அண்ணாமலைப் பல்கலைக்கழகம்

Annamalai University

ACCREDITED WITH 'A' GRADE BY NAAC

FACULTY OF ENGINEERING AND TECHNOLOGY

B.E. (Chemical Engineering)

Degree Program (FULL-TIME)

Choice Based Credit System (CBCS)

COURSE STRUCTURE AND SCHEME OF REGULATIONS

(2025)

Curriculum for B.E. (Chemical Engineering) 2025–26 onwards



ANNAMALAI UNIVERSITY

FACULTY OF ENGINEERING AND TECHNOLOGY

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

Choice Based Credit System (CBCS)

REGULATIONS 2025

1. Condition for Admission

Candidates for admission to the first year of the four year B.E. Degree programmes shall be required to have passed the final examination of the Higher Secondary Course (Plus 2) 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 Tamil Nadu 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, Tamil Nadu 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 Electives and Open Electives in addition to Seminar & Industrial Training and Project. Each semester curriculum shall normally both theory and practical courses. The total credits for the entire degree Programme are **172 (130** 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 172 credits (130 for lateral entry students).

He / She should serve in any one of the following Co-curricular activities for at least one year.

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

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 192. Out of 192 credits (150 credits for lateral entry students), 20 credits must be earned by studying honours electives offered by his/her branch of study in 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 192 credits (150 credits for lateral entry students),20 credits must be earned from the courses offered by any other Department 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 and second 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 172 (130 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 First 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 two professional elective courses of eighth semester in fifth/sixth/seventh semesters through SWAYAM/NPTEL with the approval of the Head of the concerned Department. On successful completion of two courses, they are permitted to pursue industrial training/ internship/project work in the entire eighth semester period.

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 Programme

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

- 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 **three** open elective courses. The student has to study three open elective courses offered by other Departments in the Faculty with the approval of the Head of the concerned Department and the Head of the Department offering the courses or Naan Mudhalvan courses or SWAYAM/NPTEL courses in fifth, sixth and seventh semesters. In case the student opts to study an open elective course offered by another Department in the Faculty, it shall be handled by the faculty of that Department offering the chosen open elective.

11.3 MOOC (SWAYAM) Courses

The student can be permitted to study Massive Open Online Courses (MOOCs) offered through the SWAYAM/NPTEL with the approval of the Head of the Department concerned and the Dean of the Faculty. The courses will be considered as equivalent to professional elective / open elective courses from third to 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/NPTEL 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 course 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 Naan Mudhalvan (Skill Related) Courses

A student may opt to study the courses listed in the Naan Mudhalvan (Skill Related) portal against the professional elective courses in third and fourth semesters and open elective courses in fifth, sixth and seventh semesters of study as part of acquiring skills in the specified field.

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, 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.

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

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)	:	15 marks
Second Assessment (Test-II)	:	15 marks
Maintenance of Record book	:	10 marks
End Semester Examination	:	60 marks

12.3 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.

12.4 Industrial Internship

After attending the internship during the semester vacation of IV and VI semester 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 and 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. Mentoring & Statutory Support for Students

14.1 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, given 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.

14.2 POSH

Prevention of Sexual Harassment (POSH) Cell is established to ensure a safe and secure working / studying environment for Girls and Women in the University. More information about this cell can be accessed at the following link: https://annamalaiuniversity.ac.in/stud_posh.php

14.3 SC / ST Cell

A separate cell is functioning in the University to safeguard the rights and privileges of the students, belonging to SC/ST category. This cell also informs the students about the various scholarships and fellowships and encourages them to apply relevant ones. More information about this cell can be accessed at the following link: https://annamalaiuniversity.ac.in/stud_eoc_sccell.php

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 end 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), 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 answers 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 (or) CGPA - 0.25) x 10

Where $\text{OGPA (or) CGPA} = \frac{\sum C_i GP_i}{\sum C_i}$

C_i - Credit hours of a course
GP_i- Grade Point of that course

20.1 Honours Degree

The student needs to earn a minimum of 192 credits within four years (150 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 172 Credits within four years (130 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 172 credits within ***five*** years (130 credits within ***four*** years for lateral entry students) from the time of admission and obtain an 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 172 credits within **seven** years (130 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 other than his/her branch of study 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 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.

