1967.
3. Slack, A.V.; Chemistry and Technology of Fertilizers, 1966, Interscience, New York,

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Describe about various Nitrogen fertilizer production and its characteristics
2. Explain about Phosphatic fertilizer with flow diagram
3. Develop the knowledge of Potassic fertilizer with their specifications
4. Explain about mixed fertilizer and NPK fertilizer in our country
5. Justify the different types of fertilizer applied to agriculture production of various crops

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	3	-
CO3	**3**	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO4	2	-	3	-	-	-	-	-	-	-	-	-	3	-	-
CO5	-	3	3	2	-	-	-	-	-	-	-	-	-	3	2

22CHPESCN	**TECHNOLOGY OF FINE AND SPECIALTY CHEMICALS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To introduce the Fine chemical production methods in Global level and basic need of fine chemical industries
- Study of Chemical technology of selected Fine chemicals and Specialty chemicals
- Role of Catalysis and catalytic processes in fine chemical production
- Fine chemical manufacturing methods and scale up procedure
- To analyze the design, cost and operation for fine chemical process

UNIT I

Introduction. Characteristic features of fine and specialty chemicals manufacture. Types of Catalysts in Fine Chemicals Synthesis**.** Role of Heterogeneous Catalyst in Improving Selectivity**.** Aspects of Process Development of Fine Chemicals**.** Relevant Separation Methods**.** Different Types of Manufacturing Facilities of Fine Chemicals.

UNIT II

Chemistry of Fine and Specialty Chemicals Synthesis. Fine and specialty chemicals introduction, Historical development of organic synthesis. Fine and specialty chemicals vs. bulk chemicals manufacture. Process selection: process profile analysis. Factors influencing process choice: cleaner and safer technologies. E factors and atom utilization. The role of catalysis in waste minimization. Fine chemicals and specialty chemicals and catalysis: examples.

UNIT III

Types of Catalysts in Fine Chemicals and specialty Synthesis. Introduction. Mechanism of catalysis. Heterogeneous catalysts - types and preparation. Catalyst performance: activity, selectivity, and

stability. Catalyst selection. Catalyst characterization. Homogeneous catalysis. Phase-transfer catalysis. Biocatalysis.

Role of Heterogeneous Catalyst in Improving Selectivity. Heterogenization of homogeneous catalysis. Additional liquid phase. Rate and selectivity improvement via manipulation of 'microenvironment'. Rate and selectivity improvement via manipulation of 'macro environment'. Unconventional techniques. Continuous processes.

UNIT IV

Brief overview of Relevant Separation Methods. Application of Distillation. Extraction. Crystallization. Adsorption. Membrane separations for fine and specialty chemicals Processing.

Aspects of Process Development of Fine and specialty Chemicals. Introduction. Steps in process development. Scale-up procedures. Chemical reactor scale-up, design, and Operation. Acronyms and symbols.

UNIT V

Brief overview of Different Types of Manufacturing Facilities of Fine and specialty Chemicals. Types of production plants for Fine Chemicals. Typical equipment in a multi-product plant. Production costs. Design and scheduling of batch plants. Principles of good Manufacturing practice.

TEXTBOOKS:

1. Fine Chemicals Manufacture: Technology and Engineering, A. Cybulski M.M. Sharma R.A. Sheldon J.A. Moulijn, Elsevier Science 2001.
2. Sustainable Value Creation in the Fine and Specialty Chemicals Industry – R Rajagopal Wiley publications, 2014.
3. Specialty Chemicals Innovations in industrial synthesis and applications - B Perason, Springer Netherlands, 1991.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand and analyze the characteristic features of fine and specialty chemicals.
2. Know and the development of the cleaner and safer technologies for the synthesis of fine and specialty chemicals.
3. Understand the mechanism and design of catalysts used in the fine and specialty chemicals production.
4. Assess, design and apply various separation methods for the development of fine and specialty chemicals
5. Apply the principles of costing, management, and good manufacturing practice for the production of fine and specialty chemicals.

Mapping with POs & PSOs															
COS	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	-	2	2	2	1	-	-	2	2	2	1
CO2	3	3	3	3	-	2	2	2	1	-	-	2	2	2	1
CO3	3	3	3	3	-	2	2	2	1	-	2	2	2	2	1
CO4	3	3	3	3	-	2	2	2	2	-	2	2	2	2	1
CO5	3	3	3	3	-	2	2	2	2	-	2	2	2	2	1

OPEN ELECTIVES

22CHOESCN	SOLID WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Provide students with an understanding of technical issues and the management of resources and solid waste.
- Examine appropriate methods of storage, collection, transfer, treatment and disposal appropriate for industrialized and developing countries.

UNIT-I

Sources and types of municipal solid wastes-waste generation rates-factors affecting generation, characteristics-methods of sampling and characterization; Effects of improper disposal of solid wastes-Public health and environmental effects. Elements of solid waste management –Social and Financial aspects – Municipal solid waste (M&H) rules – integrated management-Public awareness; Role of NGO"s.

UNIT-II

On-site storage methods – Effect of storage, materials used for containers – segregation of solid wastes – Public health and economic aspects of open storage – waste segregation and storage – case studies under Indian conditions – source reduction of waste – Reduction, Reuse and Recycling.

UNIT-III

Methods of Residential and commercial waste collection – Collection vehicles – Manpower– Collection routes – Analysis of collection systems; Transfer stations – Selection of location, operation & maintenance; options under Indian conditions – Field problems- solving.

UNIT-IV

Objectives of waste processing – Physical Processing techniques and Equipments; Resource recovery from solid waste composting and biomethanation; Thermal processing options – case studies under Indian conditions.

UNIT-V

Land disposal of solid waste; Sanitary landfills – site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas- Landfill bioreactor– Dumpsite Rehabilitation. Incineration, composting methods.

TEXT BOOKS:

1. Tchobanoglous, G., Theisen, H. M., and Eliassen, R. "Solid. Wastes: Engineering Principles and Management Issues". 1993, McGraw Hill, New York,
2. Vesilind, P.A. and Rimer, A.E., "Unit Operations in Resource Recovery Engineering", 198, Prentice Hall, Inc.

REFERENCES:

1. Government of India, "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of Urban Development, New Delhi, 2000.
2. Bhide A.D. and Sundaresan, B.B. "Solid Waste Management Collection", Processing and Disposal, 2001
3. Manser A.G.R. and Keeling A.A.," Practical Handbook of Processing and Recycling of Municipal solid Wastes", 1996, Lewis Publishers, CRC Press,
4. George Tchobanoglous and Frank Kreith"Handbook of Solid waste Management", 2002, McGraw Hill, New York.
5. Paul T Willams, "Waste Treatment and Disposal", 2000, John Wiley and Sons.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand the nature and characteristics of municipal solid wastes
2. Understand the regulatory requirements regarding municipal solid waste management
3. Plan waste minimization and design storage, collection, transport, processing and disposal of municipal solid waste
4. Describe about treatment of solid wastes.
5. Explain about the landfill in solid waste management.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	-	-	2	3	2	-	2	-	2	3	2	3
CO2	3	2	2	3	-	3	3	2	-	2	-	2	3	2	3
CO3	3	2	3	-	3	2	3	2	-	2	-	2	3	2	2
CO4	3	2	2	-	-	2	2	2	-	2	-	2	3	2	3
CO5	3	3	2	-	-	2	2	2	-	2	-	2	3	2	3

22CHOESCN	MATERIALS OF CONSTRUCTION IN THE PROCESS INDUSTRIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop the skills of engineering students in Materials of constructions
- To appreciate the important role of materials concepts in engineering application.

UNIT I

Materials Classification: Engineering materials and their classification - Properties: Intrinsic and extrinsic, Structure sensitive ad Structure insensitive properties- Mechanical, Electrical, Thermal, magnetic and optical properties of materials - Deformation of materials- Heat Treatment techniques – Failure of Materials : Brittle and ductile fracture, Creep failure, Fatigue, Development of creep and fatigue resistant materials- Corrosion Of Material – corrosion - theories of corrosion - control and prevention of corrosion.

UNIT II

Metals: Fundamentals of metal forming: Classification of forming process, mechanisms of metal forming Rolling of metals; Rolling Process - Forging: Classification of forging process - Engineering materials - ferrous metals - Iron and their alloys Iron and steel Iron carbon equilibrium diagram. Non ferrous metals and alloys.

UNIT III

Aluminium, copper, Zinc, lead, Nickel and their alloys with reference to the application in chemical industries.

UNIT IV.

Non Metals: Inorganic materials: Ceramics, Glass and refractories

UNIT V

Organic materials: wood, plastics, and rubber and wood with special reference to the applications in chemical Industries.

TEXT BOOKS:

1. Lawrence H. Van Vlack, "Elements of Material Science and Engineering", VI Edn. 1989, Addison Wesley Publishing
2. S. K. Hajra Choudhury, "Material Science and processes", 1st Edn. , 1977. Indian Book Distribution Co., Calcutta.

REFERENCES:

1. V. Raghavan, Materials Science and Engineering, 2004, Prentice Hall of India..
2. Fundamentals of Metal forming Processes – B.L.Juneja.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand the classification, properties, deformation and corrosion of materials.
2. Explain describe forming, classification, rolling and forging of metals.
3. Ferrous and Non-Ferrous metals and their alloys with reference to chemical industries.
4. Describe the properties and applications of Non Metals; Inorganic materials; Ceramics, Glass and refractories.
5. Describe the properties and applications of organic materials.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	-	-	2	2	-	-	-	2	3	2	3
CO2	3	2	2	2	-	-	2	2	-	-	-	2	3	2	3
CO3	3	-	3	-	-	-	2	2	-	-	-	2	3	2	3
CO4	3	-	2	-	-	-	2	2	-	-	-	2	3	2	3
CO5	3	-		3	-	-	2	2	-	-	-	2	3	2	3

22CHOESCN	**PROJECT ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To familiarize the students on project engineering, operations and contracts.
- To provide knowledge about the selection of heat exchangers, pumps, compressors turbines etc.
- To illustrate the concepts of pipe design and thermal insulation.
- To impart knowledge on fire, explosion and other industrial hazards and to provide basic knowledge on personal protective equipments and their applications.
- To gain knowledge on hazard analysis, its types, hazard evaluation, health, safety and ergonomics.

UNIT - I

Preliminary data for construction projects- process Engineering - process flow and PI diagrams, scheduling the project; procurement operations - contracts.

UNIT - II

Selection of heat exchangers, pumps, compressors, vacuum pumps, motors turbines and other process equipment.

UNIT - III

Piping design - pipes and fittings, pipe supports, selection of valves - piping layout and arrangement. **Thermal insulation**: types and characteristics, Selection and erection of insulation.

UNIT - IV

Fire Types of fire- fire hazards-hazards of flammable liquids and gases-ignition hazards-fire extinguishers-fire exits. **Explosion** Fire and explosion index-dust explosion and prevention. **Toxic releases-** Toxicity and its measurements- release control- reduction and removal methods maintenance- emergency management plans.

Personal protective equipment - Types-helmets-respirators-air purification-chemical protective clothing-gloves-eye glasses- foot and knee protection-skin care.

UNIT - V

Hazard analysis- Types of hazard analysis-hazard identification-hazard survey-hazard and operability studies-fault tree analysis -event tree analysis-technique of operation review- safety audit-hazard evaluation. Health and safety-ergonomics.