DETAILS OF COURSE CODE

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

- **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 2025)

Curriculum for B.E (Chemical Engineering) 2025-26 onwards

SEMESTER I									
Course Code	Category	Course	L	T	P/D	CA	FE	Total	Credits
25ETBS101	BS-I	Chemistry	3	-	-	25	75	100	3
25ETBS102	BS-II	Mathematics-I	3	1	-	25	75	100	4
25ETHS103	HS-I	Technical English	2	-	-	25	75	100	2
25ETHS104	HS-II	Heritage of Tamils தமிழர்மரபு	1	-	-	25	75	100	1
25ETES105	ES-I	Basic Electrical and Electronics Engineering	2	-	-	25	75	100	2
25ETES106	ES-II	Basic Engineering - Mechanical	3	-	-	25	75	100	3
25ETSP107	BSP-I	Chemistry Laboratory	-	-	3	40	60	100	1.5
25ETSP108	ESP-I	Design Thinking	1	-	2	40	60	100	2
25ETSP109	ESP-II	Programming for Problem Solving Lab	-	-	3	40	60	100	1.5
25ETAC110	AC	NCC /NSS/YRC/Sports							-
								Total Credits	20

SEMESTER II									
Course Code	Category	Course	L	T	P/D	CA	FE	Total	Credits
25ETBS201	BS-III	Physics	3	-	-	25	75	100	3
25ETBS202	BS-IV	Mathematics-II	3	1	-	25	75	100	4
25ETHS203	HS-III	Universal Human Values	2	-	-	25	75	100	2
25ETHS204	HS-IV	Tamils and Technology தமிழரும் தொழில்நுட்பமும்	1	-	-	25	75	100	1
25ETES205	ES-III	Basic Civil Engineering	3	-	-	25	75	100	3
25ETES206	ES-IV	Environmental Studies	2	-	-	25	75	100	2
25ETBP207	BSP-II	Physics Laboratory	-	-	3	40	60	100	1.5
25ETHP208	HSP-I	English Communication Laboratory	-	-	3	40	60	100	1.5
25ETSP209	ESP-III	Electrical Wiring and Earthing Practices Laboratory	-	-	2	40	60	100	1
25ETSP210	ESP-IV	Engineering Graphics & Design	1	-	4	40	60	100	3
								Total Credits	22

SEMESTER III									
Course Code	**Category**	**Course**	**L**	**T**	**P/D**	**CA**	**FE**	**Total**	**Credits**
25CHBS301	BS-V	Material Technology	3	0	0	25	75	100	3
25CHES302	ES-V	Chemistry for Chemical Engineers	3	0	0	25	75	100	3
25CHPC303	PC-I	Chemical Technology	3	0	0	25	75	100	3
25CHPC304	PC-II	Chemical Process Calculations	3	0	0	25	75	100	3
25CHPC305	PC-III	Process Safety	3	0	0	25	75	100	3
25CHPC306	PC-IV	Chemical Engineering Thermodynamics – I	3	0	0	25	75	100	3
25CHPE307	PE-I	Professional Elective - I	3	0	0	25	75	100	3
25CHCP308	PCP-I	Organic & Physical Chemistry Laboratory	-	-	3	40	60	100	1.5
25CHCP309	PCP-II	Technical Analysis Laboratory	-	-	3	40	60	100	1.5
								Total Credits	24

SEMESTER IV									
Course Code	**Category**	**Course**	**L**	**T**	**P/D**	**CA**	**FE**	**Total**	**Credits**
25CHBS401	BS-VI	Numerical Methods	3	0	0	25	75	100	3
25CHES402	ES-VI	Python for Chemical Engineering	3	0	0	25	75	100	3
25CHPC403	PC-V	Fluid Mechanics	3	0	0	25	75	100	3
25CHPC404	PC-VI	Heat Transfer	3	0	0	25	75	100	3
25CHPC405	PC-VII	Mass Transfer – I	3	0	0	25	75	100	3
25CHPC406	PC-VIII	Chemical Engineering Thermodynamics II	3	0	0	25	75	100	3
25CHPE407	PE-II	Professional Elective - II	3	0	0	25	75	100	3
25CHCP408	PCP-III	Fluid Mechanics Laboratory	-	-	3	40	60	100	1.5
25CHCP409	PCP-IV	Heat Transfer Laboratory	-	-	3	40	60	100	1.5
								Total Credits	24
Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming V Semester.									

SEMESTER V									
Course Code	**Category**	**Course**	**L**	**T**	**P/D**	**CA**	**FE**	**Total**	**Credits**
25CHPC501	PC-IX	Particle Mechanics & Mechanical Operation	3	0	0	25	75	100	3
25CHPC502	PC-X	Chemical Reaction Engineering – I	3	0	0	25	75	100	3
25CHPC503	PC-XI	Mass Transfer – II	3	0	0	25	75	100	3
25CHPC504	PC-XII	Process Instrumentation	3	0	0	25	75	100	3
25CHPE505	PE-III	Professional Elective - III	3	0	0	25	75	100	3
25CHOE506	OE-I	Open Elective - I	3	0	0	25	75	100	3
25CHCP507	PCP-V	Particle Mechanics & Mechanical Operation Laboratory	-	-	3	40	60	100	1.5
25CHCP508	PCP-VI	Mass Transfer Laboratory	-	-	3	40	60	100	1.5
25ETIT509	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	25

SEMESTER VI									
Course Code	**Category**	**Course**	**L**	**T**	**P/D**	**CA**	**FE**	**Total**	**Credits**
25CHPC601	PC-XIII	Process Dynamics & Control	3	0	0	25	75	100	3
25CHPC602	PC-XIV	Chemical Reaction Engineering – II	3	0	0	25	75	100	3
25CHHS603	HS – V	Management for Engineers	3	0	0	25	75	100	3
25CHPE604	PE-IV	Professional Elective - IV	3	0	0	25	75	100	3
25CHPE605	PE-V	Professional Elective - V	3	-	-	25	75	100	3
25CHOE606	OE-II	Open Elective - II	3	-	-	25	75	100	3
25CHCP607	PCP-VII	Chemical Reaction Engineering & Thermodynamics Laboratory	-	-	3	40	60	100	1.5
25CHCP608	PCP-VIII	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 V Semester.									

SEMESTER VII									
Course Code	**Category**	**Course**	**L**	**T**	**P/D**	**CA**	**FE**	**Total**	**Credits**
25CHES701	ES -VII	Research Methodology	2	0	0	25	75	100	2
25CHPC02	PC-XV	Transport Phenomena	3	0	-	25	75	100	3
25CHPC703	PC-XVI	Process Engineering Economics	3	0	0	25	75	100	3
25CHPE704	PE-VI	Professional Elective - VI	3	-	-	25	75	100	3
25CHPE705	PE-VII	Professional Elective - VII	3	-	-	25	75	100	3
25CHOE706	OE-III	Open Elective - III	3	-	-	25	75	100	3
25CHCP707	PCP-IX	Chemical Process Simulation Laboratory	-	-	3	40	60	100	1.5
25CHCP708	PCP-X	Chemical Plant Design and Drawing Laboratory	-	-	3	40	60	100	1.5
25ETIT709	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

SEMESTER VIII									
Course Code	**Category**	**Course**	**L**	**T**	**P/D**	**CA**	**FE**	**Total**	**Credits**
25CHPE801	PE-VIII	Professional Elective - VIII	3	-	-	25	75	100	3
25CHPE802	PE-IX	Professional Elective - IX	3	-	-	25	75	100	3
2 CHPV803	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. Chemical Plant Utilities

Professional Elective – III

9. Petrochemical Technology
10. Pulp and Paper Technology
11. Industrial Bio-technology
12. Wastewater Treatment Technology

Professional Elective - IV

13. Modern Separation Processes
14. Membrane Science and Engineering
15. Food Processing Technology
16. Fertilizer Technology

Professional Elective - V

17. Fluidization Engineering
18. Distillation
19. Mixing Theory and Practice
20. Technology of Fine and Specialty Chemicals

Professional Elective – VI

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

Professional Elective – VII

25. Green Chemistry and Technology
26. Hazardous Chemical Storage and Handling
27. Computing Techniques in Chemical Engineering

Professional Elective – VIII

28. Total Quality Management
29. Chemical Works Organization and Management
30. Pilot Plant and Scale Up Methods in Chemical Engineering
31. Disaster Management

Professional Elective – IX

32. Entrepreneurship & Innovation: Building the Future
33. Industrial Relations and Organizational Development
34. AI and ML in Chemical Engineering
35. Human Factors Engineering, BBS and Occupational Health

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. Bioconversion and Processing of Waste
8. Intellectual Property Rights
9. Biology for Engineers
10. Machine Learning (Naan Mudhalvan)
11. Augmented and Virtual Reality (AR VR) Development (Naan Mudhalvan)
12. Block Chain (Naan Mudhalvan)
13. 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

INSTITUTIONAL VISION & MISSION

VISION

Providing world class quality education with strong ethical values to nurture and develop outstanding professionals fit for globally competitive environment.