TEXT BOOKS:

1. Rase,H.F.,and M.H.Barrow, Project Engineering of process plants, 1987, John Wiley & Sons.
2. Dan Patterson, Techniques of Safety Management, 2nd edition, 1996, Mc Graw Hill, Kogakusha,

REFERENCES:

1. Anilkumar, Chemical Process Synthesis and Engg. Design, 1997, Tata McGraw Hill Pub. Co. New Delhi.
2. R.V.Betrabeta and TPS.Rajan, Safety in Chemical Industry in Chemical Technology - I, Chemical Engg. Division center IIT, Chennai.
3. K.V.Ragavan and A.A.Khan, Methodologies in Hazard Identification and Risk Assessment, Manual by CLRI - 1990.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Create data for construction projects and process equipment.
2. Select various process equipment based on process conditions.
3. Apply the concepts of pipe design and to eruct thermal insulation.
4. Express knowledge on fire, explosion, industrial hazards and personal protective equipment.
5. lentify hazard and to conduct hazard analysis, safety audit, hazard survey & hazard evaluation.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	-	-	-	-	-	3	3	2	2
CO2	3	3	3	2	2	-	-	-	2	-	2	3	3	2	2
CO3	3	2	3	-	-	2	2	-	3	-	-	3	3	2	2
CO4	3	2	-	-	-	2	2	3	3	-	-	3	3	2	2
CO5	3	2	-	3	3	2	2	3	3	-	2	3	3	2	3

.

22CHOESCN	**FUEL TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand about the Fuels and its Types and properties.
- To impart knowledge on Distillation Techniques
- To familiarize Combustion Technology and calculations of calorific values

UNIT I

Introduction -History of Fuels - Solid fuels, Liquid fuels and Gaseous fuels - Production- Present scenario - Consumption pattern of fuels - Fundamental definitions, properties and various measurements- Definitions and Properties of Solid fuels, Liquid fuels and Gaseous fuels - Various measurement techniques

UNIT II

Solid Fossil Fuel - Coal classification - Composition and basis - Coal mining - Coal preparation and washing- Combustion of coal and coke making- Action of heat on different coal samples-Different types of coal combustion techniques- Coal tar distillation- Coal liquefaction- Direct liquefaction- Indirect liquefaction - Coal gasification

UNIT III

Liquid Fossil Fuel - Exploration of crude petroleum - Evaluation of crude - Distillation - Atmospheric distillation - Vacuum distillation - Secondary processing - Cracking - Thermal cracking-Visbreaking - Coking- Catalytic cracking - Reforming of Naphtha -Hydro treatment - Dewaxing -Deasphalting - Refinery equipments

UNIT IV

Gaseous Fuels- Natural gas and LPG - Producer gas - Water gas- Hydrogen - Acetylene- Other fuel gases

UNIT V

Combustion Technology - Fundamentals of Thermo chemistry - Combustion air calculation - Calculation of calorific value of fuels - Adiabatic flame temperature calculation - Mechanism

and kinetics of combustion - Flame properties - Combustion burners - Combustion furnaces - Internal combustion engines

TEXT BOOKS:

1. Glassman, Yetter and Glumac, Combustion, V edn., 2014, Academic Press.
2. John Griswold, Fuels Combustion and Furnaces, 1946, Mc-Graw Hill Book Company Inc.
3. Samir Sarkar, Fuels and Combustion, 3rd. ed 2010, Universities Press.
4. W.L. Nelson, Petroleum Refinery Engineering, 4th ed. 1958., Mc-Graw Hill Book Company.

REFERENCES:

1. B.K. Bhaskar Rao, Modern Petroleum Refining Processes, 4th ed., , 2008, Oxford & IBH Publishing Co. Pvt. Ltd.
2. Richard A. Dave, IP, Modern Petroleum Technology, Vol 1, Upstream, 6th ed., 2000, John Wiley & Sons. Ltd.
3. Alan G. Lucas, IP, Modern Petroleum Technology, Vol 2, Downstream, 6th ed., 2002, John Wiley & Sons. Ltd.
4. Report on the project "Coal Combustion Study", sponsored by Tata Tron and Steel Company Ltd., Jamshedpur.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Illustrate about fuels, characteristics and classification.
2. Describe solid fuels; their combustion technologies, efficiency and applications.
3. Describe liquid fuels; their characterization, processing and equipment.
4. Describe gaseous fuels and applications.
5. Discuss thermo chemistry and combustion properties.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	-	2	2	2	3	3	3	2	3	2	3
CO2	3	2	3	2	-	2	2	2	3	3	3	2	3	2	3
CO3	**3**	2	2	2	3	3	2	2	3	3	3	2	3	2	3
CO4	3	2	3	2	-	2	2	3	3	3	3	2	3	2	3
CO5	3	2	3	2	-	3	2	3	3	3	3	2	3	2	3

22CHOESCN	**RENEWABLE ENERGY TECHNOLOGY**	**L**	**P**	**T**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the various methods of conventional and renewable energy resources and present scenario with energy conservation and regulations.
- To illustrate the aspects in utilization of solar energy storage technologies.

- To understand the description, selection, sizing and performance of wind energy system.
- To explain the basic principles and operations analysis of bio-energy systems.
- To understand the aspects of ocean, geothermal, hydrogen production and fuel cell.

UNIT I

Introduction to energy

Indian Energy Scenario – Types & Forms of Energy - Primary / Secondary Energy Sources – Energy Conservation – Need – EC Act 2003 : Salient Features – Energy Intensive Industries – Barriers -Roles & Responsibility of Energy Managers – Energy Auditing : Preliminary & Detailed - Benchmarking .

UNIT II

Solar energy

Solar radiation at the earth's surface – solar radiation measurements – estimation of average solar radiation - solar thermal flat plate collectors - concentrating collectors – solar thermal applications - heating, cooling, desalination, drying, cooking, etc – solar thermal electric power plant - principle of photovoltaic conversion of solar energy, types of solar cells - Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping etc - solar PV power plant – Net metering concept.

UNIT III

Wind energy

Nature of the wind – power in the wind – factors influencing wind – wind data and energy estimation - wind speed monitoring - wind resource assessment - Betz limit - site selection - wind energy conversion devices - classification, characteristics, applications – offshore wind energy – Hybrid systems - safety and environmental aspects – wind energy potential and installation in India-Repowering concept.

UNIT IV

Bio-energy

Biomass resources and their classification - Biomass conversion processes - Thermochemical conversion - direct combustion – biomass gasification - pyrolysis and liquefaction – biochemical conversion - anaerobic digestion - types of biogas Plants - applications - alcohol production from biomass – bio diesel production – Urban waste to energy conversion - Biomass energy programme in India.

UNIT V

Other types of energy

Ocean energy resources - principle of ocean thermal energy conversion (OTEC) - ocean thermal power plants - ocean wave energy conversion - tidal energy conversion – small hydro – geothermal energy - geothermal power plants – hydrogen production and storage - Fuel cell – principle of working - various types - construction and applications.– Energy scenario in India – Growth of energy sector and its planning in India.

TEXT BOOKS:

1. Chetan sing solanki, Renewable Energy Technologies, PHI Learning pvt Ltd, 2009

2. D.P.Kothari, K.C.Singal, Rakesh ranjan, II edn,Renewable Energy Sources and Emerging Technology,PHI Learning pvt Ltd, 2019

3. Sukhatme, S.P., J.K.Nayak, Solar Energy, III Edn. 2008,Tata McGraw Hill,.
4. Twidell, J.W. and Weir, A., Renewable Energy Sources,1986, EFN Spon Ltd..

REFERENCES:

1. Kishore VVN, Renewable Energy Engineering and Technology, 2012, Teri Press, New Delhi
2. Peter Gevorkian, Sustainable Energy Systems Engineering, 2007, McGraw Hill
3. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, 1996, Oxford University Press, U.K,
3. Yogi Goswami, Kreith, F and Kreider, J. F., Principles of Solar Engineering, 2000, McGraw-Hill, II Edn.
4. Veziroglu, T.N., Alternative Energy Sources, Vol 5 and 6, 1990, McGraw-Hill
5. Anthony San Pietro, Biochemical and Photosynthetic aspects of Energy Production, 2012, Academic Press

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Acquire knowledge on environmental aspects and impacts of non-renewable and renewable energy resources.
2. Understand the solar energy technology for domestic and commercial applications.
3. Analyze the functionality of components of the wind energy systems and their behavior in operation.
4. Understand the bio-energy system to pre-feasibility study and perform an initial design.
5. Acquire knowledge on present technologies to connect renewable energy such as geothermal, hydrogen production and fuel cell.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	-	2	3	2	3	2	2	2	2	3	3
CO2	3	3	3	3	-	2	3	2	3	2	2	2	2	3	3
CO3	3	3	3	3	-	2	3	2	3	2	2	2	2	3	3
CO4	3	3	3	3	-	2	3	2	3	2	2	2	2	3	3
CO5	3	3	3	3	-	2	3	2	3	2	2	2	2	3	3

22CHOESCN	**HAZARDOUS WASTE MANAGEMENT**	**L**	**P**	**0**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To define and identify the characteristics of hazardous wastes.
- To identify the environmental concerns for hazardous waste on water, land and air
- To impart knowledge and skills in the collection, storage, transport, treatment, disposal and recycling options for hazardous wastes.
- To familiarize students with laws and regulations governing hazardous wastes.

UNIT I

Introduction

Definition – Introduction – Sources of hazardous wastes – Effects on community – terminology and classification – Need for hazardous waste management — Problems in developing countries – Protection of public health and the environment.

UNIT II

Nuclear wastes and e-waste

Characteristics – Types – Nuclear waste – Uranium mining and processing – Power reactors– Refinery and fuel fabrication wastes – spent fuel – Management of nuclear wastes – Decommissioning of Nuclear power reactors – Health and environmental effects of Nuclear waste - E-waste – sources and management.

UNIT III

Biomedical and chemical wastes

Biomedical wastes – Sources - Types – Collection- Segregation and Labelling – Treatment – Autoclaving, Incineration, Chemical Disinfection – Disposal, Infection control practices - Chemical wastes – Sources – Domestic and Industrial - Inorganic pollutants – Environmental effects – Need for control – Treatment and disposal techniques – Physical, chemical and biological processes – Health and environmental effects.

UNIT IV

Hazardous wastes management

Handling, collection, Segregation, storage and transport, TSDF concept. Hazardous waste

treatment technologies - Physical, chemical and thermal treatment, solidification, chemical fixation, encapsulation, pyrolysis and incineration of Hazardous wastes.

UNIT V

Waste disposal

Waste disposal options – Disposal in landfills - Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – Rehabilitation of open dumps – landfill remediation – Hazardous waste management Rules 2016.

TEXT BOOKS:

1. Hazardous waste management by Charles A. Wentz. Second edition 1995, McGraw Hill International.
2. Harry M. Freeman, Standard handbook of Hazardous waste treatment and disposal, 1996, McGraw Hill.

REFERENCES:

1. Criteria for hazardous waste landfills – CPCB guidelines 2000.
2. Daniel B. Botkin and Edward A. Keller Environmental Sciences, Wiley student, 6th Edn 2009.
3. Biomedical waste (Management and Handling) Rules, 1998.
4. Paul T Williams, Waste Treatment and Disposal, 2005, Wiley.
5. J. Glynn Henry and Gary. W. Heinke Environmental Science and Engineering, , 2004, Prentice Hall of India.
6. Anjaneyulu, Hazardous waste management

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Identify the sources, characteristics of hazardous wastes and its effects on community.

2. Understand the characteristics, effects and management of Nuclear wastes and e-waste.

3. Evaluate different treatment technologies used for Biomedical and Chemical wastes.

4. Discuss the facilities for the Handling, collection, Segregation, storage and transport, TSDF concept. Hazardous waste treatment technologies.

5. Understand and an insight into the Secure land filling and the national legal frame work of hazardous waste management.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	-	2
CO2	3	2	3	-	2	-	2	2	2	2	-	2	3	3	2
CO3	3	2	3	-	3	3	2	2	3	2	2	2	3	3	2
CO4	3	2	3	-	3	2	2	2	3	2	-	2	2	3	2
CO5	3	2	3	-	2	2	2	2	3	2	-	2	2	3	2

22CHOESCN	DISASTER MANAGEMENT	L	P	0	C
		3	0	0	3

COURSE OBJECTIVES:

- To summarize the basics of disasters and management
- To explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- To illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- To describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- To develop the strengths and weaknesses of disaster management approaches

UNIT – I

Introduction – Disaster- Characteristics and types of Disasters- Causes and effects of Disaster - Risk- Vulnerability – Preparedness- Disaster mitigation and disaster management- Classification of mitigation measures-Vulnerability Analysis- Observation and Perception of Vulnerability- Socio- Economic Factors of Vulnerability- Vulnerability in India- Disaster related policy goals of UNDP UNDRO and Govt. of India- Appraising disaster needs - Needs for technical expertise- Role of various Agencies in Disaster Management and Development - Disaster risk reduction planning- Role of Developmental Planning for disaster Management.