MISSION

- Provide quality technical education with a sound footing on basic engineering principles, technical and managerial skills, and innovative research capabilities.
- Transform the students into outstanding professionals and technocrats with strong ethical values capable of creating, developing and managing global engineering enterprises.
- Develop a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the Industry and Society.
- Inculcate the importance and methodology of life-long learning to move forward with updated knowledge to face the challenges of tomorrow.

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)

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life COs/POst, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering commUNITy and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Mapping of PEO with POs

PO → / PEO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
PEO1	3	3	3	3	2	3	2	2	1	1	3
PEO2	3	3	3	3	2	3	2	2	1	1	3
PEO3	3	3	3	3	2	3	2	2	2	1	3
PEO4	3	3	3	3	2	3	2	2	2	1	3
PEO5	3	3	3	3	2	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.

25ETBS101	CHEMISTRY	L	T	P	C
		3	0	0	3

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, nano materials and Phase rule.
- To get basic knowledge on Refractories, Lubricants, Spectroscopical techniques and Explosives

UNIT – I: Water Chemistry and Surface Chemistry

Hardness of water–Types –Units - Estimation of hardness by EDTA method. Softening of hard water by Ion exchange method and Zeolite method. Desalination of brackish water by Reverse Osmosis. Boiler feed water–boiler troubles – Internal treatment methods. Municipal water treatment –Sedimentation, Coagulation, Filtration, Sterilization -- 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 – Conducto metry – Conductance, Specific conductance (molar and equivalent), Cell constant– Conductometric titrations (types of acid-base titrations). Potentiometry–Principle, Acid–base titration. Corrosion – Dry and wet corrosion – Galvanic and Concentration cell corrosion (Pitting) – Control of corrosion – Cathodic Protection (Sacrificial anodic method, Impressed voltage method) – Metal coatings –Galvanizing and Tinning.

UNIT – III: Fuels and Storage Devices

Fuels– Calorific values (HCV and LCV) – Classification– Coal - Analysis of coal (Proximate and Ultimate analysis)– Crude Petroleum- Refining and fractional distillation- Cracking of heavy oil (Fixed bed Method)– Synthetic petrol (Fischer–Tropsch process). Gaseous Fuel (Producer gas, Water gas LPG, CNG). Flue gas analysis using Orsat apparatus. Batteries– Primary cell- Dry cell (Leclanche cell, Alkali cell)- Secondary cell (Lead acid storage battery, Ni-Cd battery, Lithium -ion battery)– Flow Cell (H_2-O_2 fuel cell and Solid oxide fuel cell).

UNIT – IV: Polymers, Nano Materials and Phase rule

Polymers – Polymerization – Types (Addition, condensation and copolym0.erization) – Mechanism of addition polymerization (Free radical). Plastics– Types (Thermoplastics and Thermosetting plastics) – Preparation, properties and uses of polyethylene, polyvinyl chloride, polystyrene, Nylon and Bakelite. Elastomers – Vulcanization – Synthetic Rubber (Buna-S, Buna-N, Neoprene) – Silicone Rubber. Nanochemistry – Introduction to nano-materials– Synthesis (Precipitation, sol-gel, Electro deposition and chemical vapour deposition methods) - Carbon nano tubes, Fullerenes, Nano wires and Nano rods. Phase Rule– Introduction, Definition of terms with examples. One component system (Water and Sulphur).

UNIT – V: Engineering Materials Spectroscopic Techniques and Explosives

Refractories – Classification, characteristics (Refractoriness, RUL, Thermal spalling, porosity) and uses, Lubricants – Classification, properties (cloud and pour point, flash and fire point, viscosity/porosity index) and applications. Principles of spectroscopy – Beer – Lambert's Law– UV Visible and IR spectroscopy– Basic principles and instrumentation (block diagram). Explosives– Structure, Preparation, properties and uses of some important explosives (Lead azide, Dynamite, TNT, PETN and RDX).

TEXT BOOKS

1. Jain, P.C. and Monica Jain (2010) "Engineering Chemistry" Dhanpat Rai &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 Mc Graw 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

Upon successful completion of the course, students will be able to

1. Explain the principles of water treatment methods, adsorption phenomena, electrochemical processes, corrosion mechanisms and engineering materials used in engineering applications.
2. Apply water softening, desalination, electrochemical and corrosion control techniques for solving engineering problems related to industrial and municipal applications.
3. Analyze the characteristics and performance of fuels, batteries, fuel cells, polymers and nanomaterials for suitable engineering applications.
4. Evaluate the properties, performance and suitability of engineering materials, lubricants, refractories and spectroscopic techniques for industrial and research applications.
5. Develop appropriate material selection, energy storage and corrosion prevention strategies using modern engineering concepts for sustainable engineering systems.

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

25ETBS102	MATHEMATICS - I	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

- To familiarize definite integrals and its application in finding area and volume.
- To introduce the fundamentals of functions of single variable.
- To make the student to learn infinite series and its nature.
- To introduce the fundamentals of Multivariable Differential Calculus
- To introduce the fundamentals of Multivariable Integral Calculus

UNIT I: Basic Calculus

Curvature, Evolutes and Involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

UNIT II: Single-variable Calculus (Differentiation)

Rolle's Theorem, Mean value theorems and applications; Extreme values of functions; Indeterminate forms and L'Hospital's rule.

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: Multivariable Calculus (Differentiation)

Limit, continuity and partial derivatives, total derivative; Euler's theorem; Jacobians; Taylor and Maclaurin series; Maxima, minima and saddle points; Method of Lagrange multipliers.

UNIT V: 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), Volume as a triple integral.

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, 36thEdition, 2010

REFERENCE BOOKS

1. Reena Garg, Mathematics-II (Calculus, Ordinary Differential Equations and Complex Variable), Khanna Book Publishing Co, 2023
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9thEdition, Pearson publishers, 2002.
3. Erwin kreyszig, Advanced Engineering Mathematics, 9thEdition, John Wiley &Sons,2006.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi,11th Reprint, 2010.
5. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint,2008.

COURSE OUTCOMES

On successful completion of the course, students will be able to

1. Describe the fundamental concepts of differential calculus, integral calculus, sequences and series, multivariable differentiation and multivariable integration applicable to engineering and scientific problems.
2. Apply the principles of single-variable and multivariable calculus, definite integrals, sequences and series to formulate and solve engineering and real-life mathematical problems.
3. Analyze engineering problems involving limits, differentiation, integration, convergence of series and multivariable functions to interpret mathematical models and obtain appropriate solutions
4. Evaluate alternative mathematical techniques for solving engineering problems involving calculus, optimization, infinite series and multiple integrals based on accuracy and computational efficiency
5. Develop mathematical models by integrating concepts of differential calculus, integral calculus, multivariable calculus and series for solving multidisciplinary engineering applications

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

25ETHS103	TECHNICAL ENGLISH	L	T	P	C
		2	0	0	2

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

1. The concept of Word Formation
2. Root words from foreign languages (Greek, Latin and French) and their use in English
3. Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives, Count and Non count nouns.
4. Synonyms, antonyms and standard abbreviations.
5. Homophones, Homonyms, and one word substitution.

UNIT II: Basic Writing Skills

1. Use of phrases and clauses in sentences.
2. Sentence Structures and Transformation of Sentences.
3. Importance of proper punctuation.
4. Creating coherence and Techniques for writing precisely.
5. Note making Techniques

UNIT III: Identifying Common Errors in Writing

1. Subject-verb Agreement
2. Noun, Pronoun Agreement
3. Articles and Prepositions
4. Active and Passive voice
5. Common errors in writing

UNIT IV: Nature and Style of sensible Writing

1. Describing and Defining
2. Classifying and Providing Evidences and Examples with Introduction and Conclusion
3. Essay Writing–Writing analytical essays and issue-based essays.
4. Comprehension
5. Letter Writing – Formal, Informal and Job application with CV

UNIT V: Writing Practices and Oral Communication

1. Dialogue Writing and conversation in the work place
2. Report Writing – Preparing agenda, Minutes of meeting and a Circular
3. Mechanics of Presentation
4. Public speaking and Interview Skills
5. E-mail– etiquette

TEXT-CUM-REFERENCE BOOKS

1. Practical English Usage, Michael Swan, Oxford University Press, 2016.
2. Remedial English Grammar, F.T.Wood. Macmillan, 2007.
3. On Writing Well, William Zinsser, Harper Resource Book, 2001
4. Study Writing, Liz Hamp-Lyons and Ben Heasly, Cambridge University Press. 2006.
5. Communication Skills, Sanjay Kumar and Pushp Lata, 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 the course, students will be able to

1. Explain the principles of English vocabulary, word formation, sentence structures, grammatical conventions, and the fundamentals of effective written and oral communication.
2. Apply appropriate vocabulary, grammatical rules, sentence structures, punctuation, coherence techniques, and conventions of professional writing to communicate ideas accurately and precisely.
3. Analyze written and spoken communication to identify grammatical, structural, lexical, and contextual errors and use appropriate strategies to improve clarity, accuracy, and effectiveness.
4. Evaluate different forms of technical and professional communication, including analytical writing, comprehension, formal correspondence, CVs, reports, presentations, and workplace interactions, for their clarity, organization, appropriateness, and effectiveness.
5. Create coherent and audience-appropriate professional communication such as essays, job applications, CVs, emails, reports, minutes, circulars, dialogues, presentations, and interview responses using suitable language and communication strategies.