UNIT - II

Earthquake - Cause of Earthquake- General characteristics- Measuring Earthquakes- Distribution
pattern of Earthquakes in India- Earthquake prone areas- case studies of important Indian earthquakes - Forecasting techniques and risk analysis- Possible risk reduction measures- earthquake resistance buildings and re-engineering techniques in India.

UNIT - III

Tsunamis- Causes of a Tsunami- General Characteristics- Tsunami warning system- Distribution pattern of Tsunami in India- Possible risk reduction measures- Integrated coastal zone management- Avalanches- Mud flows and glaciers- Landslides and rock falls- landslide hazard zonation- Instrumentation and monitoring- Techniques for reducing landslide hazards.

UNIT - IV

Tropical cyclones- Structure of tropical cyclones- Nature of tropical cyclones- Cyclone experience n India and Tamilnadu- Preparedness- Tropical cyclones and their warning systems- Tropical cyclone warning strategy in India special nature of the problem in the region Classification- Protection of buildings from cyclones of India- Precautions during and before cyclones.

UNIT- V

Coastal floods - Intensification of hazards due to human interference- Management - River and coastal floods - Temperature extremes and wild fires - Physiological hazards- Flood forecasting - mitigation - planning-management - flood prone areas the Indian scenario - Flood experience in India and Tamilnadu. Environmental hazards- Typology- Assessment and response- Strategies -The scale of disaster-Vulnerability- Disaster trends- Paradigms towards a balanced view- Chemical hazards and toxicology-Biological hazards- Risk analysis- Other technological disasters.

TEXT BOOKS:

1. David R. Godschalk (Editor), Timothy Beatiey, Philip Berke,.David J. Browt:r, Edward J. Kaiser Charles C. Boh, R. Matthew Goebel, Natural Hazard Mitigation: Recasting Disaster Policy and Planning Island Press; (January 1999), ISBN) 559636025
2. Sinha, P.C. Wind & Water Driven Disasters, 1998, 250pp, Anmol Publications

REFERENCES:

1. Davide Wikersheimer Windstorm Mitigation Manual for Light Frame Construction, 1997, DIANE Publishing Company
2. Brown D Redevelopment After the Storm: Hazard Mitigation Opportunities in the Post Disaster Setting, 1985,John Wiley & Sons.
3. Sinha, P.C. Technological Disasters, 1997, 516 pp Anmol Publications Trivedi,

COURSE OUTCOMES

On completion of the course, the students would be able to

1: Summarize the basics of disaster management problems and solutions

2: Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

3: Explain and illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

4: Described the standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

5: Explain the strengths and weaknesses of disaster management approaches.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	1	3	3	3	3	3	2	3	2	3	3
CO2	3	3	3	3	2	3	3	3	3	3	3	3	2	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3

22CHOESCN	INDUSTRIAL SAFETY & OCCUPATIONAL HEALTH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To give an idea about different hazards and other safety procedures to be followed in an industry
- To offer comprehensive knowledge of industrial safety and occupational health be immensely useful for the students from all fields

UNIT- I

Concepts of Safety-Types of Hazards-Physical, Chemical, Biological, Mechanical and ergonomic Hazards and their control measures.

Human factors contributing to accidents-Causes of unsafe acts-Safety and Psychology-Theories of Motivation and their application to Safety-Personnel Protective Equipment-Types

UNIT II

Factors contributing towards fire-Chemistry of Fire-Types of Fire-Fire extinguishers-types and handling-Fire detection and alarm systems-BLEVE-CVCE and UVCE-Control measures

UNIT III

Hazard Analysis - Types of hazard analysis-hazard identification-HAZOP studies-fault tree analysis-event tree analysis-Failure modes and effects analysis.

Emergency planning-Disaster management plans-Onsite and Offsite emergency planning-Accident Investigation-Purpose and step of investigation-Remedial Measures and rehabilitation of workers

UNIT IV

Occupational health - Concept and spectrum of health - functional units and activities of occupational health services, pre-employment and post-employment medical examinations – occupational related diseases, notifiable occupational diseases such as silicosis, asbestosis, pneumoconiosis, siderosis, anthracosis, aluminosis and anthrax, lead nickel, chromium and manganese toxicity, gas poisoning (such as CO, ammonia, coal and dust etc) their effects and prevention – cardio pulmonary resuscitation, audiometric tests, eye tests, vital function tests.

UNIT V

Occupational physiology - Man as a system component – allocation of functions– efficiency – work capacity aerobic and anaerobic work – evaluation of physiological requirements of jobs – parameters of measurements – categorization of job heaviness – work organization – stress – strain – fatigue – rest pauses – shift work – personal hygiene.

TEXT BOOKS:

1. McCornick, E.J. and Sanders, M.S., Human Factorsin Engineering and Design, 1992, Tata McGraw-Hill.

2. Dan Patterson, Techniques of Safety Management, IV edition, 2003, Mc Graw Hill, Kogakusha.
3. Lees, F.P., Loss Prevention in Process Industries, Vol.I,II and III. 4th edition, Butterworth Heinemann, 2012.

REFERENCES:

1. K.V.Ragavan and A.A.Khan, Methodologies in Hazard Identification and Risk Assessment, Manual by CLRI 1990
2. R.V.Betrabeta and TPS.Rajan,, Safety in Chemical Industry in Chemical Technology-I, Chemical Engg. Division center IIT, Chennai.
3. Handbook of Occupational Health and Safety, NSC Chicago, 1982
4. Encyclopedia of Occupational Health and Safety, Vol. I & II, International Labour Organisation, Geneva, 1985

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand the importance of safety and the types of hazards in industrial environment and the various types of PPE.
2. Recognize the causes of fire and to use the fire extinguishers.
3. Carry out hazard analysis and design emergency management plans.
4. Understand the causes for various occupational diseases.
5. Evaluate the physiological requirements and parameters of measurements such as job heaviness, fatigue, stress, strain, etc.

Mapping with POs & PSOs															
COS	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	1	-	3	2	2	-	1	1	3	3	-	2
CO2	3	1	-	2	-	3	2	-	-	-	-	2	3	3	2
CO3	3	2	1	3	2	3	3	1	2	1	3	1	3	2	3
CO4	1	1	1	1	-	3	2	-	-	3	1	1	2	-	3
CO5	2	2	1	-	-	3	2	1	1	2	1	1	2	1	2

22CHOESCN	**BIOCONVERSION AND PROCESSING OF WASTE**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To give an idea about different biomass and other solid waste materials as energy source and their processing and utilization for recovery of energy and other valuable products.
- A comprehensive knowledge of how wastes are utilized for recovery of value would be immensely useful for the students from all fields.

.

UNIT-I

Biomass definition - resources - properties – classification – availability –estimation of availability, consumption and surplus biomass –energy plantations. Proximate analysis, Ultimate analysis, thermo gravimetric analysis and summative analysis of biomass briquetting

UNIT-II

Biomass pyrolysis – pyrolysis – types, slow fast – manufacture of charcoal, methods, yields and application – manufacture of pyrolytic oils and gases, yields and applications.

UNIT-III

Biomass gasification – gasifiers – fixed bed system – downdraft and updraft gasifiers – fluidized bed gasifiers – design, construction and operation – gasifier burner arrangement for thermal heating – gasifier engine arrangement and electrical power – equilibrium and kinetic consideration in gasifier operation.

UNIT-IV

Biomass combustion – biomass stoves – improved chullahs, types, some exotic designs – fixed bed combustors – types, inclined grate combustors – fluidized bed combustors – design, construction and operation and operation of all the above biomass combustors.

UNIT-V

Introduction to Energy from waste -classification of waste as fuel – agro based, forest residue, industrial waste, MSW – conversion devices – incinerators, gasifiers, digestors. Separation of components of solid wastes and processing techniques, Bioconversion into biogas, mechanism, Composting technique, Bioconversion of substrates into alcohols, Bioconversion into hydrogen, Solvent extraction of hydrocarbons, Fuel combustion into electricity, case studies

TEXT BOOKS:

1. Desai, Ashok V., Non Conventional Energy, 1990, Wiley Eastern Ltd.
2. H.D.Joseph, P.Joseph, H.John, Solid Waste Management, 1993, New York, Van Nostrand,

REFERENCES

1. Khandelwal, K. C. and Mahdi, S. S., Biogas Technology -A Practical Hand Book -Vol. I & II, 1983, Tata McGraw Hill Publishing Co. Ltd.
2. Challal, D. S., Food, Feed and Fuel from Biomass, 1981, IBH Publishing Co. Pvt. Ltd.,
3. C. Y. WereKo-Brobby and E. B. Hagan, Biomass Conversion and Technology, 1996, John Wiley & Sons.
4. G.Tchobanoglous, H.Theisen, S.V.Tchobanoglous, G.Theisen, H.V.Samuel, Integrated Solid Waste management: Engineering Principles and Management issues, 1993, McGraw Hill.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Know about the renewable organic materials and its availability.
2. Understand the principle of thermochemical treatment of biomass and its application in

industry.

3. Know about the gasification process, types of gasifiers and its design considerations.
4. Familiar with the process of biomass combustion, efficiency and applications.
5. Observe the Conversion of biomass through different technologies and its mechanism.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	2	1	1	1	2	1	-	-	-	1	2	1	-
CO2	1	1	2	1	-	1	2	1	-	-	-	1	1	1	-
CO3	2	2	2	1	1	2	3	1	-	-	-	2	2	1	1
CO4	1	1	2	1	2	1	2	1	-	-	-	1	2	1	-
CO5	2	2	3	2	2	2	2	2	-	-	-	2	2	2	-

22**CHOESCN**	**BIOLOGY FOR ENGINEERS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- The course acts as a bridge between engineering and biology to provide basic understanding of biological mechanisms of living systems from engineering perspective.
- It will illustrate the many possible means to utilize living things' relevance to engineering principles.
- With substantial knowledge and continuing interest will make a student into a specialist in the technical diversity.

UNIT I

Requirements of biological systems: Biological Units Need Water; Biological Units Need the Right Amount of Oxygen; Biological Units Need Food and Nutrients; Biological Units Become Ill in the Presence of Wastes; Biological Units Need Heat Sources and Sinks.

UNIT II

Behavior of biological systems: Biological Units Adapt to Their Environments; Biological Units Modify Their Environments; Adaptations Require Extra Energy and Resources; Biological Units, If Possible, Move to Friendlier Environments; Biological Units Evolve under Environmental Pressures.

UNIT III

Response to stress by biological systems: Crowding of Biological Units Produces Stress; Biological Units Are Affected by Chemical Stresses; Biological Units Respond to Mechanical Stresses; Optimization Is Used to Save Energy and Nutrient Resources; Biological Units Alter Themselves to Protect against Harsh Environments.

UNIT IV

Existence of biological systems: Biological Units Cooperate with Other Biological Units; Biological Units Compete with Other Biological Units; Biological Units Reproduce; Biological

Units Coordinate Activities through Communication; Biological Units Maintain Stability with Exquisite Control; Biological Units Go through Natural Cycles; Biological Units Need Emotional Satisfaction and Intellectual Stimulation; Biological Units Die.

UNIT V

Scaling factors and biological engineering solutions: Allometric Relationships from Evolutionary Pressure; Dimensional Analysis; Golden Ratio; Fractal Scaling within an Organism; Self-Similarity for Tissues and Organs; Self-Similarity in Populations; Systems Approach; Relationships between Engineering and Biology; The Completed Design.