Mapping with POs & PSOs											
COs\ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	3	–	–	–	–	–	–	3	–	1
CO2	3	3	3	–	–	–	–	1	3	–	1
CO3	3	3	3	3	–	–	–	–	3	–	1
CO4	3	3	3	3	–	1	1	1	3	1	1
CO5	3	3	3	3	–	1	1	1	3	1	1

25ETHS104	HERITAGE OF TAMILS தமிழர் மரபு	L	T	P/D	C
		1	0	0	1

UNIT-I: Language and Literature: Language Families in India - Dravidian Languages -Tamil as a Classical Language - Classical Literature in Tamil -Secular Nature of Sangam Literature –Distributive Justice in Sangam Literature – Management Principles in Thirukural –Tamil Epics and Impact of Buddhism &Jainismin Tamil Land –Bakthi Literature Azhwars and Nayanmars.- Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT-II: Heritage - Rock art paintings to modern art - Sculpture: Hero stone to modern sculpture –Bronze icons – Tribes and their handicrafts-Art of temple car 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.

UNIT-III: Folk and Martial arts - Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT-IV: 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.

UNIT-V: 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. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL -(in print)
2. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
3. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of TamilStudies.)
5. 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)
6. Studies in the History of India with Special Reference to TamilNadu (Dr.K.K.Pillay) (Published by: The Author)
7. Porunai Civilization (Jointly Published by Department of Archaeology & TamilNadu Text Book and Educational Services Corporation, TamilNadu)
8. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) -Reference Book.

COURSE OUTCOMES

By the completion of the course, students will be able to

1.Explain the evolution of Tamil language, literature, culture and heritage through Sangam literature, epics and Bhakti literature.

2.Apply the knowledge of Tamil heritage, arts, architecture and cultural traditions to understand the socio-economic development of Tamil society.

3.Analyze the significance of folk arts, martial arts, ancient trade practices and Thinai concepts in shaping Tamil civilization and cultural identity.

4.Evaluate the contribution of Tamil culture, Siddha medicine, inscriptions and freedom movements towards Indian society and national development.

5.Develop awareness and appreciation of Tamil cultural values, ethical principles and heritage for social harmony and lifelong learning.

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

25ETES105	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P/D	C
		2	0	0	2

COURSE OBJECTIVES:

- Understand the fundamental principles of electrical circuits and their analysis
- Explore the construction, working principles, and applications of various electrical machines
- Gain knowledge of electrical measurement techniques and instrumentation used in the measurement of electrical parameters
- Develop an understanding of analog electronics and their applications
- To teach the basics of digital electronics.

UNIT I: ELECTRICAL CIRCUITS

DC Circuits-Basic circuit elements and sources-Ohm's law- Kirchhoff's laws- AC Circuits-Alternating voltages and currents-RMS, average, maximum values- real power, reactive power and apparent power- Power Factor- Three phase balanced systems-Star and delta connections (simple problems only)

UNIT II: ELECTRICAL MACHINES

Construction, working principle, types and applications of DC Machines, Transformers, Three phase Induction motors, Three-phase Alternators, Three-phase Synchronous Motors, Single phase induction motors and universal motor.

UNIT III: MEASUREMENTS AND INSTRUMENTATION

Functional elements of an instrument, Construction, Operating Principle, types-Moving Coil and Moving Iron meters, Dynamometer Wattmeter, Energy Meter, Instrument Transformers-CT and PT

UNIT IV: ANALOG ELECTRONICS

Characteristics: PN junction diode, Zener diode, BJT- Applications: Rectifier, Voltage regulator, Operational amplifier

UNIT V: DIGITAL ELECTRONICS

Number system – Logic Gates – Boolean Algebra– De-Morgan's Theorem – Half Adder and Full Adder – Flip Flops-multiplexers and de-multiplexers

TEXT BOOKS

1. R.Muthusubramanian, S.Salivahanan, Basic Electrical and Electronics Engineering, McGraw Hill Education, 2024.
2. A K Theraja& B L Theraja, Fundamentals of Electrical Engineering and Electronics, S Chand Publishing, 2022.

REFERENCE BOOKS

1. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", McGraw Hill Education, 2019.
2. S. K. Bhattacharya, Basic Electrical and Electronics Engineering, Pearson India, 2017
3. R. K. Rajput, Basic Electrical and Electronics Engineering, Laxmi Publications, 2013

COURSE OUTCOMES:

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

1. Describe the fundamental principles, characteristics, operating concepts and applications of electrical circuits, machines, measuring instruments, analog devices and digital circuits.
2. Apply electrical, measurement, electronic and digital principles to solve basic problems involving circuits, machines, instrumentation, analog and digital systems.
3. Analyze the behaviour and performance of electrical circuits, machines, measurement systems, analog circuits and digital systems using appropriate engineering principles.
4. Evaluate the performance, accuracy, efficiency, suitability and limitations of electrical and electronic systems for specified engineering applications.
5. Design basic integrated electrical and electronic systems by combining circuit, machine, measurement, analog and digital concepts to meet specified requirements.

Mapping with POs & PSOs											
COS\ POS	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	1	–	–	–	–	–	–	1	1	–
CO2	3	3	2	2	2	–	1	–	1	1	–
CO3	3	3	2	3	2	–	1	–	1	1	–
CO4	3	3	3	2	2	1	2	1	1	1	1
CO5	3	3	3	2	3	2	2	1	2	2	2

25ETES106	BASIC ENGINEERING - MECHANICAL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main objectives of the course for the students is

- To familiarize the functions of different types of Boilers and Turbines
- To provide basic knowledge about the functions of Internal Combustion Engines and Electric Vehicles
- To provide fundamental knowledge on the various conventional machining operations and Metal forming operations
- To illustrate the concepts of various metal joining techniques, brazing and soldering
- To understand the fundamentals of CNC machining and Additive Manufacturing process

UNIT I

Steam generators: Boilers – Classification–Construction and working of Cochran boiler and Babcock & Wilcox boiler– Boiler Mountings and Accessories – Pressure gauge, Water level indicator, Safety valve— Applications of Boilers. Prime Movers: Steam turbines–Types – Working Principles of Impulse and Reaction turbines – Comparison – Gas turbines: Working Principles of Open cycle and Closed cycle gas turbines.

UNIT II

Internal Combustion Engines: Classification – Description and of I.C. engines– Two stroke - Four stroke– Comparison – Petrol and diesel engines –Comparison - Fuel system for Petrol and Diesel engines – Concepts of CRDI and MPFI fuel injection systems – Applications– Electric Vehicles: Architecture - Battery Electric Vehicles (BEV) - Hybrid Electric vehicles (HEV).

UNIT III

Metal Machining: Description and Types of operations performed on various machine tools -Lathe, Drilling machine and Milling machine. Metal Forming: Hot and cold working - Principle of forging –Types –Rolling: definition - roll mill configurations - Extrusion: Definition –Direct and indirect extrusion.

UNIT IV

Metal Casting: Green Sand Molding –Principle - Steps – Solid and split pattern - Injection Molding Metal Joining: Gas welding -Oxy-acetylene welding – principle– Equipment - Advantages and Disadvantages – Arc welding: Shielded Metal Arc Welding (SMAW) - principle – Equipment - Advantages and Disadvantages. Brazing – Soldering - comparison.

UNIT V

Computer Numerical Control (CNC)machining – Classifications – co-ordinates – codes - Applications – Advantages - Limitations – Machining centre – concept. Additive Manufacturing Process – Definition - Classifications - Stereo-lithography (SLA) process – Direct Metal Laser Sintering (DMLS) - Applications - Advantages – Disadvantages.

TEXT BOOKS:

1. Prabhu, T, J.Jaiganesh Vand Jebaraj S. (2000). Basic Mechanical Engineering, Scitech Publications Pvt. Ltd., Chennai.
2. Venugopal and Prabhuraj T J. (1996). Basic Mechanical Engineering, ARS publishers, Sirkali.
3. P. Radhakrishnan, S.Subramanyan. (1994). CAD/CAM/CIM, New Age International Publishers pvt, Ltd, New Delhi.

REFERENCE BOOKS:

1. Hajra Choudhury S. K., Nirjhar Roy, Hajra Choudhury A. K. (2008). Elements of Workshop Technology (Vol 1 and Vol II), Media Promoters Pvt. Ltd.
2. Rao P.N. (2013). Manufacturing Technology: Foundry, Forming and Welding–Vol1, McGraw Hill Education.
3. Steven R.Schmid, Serope Kalpakjian. (2009). Manufacturing Processes for Engineering Materials (English), 5th Edition, Pearson India.