TEXT BOOKS:

1. Arthur T. Johnson, "Biology for Engineers", 2000, CRC Press.
2. S. Thyaga Rajan, N. Selvamurugan, M. P. Rajesh, R. A. Nazeer, Richard W. Thilagaraj, S. Barathi, and M. K. Jaganathan, "Biology for Engineers," 2012, Tata McGraw-Hill, New Delhi.

REFERENCES:

1. Aydin Tözeren, Stephen W. Byers, New Biology for Engineers and Computer Scientists, 2004, Pearson/Prentice Hall.

COURSE OUTCOMES

On completion of the course, the students would be able to

1. Understand the information about requirements of living systems.
2. Anticipate the properties of an unfamiliar group of living things from knowledge about a familiar group.
3. Observe the relevance of engineering to biological systems.
4. Exhibit knowledge about biological responses and it is scaling with respect to scientific principles that cannot be related back.
5. Demonstrate biological principles and generalizations that can lead to useful products and processes.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	-	1	-	-	1	2	2	-	-	-	2	2	2	-
CO2	1	1	2	1	-	1	2	1	-	-	-	1	2	2	-
CO3	2	2	2	1	-	2	2	2	-	-	-	2	2	2	-
CO4	1	-	1	1	2	3	2	1	1	-	-	2	2	2	1
CO5	2	1	2	1	2	2	1	1	1	-	-	2	2	2	-

22CHOESCN	**INTELLECTUAL PROPERTY RIGHTS**	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**

COURSE OBJECTIVES:

- To understand the concepts IPR
- To understand Trademarks, Trade Secretes and GI of goods.
- To understand Copyrights, Patents and Industrial Designs.
- To learn about how to manage IP rights and legal aspects.

- To understand the concepts of Cyber laws in IPR.

UNIT - I

Introduction to Intellectual Property: IPR - Definition - Types of IPR: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, IP as a factor in R&D; Few Case Studies WTO - Definition - Functions - Forms of IPR Protection.

UNIT–II

Trade Marks: Purpose and function of trademarks, Acquisition of trade mark rights, transfer of rights, Selecting and evaluating trademark, registration of trademarks, claims.

Trade Secrets: Trade secret law, determination of trade secret status, liability for misappropriation of trade secrets, trade secret litigation. Geographical Indication of Goods: Basic aspects and need for the registration

UNIT–III

Copyrights: Fundamentals of copyright law, originality of material, right of reproduction, right to perform the work publicly, copyright ownership issues, notice of copyright.

Patents: Foundation of patent law, patent searching process, Basic Criteria of Patentability

Industrial Designs: Kind of protection provided in Industrial design

UNIT–IV

Managing IP Rights: Acquiring IP Rights: letters of instruction, joint collaboration agreement.

Protecting IP Rights: nondisclosure agreement, cease and desist letter, settlement memorandum.

Transferring IP Rights: Assignment contract, license agreement, deed of assignment

UNIT-V

Introduction to Cyber law: Information Technology Act, cybercrime and e-commerce, data security, confidentiality, privacy, international aspects of computer and online crime.

Reference Books

1. Bare Act, The Indian Patent Act 1970 and the Patent Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.
2. Mittal D.P., Indian Patents Law. Taxmann Allied Services (p) Ltd., 1999.
3. Deborah E Bouchoux, Intellectual Property: Right: The Law of Trademarks, Copyrights, Patents and Trade Secrets, 2012.
4. Gerald R. Ferrera,Cyber law: Text and Cases, South-Western Cengage Learning, 2012.
5. N.K Acharya, Intellectual property rights, Scandinavian Languages Edition, 2021.
6. Kompal Bansal, Fundamentals of Intellectual Property for Engineers, BS Publications 2013.
7. P. Radhakrishna, Intellectual Property Rights: Text and Cases, Excel Books, 2008.

COURSE OUTCOMES

On completion of the course, the students would be able to

1. Learner should be able to demonstrate understanding of basic concepts of IPR.
2. Able to differentiate between Trademarks, Trade secrets and GI of goods.
3. Able to understand Copyrights, Patents and Industrial Designs.
4. Able to manage and protect IP
5. Will gain Knowledge on Cyber law

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2					2			2	2			2		
CO2	2					2			2	3			2		
CO3	2					3		3	2	2			2		
CO4	2					2		3	2	3			2		
CO5	2					2		3	2	3			2		

22CHOESCN	**NCC Studies (Army Wing) – I (Offered by Faculty of Engineering and Technology)**	**L**	**T**	**P**	**C**
		2	**0**	2	**3**

Course Objective

- This course is designed especially for NCC Cadets. This course will help develop character, camaraderie, discipline, secular outlook, the spirit of adventure, sportsman spirit and ideals of selfless service amongst cadets by working in teams, learning military subjects including weapon training.

Unit – I (Lecture)

NCC Organisation and National Integration

NCC Organisation – History of NCC- NCC Organization - NCC Training- Promotion of NCC cadets – Aim and advantages of NCC Training- NCC badges of Rank- Honours and Awards – Incentives for NCC cadets by central and state govt. National Integration- Unity in diversity- contribution of youth in nation building- national integration council- Factors affecting national integration.

Unit – II (Lecture)

Personality Development and Leadership

Introduction - Factors influencing / shaping Personality - Self-Awareness – Know yourself/ Insight - Communication Skills - Leadership Traits – Types – Attitude - Time Management - Effects of Leadership - Stress Management Skills - Interview Skills - Conflict Motives - Resolution - Importance of Group / Team Work - Influencing Skills - Body Language - Sociability: Social Skills

Unit – III (Lecture)

Social Awareness and Community Development

Aims of Social service-Various Means and ways of social services- family planning – HIV and AIDS- Cancer its causes and preventive measures- NGO and their activities- Drug trafficking- Rural development programmes - MGNREGA-SGSY-JGSY-NSAP-PMGSY-Terrorism and counter terrorism- Corruption – female foeticide -dowry –child abuse-RTI Act- RTE Act- Protection of children from sexual offences act- civic sense and responsibility

Unit – IV (Lecture)

Specialized Subject (Army Wing)

Basic structure of Armed Forces- Military History – War heroes- battles of Indo-Pak war- Param Vir Chakra- Career in the Defence forces- Service tests and interviews-Fieldcraft and Battlecraft-Basics of Map reading.

Unit – V (Practical)

Basic Physical Training and Weapon Training

Basic physical Training – various exercises for fitness (with Demonstration) - Food – Hygiene and Cleanliness. Drill- Words of commands- position and commands- sizing and forming- saluting- marching (WITH DEMONSTRATION)

Main Parts of a Rifle- Characteristics of .22 rifle- Characteristics of 7.62mm SLR- Characteristics of 5.56mm INSAS rifle - stripping and assembling – position and holding- safety precautions – range procedure- firing simulation.

TEXT BOOK:

1. "National Cadet Corps- A Concise handbook of NCC Cadets", Ramesh Publishing House, New Delhi, 2014.

REFERENCES:

1. "Cadets Handbook – Common Subjects SD/SW", published by DG NCC, New Delhi.
2. "Cadets Handbook- Specialized Subjects SD/SW", published by DG NCC, New Delhi.
3. "NCC OTA Precise", published by DG NCC, New Delhi.

COURSE OUTCOMES:

On completion of the course, the students will be able to

1. Display sense of patriotism, secular values and shall be transformed into motivated youth who will contribute towards nation building through national unity and social cohesion
2. Acquaint and provide knowledge on personality development, self awareness, communication skills with leadership traits to work as a team and sociability values
3. Understanding about social evils and shall inculcate sense of whistle blowing against such evils and ways to eradicate such evils

4. Acquaint, expose & provide knowledge about Army/Navy/ Air force and to acquire information about expansion of Armed Forces, service subjects and important battles.
5. Demonstrate health exercises, the sense of discipline, improve bearing, smartness, turnout, develop the quality of immediate and implicit obedience of orders and basic knowledge of weapons and their use and handling.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	-	-	3	2	3	1	1	1	3	3	3	1
CO2	3	-	-	-	-	3	3	3	2	1	-	3	3	3	1
CO3	3	-	-	-	-	3	3	3	-	-	-	3	3	3	2
CO4	3	-	-	-	-	2	2	3	3	2	3	3	3	3	3
CO5	3	-	-	-	-	3	2	3	2	1	2	3	3	3	3

EXTRA ONE CREDIT COURSES

22CHOCSCN	HEALTH, SAFETY AND ENVIRONMENT	L	C
		2	1

COURSE OBJECTIVES:

- Understanding of the fundamental principles of health, safety, and environmental management in the workplace.
- Relevant legal frameworks, regulations, and standards governing workplace health, safety, and environmental management.
- Skills and knowledge necessary to identify, assess, and control workplace hazards and risks related to health, safety, and environmental issues.

Unit – I

Occupational health and safety management:

1. General definitions: Health, safety, environment protection, occupational accident, hazard, risk, near misses, health and safety culture. 2. Key elements for health and safety system 3. Importance of health and safety policy, aim and objective of health and safety policy 4. Health and safety culture, factors influencing health and safety culture 5. Influencing factors for health and safety management.

Unit – II

Safety elements:

1. Philosophy of safety a. Need of safety philosophy b. Nature and subjects of safety philosophy 2. Safety psychology a. Need of safety psychology b. Meaning and aim of safety psychology c. Factors affecting safety at work: attitude, aptitude, frustration, morale, motivation, individual differences.

Unit - III

Environment:

1. Introduction and 5 elements 2. Environmental issues in fire protection, a. Halon and the ozone layer, b. Other special extinguishing agent, c. Water based fire protections, d. Fire protection measures.

Unit – IV

Environmental Audit

Environmental audit a. Need b. procedure c. Benefit 4. Solid waste management a. Definition b. Classification c. Characteristics of solid wasted. Environment impact e. Role of citizen

Unit – V

Various Pollution & its effects on Environment

1. Noise Pollution a) Introduction b) Fundamentals of noise c) Transmission of sound d) The ear and the measurement of hearing e) Noise control 2. Radiation a)Introduction b)The concept

of injury by radiation c) Infra red radiation d)Corpuscular radiation e) Poisoning from radio isotopes 3.Water Pollution a) Introduction b) Sources of water pollution c)Water pollution monitoring d)Control of water pollution Treatment of domestic waste water f)Treatment of industrial waste water.

TEXT BOOKS:

1. Safety, health and working condition in the transfer of technology - International Labor Office, 1988
2. Industrial Safety, Health and environment Management system - RK Jain and Sunil S Rao, 2000

REFERENCES:

1. Publications from Inter National Standard Organizations like ISO, OSHA, IOSH, NEBOSH etc.
2. Encyclopedia of occupational health and safety- International Labor Office, 2012

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. identify and assess workplace hazards related to health, safety, and environmental issues.
2. design and implement effective workplace health, safety, and environmental programs.
3. evaluate and manage risks associated with health, safety, and environmental issues in the workplace.
4. demonstrate an understanding of the relevant legal frameworks, regulations, and standards governing workplace health, safety, and environmental management.
5. foster a culture of safety and environmental responsibility in the workplace through effective communication, leadership, and collaboration.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-
CO2	3	3	3	3	-	-	-	-	-	-	-	-	3	-	-
CO3	3	3	2	2	3	-	-	-	-	-	-	-	3	-	-
CO4	3	3	2	2	-	-	3	3	3	3	3	3	3	-	-
CO5	3	3	2	2	-	-	3	-	3	3	-	3	3	-	-

22CHOCSCN	EXPLOSIONS AND INDUSTRIAL FIRE SAFETY	L	C
		2	1

COURSE OBJECTIVES:

- Basic principles of fire safety, the science of fire, the elements that contribute to its occurrence and the different types of fires that can happen in an industrial setting.
- Identify potential fire hazards in an industrial setting, including combustible materials, ignition sources, and other factors that can contribute to fire risk.
- Analyze and evaluate real-world fire incidents in industrial settings, including the causes of the fire, the effectiveness of the response, and strategies for preventing similar incidents in the future.

Unit – I

Introduction to Explosion Characteristics:

Background – Burchfield explosion case study. Other similar explosion incidents; Explosion hazards; Stoichiometry for gases- Introduction, Calculation for air, Calculation for O2; Stoichiometry for general hydrocarbons and wood (Air to fuel ratio); Application of stoichiometry- Naphtha storage tank example, Burner startup ;Boiler firebox explosion.

Unit – II

Flammability limits and Theories:

1. Lean limit and Rich limit, 2. LEL &UEL measurement techniques and equipment, 3. Minimum ignition energy, 4. Relation between auto-ignition temperature and flash point, 5. Effect of temperature and pressure on flash point, 6. Classification of flammable materials, 7. Vapour tank explosion, a. TWA flight 800 Disaster.

Unit - III

Explosion Prevention and Protection

1. Explosion prevention techniques-a. Ventilation. Separation. Physical barriers. Alternative techniques,2.Preventing the formation of explosive atmosphere,3.Explosion protection systems - a. Protection techniques- Containment, Isolation, Suppression, Venting, ventilation for explosion protection system, c. Explosion protection using inert gases,4.Flame arrest or sand quenching distance.

Unit – IV

Safety Management

Concept of Safety, Industrial Accidents, Reasons for Accident Prevention, Function of Safety Management, Safety Organizations, Objectives of Safety Organizations, Role of Industrial Organization (Safety),Essential Requirements of Safety Programs, Plant Safety Rules and Procedures, Formulation of Rules, Types of Rules, Violation of Rules, Reduction of Hazards.

Unit – V

Safety in Miscellaneous Industries

Hazards and Safety Measures for Welding Process, Types of Welding Processes, Precaution and Safety, Fertilizer Industry, Pesticides Industry, Lethal Dosages, Manipulation Process and Their Hazards and Controls, Textile Industry, Steel Industry, Chemical Hazards.

TEXT BOOKS:

1. Handbook of fire and Explosion Protection Engineering Principles for Oil, Gas, Chemical and Related Facilities-Dennis. P. Nolan Fourth Edition, 2019
2. National Fire Protection Association Handbook, 20th Edition

REFERENCES:

1. Hazards in Process Industries – Hidup Suatu Pendakian
2. Industrial Safety Management -N.K.Tarafdar, K.J Tarafdar
3. Industrial Safety-National Safety Council of India

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. develop comprehensive fire safety plans for industrial settings that include procedures for fire prevention, detection, and suppression, as well as emergency response and evacuation plans.
2. identify potential fire hazards in industrial settings and implement measures to mitigate them, such as installing fire detection and suppression systems, controlling fuel sources, and ensuring proper storage of hazardous materials.
3. demonstrate an understanding of relevant fire safety regulations, such as OSHA standards, and implement measures to ensure compliance.
4. conduct fire safety inspections in industrial settings, identifying potential hazards and ensuring that fire safety systems and equipment are functioning properly.
5. analyze and evaluate real-world fire incidents in industrial settings, identifying root causes and developing recommendations for prevention and response in the future.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	-	-	-	-	3	-	-	-	3	-	-
CO2	3	3	2	2	-	-	3	-	3	-	-	-	3	-	-
CO3	**3**	**3**	2	2	-	-	-	-	3	-	-	-	3	-	-
CO4	3	3	2	2	-	3	-	-	3	3	-	3	3	-	-
CO5	3	3	2	2	3	3	3	-	3	3	3	3	3	-	-

HONOUR ELECTIVE COURSES

22CHHE601	ADVANCED HEAT TRANSFER	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES:

- To apply scientific and engineering principles to analyze thermofluid aspects of engineering systems
- To use appropriate analytical and computational tools to investigate the steady state and unsteady state heat transfer phenomena
- To understand the heat transfer mechanisms in fluids and their applications in various heat transfer equipment in process industries.
- To recognize the broad technological context of heat transfer, especially related to energy technology

Unit - I

Transient heat conduction. Extended surfaces and fins. Numerical solutions for one-dimensional and two-dimensional steady state heat conduction problems. Unsteady state conduction: unidimensional and multidimensional systems-Use of transient heat conduction charts.

Unit - II

Convective heat transfer: theories and practice-energy equation for thermal boundary layer over a flat plate. Momentum and heat exchange in turbulent fluid flow- empirical equations for forced and free convection based on experimental results.

Unit - III

Heat transfer with change of phase: Phenomena of boiling and condensation- Regimes of pool boiling-heat transfer during boiling-dropwise and filmwise condensation-effects of turbulence and high vapour velocity on filmwise condensation.

Unit - IV

Compact heat exchangers: plate and spiral type heat exchangers-finned tube heat exchangers- heat pipes-regenerators and recuperators.

Unit - V

Special topics in heat transfer: Heat transfer in magneto fluidynamic systems-transpiration cooling-ablation-heat transfer in liquid metals-heat transfer in fluidized beds- heat transfer processes in nuclear reactors

TEXT BOOKS:

1. Knudsen.J.G., D.L.Katz, Fluid Dynamics and Heat Transfer, 1958, McGraw-Hill, New York.
2. Jacob.M., Heat Transfer, 1962, John Wiley, New York.

REFERENCES:

1. Mc Adams, Heat transmission, 1954, McGraw Hill, New York.
2. Holman.J.P., Heat Transfer, 8th edition , 1997, McGraw Hill, New York

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand and use appropriate analytical and computational tools to investigate the steady state and unsteady state heat transfer phenomena.
2. Acquire knowledge on heat transfer mechanisms in fluids and their applications.
3. Understand the various conditions of boiling and condensation
4. Acquire knowledge and design compact heat exchangers for industrial applications
5. Understand heat transfer phenomena in special conditions like electronic cooling and energy technology.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	2	2	2	2	2	-	2	2	3	2	2
CO2	3	3	3	2	2	2	2	2	2	-	2	2	3	2	2
CO3	3	3	3	2	2	2	2	2	2	-	2	2	3	2	2
CO4	3	3	3	2	2	2	2	2	2	-	2	2	3	2	2
CO5	3	3	3	2	2	2	2	2	2	-	2	2	3	2	2

22CHHE602	**ADVANCED THERMODYNAMICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- This course will help to interpret, correlate, and predict thermodynamic properties used in mixture-related phase-equilibrium calculations.
- Basic statistical mechanical principles and intermolecular forces will be discussed, and applied to the correlation and prediction of thermodynamic properties and phase equilibria.
- Concepts of statistical thermodynamics along with classical thermodynamics, molecular physics, and physical chemistry will be applied to solve real-world problems.

Unit - I

Thermodynamic properties with independent variables P & T, fugacity of a component in a mixture at moderate pressures, thermodynamic properties with independent variables V and T, fugacity of component in a mixture according to Vander Waals equation.

Unit - II

Lewis fugacity rule, Virial equations of state, Extension to mixtures, fugacities from virial equation, calculation of virial coefficients from potential functions, third Virial coefficients, Virial coefficients from corresponding states correlation, fugacities from generalized charts for pure components, fugacities from an empirical equation of state.

Unit - III

Ideal solution, fundamental relations of Excess function, Activity and activity coefficients, Normalization of activity coefficients, activity coefficients from excess functions in binary mixtures application of Gibbs Duhum equation - Thermodynamic consistency tests, Whol's expansion for Excess gibbs energy, Wilson, NRTL and UNIQUAC equation, multi component mixtures Excess functions using Whols, Wilson, NRTL and UNIQUAC.

Unit - IV

Theory of Van laar, Scat chard - Hildelrand theory, Lattice theory Wilson's empirical extension of the Flory - Huggin's equation, two liquid theory, chemical theory - Ideal gas solubility, Henry's law and its thermodynamic significance, effect of pressure and temperature on gas solubility. Estimation of gas solubility, Ideal solubility, Non ideal solutions, solubility of solid in a mixed solvent, solid solutes.

Unit - V

Chemical Reaction equilibria - Homogenous simple reactions, Heterogenous reactions, High pressure vapour liquid equilibria studies.

TEXT BOOKS:

1. John M. Prausnitz, Lichten Thaler R.N. & de Azeredo E.G Molecular thermodynamics of fluid phase equilibria, 2nd edn;, prentice Hall Inc., Engle wood cliffs NJ, 1986.
2. Hougen O.A., Watson K.M., Ragatz, R.A., Chemical process principles part II, Asia publishing house, Madras 1969.
3. J.M. Smith, H.C. Vannes, M.M. Abbotta, Introduction to chemical engineering thermodynamics, 5l Edn;, McGrawHill International edn., 1996

REFERENCES:

1. J.M. Smith. H.C.Van Ness and M.M.Abott. "Introduction to Chemical Engineering Thermodynamics, 5th ed. 1996 McGraw Hill International edition

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Formulate solutions to phase equilibrium problems
2. Knowledge on principles and methods to apply various models / equations for VLE computations for non ideal systems
3. Application of various activity coefficient models

4. Understand the behaviour of solutions for industrial applications
5. Insight on chemical reaction equilibria concepts and high pressure VLE computations

Mapping with POs & PSOs															
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	2	3	-	-	-	-	-	-	-	2	3	2	2
CO2	3	2	3	2	-	-	-	-	-	-	-	2	3	2	2
CO3	3	2	3	2	-	-	-	-	-	-	-	2	3	2	2
CO4	3	-	2	2	3	-	-	-	-	-	-	2	3	2	2
CO5	3	-	2	3	-	-	-	-	-	-	-	2	3	2	3

22CHHE701	**ADVANCED PROCESS CONTROL SYSTEMS**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

COURSE OBJECTIVES:

- To impart advanced knowledge on the concepts of chemical process control
- To give an idea on in-depth analysis of various processes and to get the input/output data
- To study the effect of time domain analysis and frequency domain analysis of a process
- To study about multivariable processes, Z-transform and stability analysis and an in-depth idea of identification of processes

Unit - I

Introduction: Some important Simulation results, General Concepts and terminology, Laws, Languages and Levels of process control. Time Domain Dynamics: Classification and definition, linearization and perturbation variables, responses to simple linear systems, solutions using MATLAB.

Unit - II

Laplace - Domain Dynamics, Laplace- Domain Analysis of conventional feedback control systems Laplace-Domain analysis of advanced control systems. Frequency-domain Dynamics and Control: Frequency-Domain Dynamics, Frequency-Domain analysis of closed loop systems.

Unit - III

Conventional control systems and Hardware: Control Instrumentation performance of feedback controllers,Controller tuning.Advanced control systems: Ratio control, cascade control, override control, computed variable control, nonlinear and adaptive control, valve position control, feed forward control aspects, control design concepts.

Unit - IV

Interaction between steady state design and dynamic control lability qualitative examples, simple quantitative example, impact of controllability on capital investment and yield, general trade-off between controllability and thermodynamic reversibility, dynamic controllability, plant wide control.

Unit - V

Multivariable processes: Matrix representation and analysis, Design of Controllers for multivariable processes, sampling, Z_Transform and stability, stability analysis. Process identification: Fundamental concepts, direct methods, pulse testing, relay feedback identification, Least-square methods, use of MATLAB identification Toolbox.

TEXT BOOK:

1. Luyben.M.L, W. L.Luyben, Essentials of Process Control, 1997, McGraw Hill International

REFERENCES:

1. B. Wayne Bequette, Process Control: Modeling, Design, and Simulation, 2003, Prentice Hall Professional.

COURSE OUTCOMES

On completion of the course, the students would be able to

1. Impart advanced knowledge on the concepts of chemical process control.
2. Analyse various processes to get the input/output data.
3. Study the effect of time domain analysis and frequency domain analysis of a process.
4. Apply various computer architecture for the study of inputs to various complex systems and to get their output.
5. Understand multivariable processes, Z-transform and its application in multivariable processes and in-depth idea of identification of processes.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	2	-	2	-	-	-	-	3	3	2	3
CO2	3	3	2	2	-	-	2	-	-	-	-	3	3	2	3
CO3	3	3	2	2	-	-	2	-	-	-	-	3	3	2	3
CO4	3	3	2	2	-	-	2	-	-	-	-	3	3	2	3
CO5	3	3	2	2	2	-	2	-	-	-	-	3	3	2	3

22CHHE702	ADVANCED FLUIDIZATION ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the fluidization phenomena, industrial applications of fluidized beds and
- To acquire knowledge on their operational and design aspects.
- To know the mathematical models of Fluidized Bed

Unit - I

The phenomenon of Fluidization - Liquid like behavior of a Fluidized Bed – Comparison with Other contacting Methods – Advantages and Disadvantages of Fluidization - Types of Fluidization Operations. Applications of fluidized bed: Physical Operations – Synthesis Reactions – Cracking and Reforming of Hydrocarbons – Carbonization and Gasification – Calcining and Clinkering – Gas Solid Reactions

Unit - II

Minimum Fluidizing Velocity, Terminal Velocity and Pressure Drop in Fluidized Beds – Types of Fluidization, bubble formation and importance of the distributors – Voidage in Fluidized Beds – Transport Disengaging Height, TDH – Variation in Size Distribution with height – Viscosity and Fluidity of Fluidized Beds – Power Consumption

Unit - III

Single Rising Bubbles – Stream of Bubbles from a Single Source – Bubbles in Ordinary Bubbling Beds – The Bubbling Bed Model for the Bubble Phase Movement of Individual Particles – Turnover of Individual Particles – Residence Time Distribution of solids – The Diffusion Model for Movement of Solids – The Bubbling model for the Emulsion Phase – Interpretation of Solids Mixing Data in terms of the Bubbling Bed Model

Unit - IV

The Bubbling Bed Model for Gas Interchange – Interpretation of Gas Mixing Data in Terms of the Bubbling Bed Model. Experimental Findings of Mass Transfer – Mass Transfer Rate from the Bubbling Bed model – Experimental Findings on Heat Transfer – Heat Transfer Rate from the Bubbling Bed Model - Two Region Models – K-L Model

Unit - V

Entrainment and elutriation, Freeboard behavior, gas outlet, entrainment from tall vessel, freeboard entrainment model, high velocity fluidization, pressure drop in turbulent and fast fluidization, Slugging, Spouted beds – Channeling – Design aspects of fluidized bed systems – Collection of fines

TEXT BOOKS:

1. Daizo Kunii, Octave Levenspiel, Fluidization Engineering, 1985, John Wiley & Sons, inc., New York
2. Davidson.J.F., Cliff.R., Harrison.D., Fluidization, II Edition, 1985, Academic press, London,

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Explain the concepts of fluidization phenomena and operational regimes
2. Understand the behavior of fluidized beds with respect to the gas velocity
3. Estimate pressure drop, bubble size, voidage, heat and mass transfer rates of the fluidized beds
4. Develop various mathematical models of the fluidized bed
5. Analyze the design aspects of fluidization systems

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	2	2	-	-	-	-	2	-	-	3	2	3
CO2	2	3	2	-	-	-	2	-	-	2	2	2	3	3	3
CO3	3	3	3	2	-	-	-	-	-	-	2	-	3	3	3
CO4	3	2	-	3	-	-	-	-	2	-	-	2	3	2	3
CO5	3	-	2	3	3	2	2	2	2	-	3	2	3	2	3

22CHHE801	**APPLICATION OF NANOTECHNOLOGY IN CHEMICAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the fundamentals of the preparation and properties of nanomaterials from a chemical engineering perspective.
- To gain knowledge of structure, properties, manufacturing, and applications of various nanomaterials and characterization methods in nanotechnology
- To give a survey of the key processes, principles, and techniques used to build novel nanomaterials and assemblies of nanomaterials

Unit – I: Introduction

Introduction to nanotechnology, Feynman's Vision-There's Plenty of Room at the Bottom, Classification of nanostructures, Nanoscale architecture, Chemical interactions at nanoscale, Types of carbon based nanomaterials, Synthesis of fullerenes, Graphene, Carbon nanotubes, Functionalization of carbon nanotubes, One, two and multidimensional structures, Crystallography.

Unit – II: Approaches to Synthesis of Nanoscale Materials

Top down approach, Bottom up approach Bottom-up vs. top-down fabrication; Top-down: Atomization, Sol gel technique, Arc discharge, Laser ablation, RF sputtering; Bottom-up: Chemical Vapor Deposition (CVD), Metal Oxide Chemical Vapor Deposition (MOCVD), Atomic layer deposition (ALD), Molecular beam Molecular self-assembly; Ultrasound

assisted, microwave assisted, Mini, micro and nanoemulsion. Wet grinding method, Spray pyrolysis, Ultrasound assisted pyrolysis, atomization techniques. Surfactant based synthesis procedures, Types of molecular modeling methods.

Unit – III: Characterization of Nanoscale Structures and Surfaces

Size, shape, crystallinity, topology, chemistry analysis using X-ray imaging, Transmission Electron Microscopy, HRTEM, Scanning Electron Microscopy, SPM, AFM, STM, PSD, Zeta potential, DSC and TGA.

Unit – IV: Semiconductors and Quantum dots

Intrinsic semiconductors, Extrinsic semiconductors, Review of classical mechanics, de Broglie's hypothesis, Heisenberg uncertainty principle Pauli exclusion principle Schrödinger's equation Properties of the wave function, Applications: quantum well, wire, dot, Quantum cryptography

Unit – V: Polymer-based and Polymer-filled Nanocomposites

Nanoscale Fillers, Nanofiber or Nanotube Fillers, Plate-like Nanofillers, Equi-axed Nanoparticle Fillers, Inorganic Filler Polymer Interfaces, Processing of Polymer Nanocomposites, Nanotube/Polymer Composites, Layered Filler Polymer Composite Processing, Nanoparticle/Polymer Composite Processing: Direct Mixing, Solution Mixing, In-Situ Polymerization, In-Situ Particle Processing, In-Situ Particle Processing Metal/Polymer Nanocomposites, Properties of nanocomposites.

TEXT BOOKS:

1. Louis Hornyak G., Dutta Joydeep, Tibbals Harry F. and Rao Anil K., "Introduction to Nanoscience", 2008, Taylor and Francis.
2. Ajayan P. M., Schadler L. S., Braun P. V., "Nanocomposite Science and Technology", 2003, Wiley.

REFERENCES:

1. Kelsall Robert W., Hamley Ian W., Geoghegan Mark, "Nanoscale Science and Technology", 2006, John Wiley & Sons, Ltd
2. Kal Ranganathan Sharma, "Nanostructuring Operations in Nanoscale Science and Engineering", 2010, McGraw-Hill Companies, Inc.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Illustrate the basics of nano science.
2. Synthesize nano materials through various methods.
3. Characterize nano materials.
4. Explain about Semiconductors and Quantum dots.
5. Distinguish polymer based nano materials.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	-	2	2	2	2	2	2	2	3	2	3
CO2	2	2	3	3	3	2	2	2	-	1	2	3	2	3	2
CO3	2	3	2	2	-	2	2	2	-	2	-	2	3	3	2
CO4	3	2	2	2	2	2	2	2	2	-	2	3	3	2	3
CO5	2	3	2	2	-	2	2	2	2	2	2	2	2	2	3

22CHHE802	**HETEROGENEOUS REACTOR DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To impart knowledge on catalytic reactions and catalyst preparation
- To develop the knowledge of the impact of mass and heat transfer effects on heterogeneous reactions.
- To understand multiphase reactors (gas-liquid and fluid-solid reactions) concept in heterogeneous reactor
- To analyse and design of different heterogeneous reactor

Unit - I

Catalyst and characterization: Introduction catalysts and reactions – catalyst preparation – characterization of catalyst – characterization of support, catalyst deactivation: deactivation by sintering – coking or fouling – poisoning – moving bed reactor.

Unit - II

Catalytic reactions, rate controlling steps, Langmuir-Hinshelwood model, Rideal-Eiley mechanism.

Unit - III

External diffusion effects in heterogeneous reactions- mass and heat transfer coefficients in packed beds, quantitative treatment of external transport effects, modeling diffusion with and without reaction-Internal transport process-porous catalyst- Intrapellet mass and heat transfer, evaluation of effectiveness factor, mass and heat transfer with reaction.

Unit - IV

Fluid-Fluid reactors- Rate equations – Kinetic regimes

Unit - V

Analysis and design of heterogeneous reactors- packed bed reactors - two-phase fluidized bed model- slurry reactor model- trickle bed reactor model-experimental determination and evaluation of reaction kinetics for heterogeneous systems-application to design reactors with particles of single size - mixture of particles of different sizes under plug flow and mixed flow conditions

TEXT BOOKS:

1. Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, 1997, John Wiley & Sons.
2. J.M. Smith, Chemical Kinetics, 3rd Edition,1984, McGraw Hill.

REFERENCES:

1. Froment, G. F. and Bischoff, K. B., "Chemical Reactor Design and Analysis", 2nd Edition, 1997, John Wiley & Sons, New York.
2. Sharma, M.M. and Doraiswamy, L.K., "Heterogeneous reactions: Analysis, Examples and Reactor Design". Vols. I & II, 1984, John Wiley and Sons, NY,

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Acquire knowledge about catalysts.
2. Understand about heterogeneous catalytic reaction mechanisms.
3. Analyse about heat and mass transfer in heterogeneous reactions.
4. Gain knowledge on fluid-fluid reaction kinetics.
5. Design and analyze industrial heterogeneous reactors.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	2	2	-	-	-	-	3	3	2	3
CO2	3	3	2	-	-	2	2	-	-	-	-	3	3	2	3
CO3	3	3	3	3	-	2	2	-	-	-	-	3	3	2	3
CO4	3	3	3	3	-	2	2	-	-	-	-	3	3	2	3
CO5	3	3	3	3	3	2	2	-	-	-	-	3	3	2	3

MINOR ENGINEERING COURSES

22CHMI601	BASIC PRINCIPLES OF CHEMICAL ENGINEERING	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES:

- The course will serve as a basis for all further engineering courses that are part of the curriculum

UNIT –I: Introduction

Stoichiometric and composition relations, Excess and limiting reactants, Degree of completion.

Ideal Gas: Ideal gas law and its applications. Dissociating gases, gas mixture & Vapour pressure -Effect o temperature Vapour pressure plots. Vapour pressure of immiscible Liquids. Raoult's law, relative vapor pressure.

UNIT – II: Humidity and saturation

Humidity chart. Relative & percent saturation evaporation and condensation processes. Solubility and crystallization: Mass balance and yield calculations in dissolution and crystallization processes. Solubility of gases (Henry's law)

UNIT – III: Material Balance

Calculation for Batch and Continuous Processes, Recycling Process, by pass and purging operation.

UNIT – IV: Fuel and Combustion

Fuels and Combustion: Problems on combustion of solids, liquids and Gaseous fuels and pyrites. Two stage conversion of SO_2 to SO_3.

UNIT – V: Thermo Physics and Thermo Chemistry

Mean specific heat. Heat of fusion & vaporization. Heat of formation, combustion and reaction. Degree of conversion based on inlet and outlet temperature. Enthalpy - Hess law. Theoretical flame temperature.

TEXT BOOKS:

Hougen,O.A.,Watsen,K.M., and R.A.Ragartz, Chemical Process Principles, part -I, 1975, John Wiley and Asia Publishing Co.

REFERENCES :

1. Bhatt,B.L, and S.M.Vohra, Stoichiometry, Tata McGraw Hill. 3rd ed

2. Himmelblau,D.M.,Basic Principles and Calculations in chemical Engineering. 2nd ed. 1967
3. Mayers and seider, Introduction to chemical Engineering and computer calculations, 3rd ed. 1982, Prentice Hall.
4. Asokan, K., Chemical Process Calculations, First Edn., 2007, Universities Press, Hyderabad.

COURSE OUTCOMES

On completion of the course, the students would be able to

1. Understand the concepts of stoichiometry and explain the gas laws and equations.
2. Interpret humidity chart.
3. Discuss the basics of material balance.
4. Calculate combustion efficiency for different fuels.
5. Explain the concepts of thermo physics and thermo chemistry.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	-	-	1	-	-	-	-	-	-	3	2	-
CO2	3	2	1	-	-	1	-	-	-	-	-	-	3	2	-
CO3	3	2	1	-	-	1	-	-	-	-	-	-	3	2	-
CO4	3	2	1	-	-	1	-	-	-	-	-	-	3	2	-
CO5	3	2	1	-	-	1	-	-	-	-	-	-	3	2	-

22CHMI602	**ORGANIC & INORGANIC CHEMICAL TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- Impart clear description of one latest process along with its Chemistry, Process parameters, Engineering Problems and Optimum Conditions.
- To improve knowledge of the chemical processes along with emphasis on recent technological development
- To understand unit operations involved in the physical separation of the products obtained during various unit processes.
- To study process technologies of various organic and inorganic process industries
- Appreciate the usage of other engineering principles such as Thermodynamics, Heat, mass and momentum transfer in operation and maintain the productivity.

UNIT -I

Industrial gases: Carbon dioxide, Hydrogen, Oxygen, Nitrogen and synthesis gas. Sulfur, Sulfuric Acid, Hydrochloric acid, Chlor-Alkali Industry: Sodium chloride, Soda ash, Sodium Bi-Carbonate, Chlorine, Caustic soda.

UNIT -II

Nitrogen Industry: Ammonia, Ammonium sulfate, Ammonium Nitrate, Ammonium Phosphate, Ammoniumchloride, urea, Nitric acid, Nitro Phosphate, cyanamide. Phosphorous Industry- Phosphorus, phosphoric acid Calcium phosphate, Sodium phosphate, Di and Triammonium phosphate, Mixed Fertilizers and compound super phosphates.

UNIT-III

Silicate industry : Ceramics, Glass and Cement, paint, Varnish, Enamel and Lacquer, White lead, Zinc oxide, Lithophone, Titanium di oxide. Fermentation products, absolute alcohol, penicillin.

UNIT - IV

Sugar, starch, glucose, pulp, paper, leather, glue and gelatin.Petroleum refining Processes, Oils, fats, soaps, glycerin, synthetic detergents

UNIT - V

Plastics - Phenol, vinyl, and urea formaldehydes; polypropylene and silicone. Elastomers, Natural and Synthetic fibers, Cellulose acetate, viscose rayon, Nylon, polyester.

TEXT BOOKS:

1. Austin.G.T., Shreve's Chemical Process Industries, Fifth Edn., 1984, McGraw Hill.
2. Gopal Rao,M., and M. Sittig., Dryden's Outlines of Chemical Technology, 2nd edition, 1979 Affiliated East West Press.

REFERENCES:

1. Kirk and Othmer, Encyclopedia of Chemical Technology, 5th edition, 2005, John Wiley.
2. Pandey,GN., A Text Book of Chemical Technology, 1997, Vikas Publishing Company, Vol. II,

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand the processes involved in manufacturing of various inorganic and organic chemicals
2. Read and interpret basic process industry drawings
3. understand the process flow diagrams.
4. Analyze important process parameters and engineering problems during production.
5. Suggest manufacturing process for a chemical.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	-	3	-	-

22CHMI701	CHEMICAL ENGINEERING OPERATIONS	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES:

The principles learnt in this course are required in almost all the courses and throughout the professional career of Chemical Engineer

UNIT-I

Introduction to Unit Operations and Chemical Engineering Processes. Single Equilibrium Stage, Binary vapor–liquid systems, bubble-point, and dew-point calculations. Absorption and Stripping of dilute mixtures: Fundamentals of absorption, equilibrium curves, Operating lines from material balances, Number of equilibrium stages.

UNIT-II

Distillation of binary mixtures: Differential distillation, Flash or equilibrium distillation, Fractionating column and multistage column, design and analysis factors, degrees of freedom, specifications, reflux, reflux ratio, need for reflux,

UNIT-III

Particulate solids: Particle characterization Shape, size, particle size measurement, Particle size analysis in process equipment. Particle Size Reduction: Necessity for size reduction of solids, Mechanism for size reduction, Energy requirements for size reduction and scale-up considerations, Operational considerations, Crushing and grinding equipment: impact and roller mills, fluid energy mills, wet/dry media mills

UNIT-IV

Liquid Filtration: Filtration theory: constant pressure, constant rate, and variable pressure-variable rate filtration, Incompressible and compressible cake filtration, Continuous filtration, filter aids, Filtration equipment. Sedimentation, Classification and Centrifugal Separations: Design and scale up equations, Performance evaluation, Sedimentation equipment, classifiers, centrifugal equipment, Sieving operations, types of sieving (dry, wet, vibro), magnetic separators, and froth flotation.

UNIT-V

Drying of solids: Mechanism of drying, drying rate curves, Estimation of drying time , Drying Equipment, operation.

TEXT BOOKS:

1. Richardson, J.F., Coulson, J.M., Harker, J.H., Backhurst, J.R., Chemical engineering: Particle technology and separation processes. 2002, Butterworth-Heinemann, Woburn, MA.
2. McCabe, W., Smith, J., Harriott, P., Unit Operations of Chemical Engineering, 7 ed. 2004, McGraw- Hill Science/Engineering/Math, Boston.

REFERENCES:

1. Green, D., Perry, R., Perry's Chemical Engineers' Handbook, Eighth Edition, 8 ed. 2007, McGraw-Hill
2. Dutta, B.K., Principles of Mass Transfer and Separation Process.2007, Prentice-Hall of India Pvt. Ltd, New Delhi.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Estimate thermodynamic properties of substances in gaseous ,liquid states and determination of thermodynamic efficiency in various energy related processes
2. Understand the separation of binary mixtures using distillation column.
3. Select suitable size reduction equipment, solid-solid separation method and conveying system
4. Evaluate the parameters of various filtration equipment and sedimentation
5. Understand the drying characteristics and mechanism of different types of dryers

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	2	2	2	2	-	-	-	3	3	2	3
CO2	3	3	3	2	2	2	2	2	-	-	-	3	3	2	3
CO3	3	3	3	2	2	2	2	2	-	-	-	3	3	3	3
CO4	3	3	3	2	2	2	2	2	-	-	-	3	3	3	2
CO5	3	3	3	2	2	2	2	2	-	-	-	3	3	3	2

22CHMI702	BASICS OF FLUID MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop an understanding of fluid statics and dynamics in chemical engineering
- To understand and use differential equations to determine pressure and velocity variation in fluid flows.
- To understand the concept of viscosity
- To use dimensional analysis to design physical or numerical experiments

UNIT I: Fluid statics and its applications

Unit systems-conversion of units- Dimensional analysis-Basic concepts; fluid mechanics

Hydrostatic equilibrium-application of fluid statics-manometers, continuous gravity decanter and centrifugal decanter

UNIT II: Fluid flow phenomena

Rheological properties of fluids-laminar and turbulent flow-boundary layers

Basic equations of flow- continuity equation, mechanical energy equation. Bernoulli equation and correction factors, pump work in Bernoulli equation.

UNIT III: Flow of incompressible fluids

Incompressible flow in pipes-shear stress and skin friction in pipes, friction factor, flow in noncircular channels, laminar and turbulent flow in pipes and channels, friction factor chart, friction loss from sudden contraction and expansion

UNIT IV: Flow past immersed bodies

Drag and drag coefficients, flow through beds of solids-Ergun's equation. Motion of particles through fluids-terminal velocity, Stoke's law and Newton's law. Hindered settling.

UNIT V: Transportation and metering of fluids

Pipes, fittings and valves. Pumps - power requirement, suction lift and cavitation. Classification of pumps - positive displacement and centrifugal pumps. Introduction to fans, blowers and compressors, selection criteria of pumps.

Measurement of flowing fluids-venturi meter, orifice meter, rotameter, pitot tube, magnetic flow meter.

TEXT BOOKS:

1. McCabe,W.L, Smith,J.C and P.Harriot., Unit Operations of Chemical Engineering, Seventh Edn., 2005, McGraw Hill
2. Noel De Nevers, Fluid Mechanics for Chemical Engineers, Third Edn.,2005, McGraw Hill.

REFERENCES:

1. J.M.Coulson, J.F. Richardson's, Chemical Engineering, Vol.1., VI Edition, 1999.

COURSE OUTCOMES

On completion of the course, the students would be able to

1. Perform dimensional analysis and explain basic concepts of fluid flow.
2. Apply Bernouli principle and compute pressure drop in flow systems of different configurations
3. Explain flow characteristics of incompressible fluids.
4. Compute power requirement in fixed bed system and determine minimum fluidization velocity in fluidized bed
5. Determine and analyze the performance aspects of fluid machinery.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	-	1	-	-	2	-	2	2	3	2	-
CO2	3	3	3	3	3	2	3	2	2	2	2	2	3	3	2
CO3	3	3	3	3	3	2	2	2	2	2	2	2	3	3	2
CO4	3	3	3	3	3	2	2	2	2	2	2	2	3	3	2
CO5	3	3	2	2	3	2	3	2	2	2	2	2	3	2	3

22CHMI 801	**BASIC PRINCIPLES OF CHEMICAL REACTION ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To provide basic knowledge on the selection of right type of reactor for the required reaction.
- To familiarize the students' knowledge on reaction kinetic principles and different type of reactors.
- To gain knowledge on ideal and non-ideal flow conditions.
- To gain knowledge on adiabatic and non-adiabatic conditions
- To familiarize the students' knowledge on non-ideal parameters.

UNIT I

Thermodynamic Restrictions, chemical Kinetics, types of complex reactions, rate equation-Temperature dependency of rate equation.

UNIT II

Interpretation of rate data in variable and constant volume systems, concentration dependency.

UNIT III

Ideal reactors: Concepts of Ideality, development of design expressions for Batch, Tubular, Stirred tank, Semi batch and Recycle reactors, Combined reactor system, comparison, advantages and limitations in application-Isothermal reactors design.

UNIT IV

Thermal characteristics of reactors, adiabatic and non-adiabatic conditions, principles of reactor stability and optimization.

UNIT V

Residence time distribution: Residence time functions and relation among them, Application to non ideal reactors-modeling of real systems. Non-ideality parameters, prediction of reactor performances, concept of macro mixing.

TEXT BOOKS:

1. Octave Levenspiel, Chemical Reaction Engineering, 3rd edition, 2006, Wiley Eastern,
2. K.A. Gavhane, Chemical Reaction Engineering -I, 10th edition, 2008, Nirali Prakashan,

REFERENCE BOOKS:

1. Fogler .S "Fundamental Chemical Reaction Engg", Prentice Hall of India, 2nd edition, 1992.
2. Smith,J.M., Chemical Engineering Kinetics, 3rd edition, McGraw Hill, 1981.

COURSE OUTCOMES

On completion of the course, the students would be able to

1. Select right type of reactor for specific type of process.
2. Interpret rate data.
3. Develop design expressions for different reactors.
4. Understand thermal characteristics of reactors.
5. Predict reactor performances and non-ideality.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	-	2	-	-	-	-	-	3	3	3	3
CO2	3	3	3	3	-	-	2	-	-	-	-	3	3	3	3
CO3	3	3	3	3	3	-	3	-	-	2	-	3	3	2	3
CO4	3	3	3	3	-	2	-	-	-	-	-	3	3	2	3
CO5	3	3	3	3	-	3	2	-	-	-	-	3	3	2	3

22**CHMI802**	**PROCESS ENGINEERING & ECONOMICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- Explain the principles of cost estimation, feasibility analysis, management, organization and quality control that will enable the students to perform as efficient managers.
- Describe the role of economic evaluation in decision making and design of processes with standard methodology.
- Estimate the value of money, worth of equipment & processes with period with different methods.
- Analyze and compare alternatives for equipment, processes and economic evaluation.
- Identify, justify and design process plants and evaluate existing facilities with budgeting and benchmarking.

UNIT - I

Value of money and equivalence - Amortization - Depreciation

UNIT - II

Capital requirements for process plants - Balance sheet chart - earnings, profits and returns - Economic production, Break even Analysis Charts

UNIT- III

Cost accounting -Pre construction cost estimation - allocation of cost.

UNIT - IV

Economics of selecting alternatives

Annual cost methods, Present worth method. Replacement, rate of return method and payout time method.

UNIT - V

Economic balance

General principles and method economic balance in single variable operation and in two variable operation.

TEXT BOOKS:

1. Schweyer, Process Engineering Economics, 1955, Me Graw Hill.
2. Peter and Timmerhaus, Plant Design and Economics for Chemical Engineers 3rd ed. 1984.

REFERENCES:

1. S.N.Maheshwari, Principles of management Accounting, 2000, sultan Chand and sons , New Delhi
2. Dhanasekaran. S, Muralikandan. K, Mukundhan .K.S., "Engineering Economics", Saitech Publication Pvt Ltd., Chennai, Tamil Nadu, India

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Calculate cost and asset accounting, time value of money, profitability, alternative investments, minimum attractive rate of return, sensitivity and risk.
2. Examine the production using economic concepts to predict and analyze the production.
3. Recommend most economical solution among alternatives in engineering problems.
4. Plan for an economical investment in process plants with fundamental knowledge encouraging them to be successful entrepreneurs.
5. Design and develop new process plant with economic evaluation.

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	3	-	-	-	3	3	3	2	3	-	3
CO2	2	3	3	3		-	-	-	-	-	-	-	3	2	2
CO3	-	3	2	3	2	-	-	-	-	-	-	-	3	3	3
CO4	-	3	-	3	2	-	-	-	-	-	-	-	3	2	-
CO5	2	2	-	2	2	-	-	-	-	-	-	-	3	2	3

VALUE ADDED COURSES

22ECHEVAC01	FOOD PRESERVATION TECHNOLOGY	L/P
		3

LEARNING OBJECTIVES:

- To study the importance of microorganisms in food preservation
- To introduce the basics of various food processing and preservation technologies.
- To train the student to analyze food components.
- To make the students aware of the standards of food quality

Unit - I

Principle of food preservation--Removal of Microorganism-Maintenance of anaerobic conditions-General principles underlying spoilage-Chemical changes caused by microorganisms - Spoilage of different kinds of foods-Intrinsic and Extrinsic Parameters that affect microbial growth.

Unit - II

Heat preservation and Processing-Degrees of preservation-Selecting heat treatments-Heat resistance of Microorganisms-Heat transfer-Protective effects of food contamination-Cold Preservation and processing Distinction between Refrigeration and Freezing-Refrigeration and cold storage-Freezing and frozen stage- Different methods of drying process-Food dehydration-Food concentration-Food irradiation-Microwave heating and ohmic heating

Unit - III

Milk and milk products-Meat and meat products-Cereals and cereal products- Sugar and sugar products-Canned foods and Bottled beverage-Fruit and Vegetable Products-Fruit juices-Jams-Marmalades-Squashes-Cordials-Ketchup/Sauces-Soup Powder.

Unit – IV (Practical)

1. Estimation of gluten content in wheat flour
2. Determination of TSS in different fruit juices
3. Determination of Moisture content of given sample
4. Estimation of Ash
5. Adulteration a) pepper b) chili powder c) Milk (Iodine) D) Coffee powder E) Honey F) Turmeric
6. Determination of milk (Water, MBRT, Coagulation).
7. Drying characteristics in vegetables.
8. Determination of titratable acidity in given sample.

Unit – V (Practical)

1. Determination of pH in different food using pH meter.
2. Extention of shelf life /preservation of food by use of low temperature.
3. Osmotic concentration / dehydration of certain fruits and vegetables using concentrated sugar and salt solution.

4. Pasteurization of milk (Low Temperature Less Time).
5. Blanching of tomato.
6. Preparation of sugar boiled Candy

TEXT BOOKS:

1. B. Srilakshmi, Food science, New Age Publishers, 2002
2. Meyer, Food Chemistry, New Age, 2004
3. Bawa. A.S, O.P Chauhan etal. Food Science. New India Publishing agency, 2013
4. Frazier WC and Westhoff DC, Food Microbiology, TMH Publication, New Delhi, 2004.
5. Desrosier NW and Desrosier JN, The Technology of Food Preservation, CBSPublication, New Delhi, 1998.

REFERENCES:

1. Paine FA and Paine HY, Handbook of Food Packaging, Thomson Press India Pvt Ltd, New Delhi- 1992
2. Potter NH, Food Science, CBS Publication, New Delhi, 1998
3. Ramaswamy H and Marcott M, Food Processing Principles and Applications CRC Press, 2006
4. Rao PG, Fundamentals of Food Engineering, PHI Learning Pvt Ltd, New Delhi, 2010
5. Toledo Romeo T, Fundamentals of Food Process Engineering, Aspen Publishers, 1999

22ECHEVAC02	PERSONAL PROTECTIVE EQUIPMENT (PPE) & FIRST AID	L/P
		3

LEARNING OBJECTIVES:

- To understand the importance of PPE and safeguard the life of workers.
- To know the different types of PPE and its applications.
- To understand the necessity of First aid in emergencies and in life saving.
- To provide appropriate First-Aid for the victim of different injuries.

Unit - I

NEED FOR PERSONAL PROTECTIVE EQUIPMENT:

Need for personal protective equipment – selection - Applicable standards, supply, use, care & maintenance.

Unit - II

RESPIRATORY & NON RESPIRATORY PERSONAL PROTECTIVE DEVICES:

Respiratory personal Protective equipment - Classification of respiratory personal protective equipment - Selection of respiratory personal protective equipment - Non-respiratory personal protective devices, Head protection, Ear protection. Face and Eye protection, Hand protection, Foot protection and Body protection.

Unit - III

FIRST AID:

Body structure and Functions, Position of causality, he unconscious casualty, fracture and dislocation, Injuries in muscles and joints, Bleeding, Burns, Scalds and accidents caused by electricity, Respiratory problems, Rescue and Transport of Casualty. Cardiac massage, poisoning, wounds.

Unit – IV (Practical)
PRACTICAL ON PERSONAL PROTECTIVE EQUIPMENT
Personal protective equipment: Respiratory and non-respiratory-demonstration-self contained breathing apparatus. Safety helmet, belt, hand gloves, goggles, safety shoe, gum boots, ankle shoes, face shield, nose mask, ear plug, ear muff, anti static and conducting plastics/rubber materials, apron and leg guard.

Unit – V (Practical)
PRACTICAL ON FIRST AID
Classroom based power-point presentation with practical components; (i.e. Dealing with Emergencies)

REFERENCES:

1. Frank P Lees - Loss of prevention in Process Industries, Vol. 1 and 2, Butterworth Heinemann Ltd., London (1991).
2. Industrial Safety - National Safety Council of India.
3. R. K. Jain and Sunil S. Rao, Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006).

22ECHEVAC03	FIRE ENGINEERING AND EXPLOSION CONTROL	L/P
		3

LEARNING OBJECTIVES:
- To provide knowledge about the science of fire
- To evaluate methods to prevent fire in industries.
- To know the various fire prevention systems.
- To inculcate the concept of explosion and its prevention..

Unit - I
PHYSICS AND CHEMISTRY OF FIRE

Sources of fire-Types & Classification-Fire triangle-fire properties of solid, liquid &gases-Fire spread-Toxicity of products of combustion - Theory of combustion and explosion – vapour clouds – Flash fire – Jet fires – Pool fires – Unconfined vapour cloud explosion, shock waves - Auto-ignition – Boiling liquid expanding vapour explosion.

Unit - II
FIRE PREVENTION AND PROTECTION

Sources of ignition – Principles of fire extinguishing –Active and passive fire protection systems – Types of fire extinguishers – Fire stoppers – Hydrant pipes – Hoses – Monitors –

Fire watchers – Layout of stand pipes – Fire station-fire alarms and sirens – Maintenance of fire trucks – Foam generators – Escape from fire rescue operations – Fire drills.

Unit - III
INDUSTRIAL FIRE PROTECTION SYSTEMS

Sprinkler-hydrants-stand pipes – Special fire suppression systems like deluge and emulsifier, selection criteria of the above installations, reliability, maintenance, evaluation and standards – alarm and detection systems. Other suppression systems – CO_2 system, foam system, dry chemical powder (DCP) system, halon system.

Unit – IV (Practical)
FIRE EXTINGUISHERS AND ITS OPERATIONS (Practical's)

Water, Foam, Carbon dioxide (CO_2), Dry chemical powder extinguisher.

Unit – V (Practical)
FIRE ALARM/SMOKE DETECTOR

Application of Fire alarm/Smoke detector – Case study

REFERENCES:

1. "Accident Prevention manual for industrial operations" N.S.C., Chicago, 1982.
2. R.S. Gupta, "Hand Book of fire technology", 1976, Orient Longman Limited
3. "Fire Prevention and fire fighting", Loss prevention Association, India.
4. Derek, James, "Fire Prevention Hand Book", Butter Worths and Company, London, 1986.
5. Dinko Tuhtar,, Fire and explosion protection: A System Approach. E. Horwood publishers, 1989

22ECHEVAC04	DAIRY TECHNOLOGY	L/P
		3

LEARNING OBJECTIVES:

- Milk and its composition, properties and uses of milk constituents.
- Qualitative and Quantitative analysis of milk.
- Manufacturing process of milk products.

Unit - I

Composition and nutritive value of milk- composition of milk from different species-Properties of Milk components-Collection, Transportation, Reception & Treatment of Milk at the Dairy Plant-Chilling-Clarification and Storage–Materials and sanitary features of the diary Equipments.

Unit - II

Pasteurization-Batch, flash and continuous (HTST) pasteurizers-Sterilization-Different type of sterilizers in bottle sterilizers, autoclaves, continuous sterilization plant-UHT Sterilization. Homogenization-Effect of Homogenization, single stage and two stage homogenizer-Drying and Different methods of drying process-Evaporation and concentration of Milk. Creams–Types of cream separators-Ice cream freezers-Classification of freezers.

Unit - III

Diary products-Pasteurized milk, Sterilized milk, Condensed milk, Reconstituted milk, Flavored Milk. Cream, Butter, Ice cream, Milk powder, casein, Khoa, Whey, Yohurt, Fermented milk and Cheese. Food hygiene, Personal hygiene, Plant hygiene-Cleaning and Sanitation-Different types of cleaning and sanitizing agents

Unit – IV (Practical)

1. Detection of Adulterants in Milk.
2. Test for Presence of Hydrogen Peroxide in Milk.
3. Preparation of Sample of Icecream.
4. Determination of Total Ash.
5. Determination of Moisture in Butter.
6. Preparation of Sample of Yoghurt.

Unit – V (Practical)

1. Preparation of Sample of Casien.
2. Determination of pH in different Milk.
3. Determination of Fat in Milk.
4. Pasteuration of Milk (Low Temperature Less Time)
5. Detection of calcium in Milk.

REFERENCES:

1. De Sukumar, 1999. "*Outlines of Dairy Technology*", Oxford University Press, New, Delhi.
2. Edgar R.Ling, 1956. "*A Text book of dairy chemistry*", Chapman And Hall Ltd.
3. Robinson, R.K.1996. "*Advances in Milk Processing*", Elsevier Applied Science Publishers, Ltd., London, UK.
4. Tufail Ahmed, 2001. Diary plant Engineering and Management, CBS Publishers and distributors, New Delhi.
5. Norman N.Potter, Joseph H.Hotchkiss, Food science, CBS Publishers and distributors, 1995.