COURSE OUTCOMES

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

1. Explain the working principles of boilers, turbines, internal combustion engines, manufacturing processes and modern machining techniques used in mechanical engineering.
2. Apply the concepts of thermal engineering, IC engines, machining and metal forming processes in manufacturing and industrial applications.
3. Analyze the performance and operational characteristics of thermal systems, machining operations, welding processes and metal forming techniques.
4. Evaluate suitable casting, joining, CNC machining and additive manufacturing methods for specific engineering and industrial requirements.
5. Develop engineering solutions using advanced manufacturing technologies, modern machining systems and sustainable thermal engineering practices.

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

25ETSP107	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 analyze quantitatively the amount of a substance present in a given sample.

List of Experiments:

1. Determination of surface tension and visCOs/POsity
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 immiscible liquids
10. Adsorption of acetic acid by charcoal
11. Volumetric analysis

COURSE OUTCOMES:

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

1. Explain the principles, procedures and safety practices involved in chemical analysis and laboratory experiments related to engineering applications.
2. Apply volumetric, electrochemical and analytical techniques to determine physical and chemical properties of engineering materials and water samples.
3. Analyze experimental data obtained from chromatography, adsorption, conductometry and reaction kinetics experiments for engineering interpretations.
4. Evaluate the accuracy and suitability of analytical methods and experimental results for industrial and engineering applications.
5. Develop practical laboratory skills to perform chemical experiments systematically with professional ethics, teamwork and scientific reporting practices.

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

25ETSP108	DESIGN THINKING	L	T	P/D	C
		1	0	2	2

COURSE OBJECTIVES

- To introduce the concept and principles of design thinking.
- To develop empathy and understanding of users through observation and research.
- To foster creative problem-solving and ideation skills.
- To equip students with prototyping and testing techniques.
- To encourage a user-centered mindset in real-world problem solving.

UNIT I: Introduction to Design Thinking:

Definition, history, and evolution - Principles and mindset of design thinking - Design thinking vs. traditional problem-solving - Overview of the 5-step process: Empathize, Define, Ideate, Prototype, Test.

UNIT II: Empathize – Understanding Users:

Importance of empathy in design - User research methods: interviews, observation, shadowing - Empathy mapping - Identifying user pain points and needs-Exercise on Empathizing.

UNIT III: Define – Framing the Problem:

Synthesizing user research - Point-of-view statements - Problem definition and opportUNITy framing - Design challenges and "How Might We" questions- Exercise on Problem Framing.

UNIT IV: Ideate – Generating Ideas:

Divergent and convergent thinking - Brain storming techniques - Story boarding and sketching ideas - Evaluating and selecting ideas. Edward de Bono's Lateral Thinking: Random Entry Idea Generation; Challenge and Provocation Techniques, Concept Extraction-Exercise on Idea Generation.

UNIT V: Prototype and Test:

Importance of prototyping in design thinking - Types: low-fidelity vs high-fidelity, digital vs physical - Storyboards, wireframes, role-playing- User testing methods: Think-Aloud, A/B testing-Iterative improvement cycles-Reflecting and learning loops.

TEXT BOOKS

1. Brown, Tim**. "***Change by Design: How Design Thinking Creates New Alternatives for Business and Society",* Harvard Business Review Press, 2009.
2. Liedtka, Jeanne, and Tim Ogilvie**. "***Designing for Growth: A Design Thinking Tool Kit for Managers",* Columbia University Press, 2011.
3. De Bono, Edward**, "***Lateral Thinking: Creativity Step by Step",* Harper Perennial, 2015.

REFERENCE BOOKS

1. Kolko, Jon**. "***Well-Designed: How to Use Empathy to Create Products People Love".*Harvard Business Review Press, 2014.
2. Cross, Nigel.**"***Design Thinking: Understanding How Designers Think and Work".* Berg Publishers, 2011.
3. Ball, Philip**. "***Critical Mass: How One Thing Leads to Another".* Farrar, Straus and Giroux, 2006.
4. Norman, Donald A**, "***The Design of Everyday Things",* Basic Books, RevisedEdition,2013.

COURSE OUTCOMES

On completion of this course, students will be able to

1. Explain the principles, stages and importance of design thinking in solving engineering and societal problems.
2. Apply empathy and user research techniques to identify customer needs, user pain points and design challenges effectively.
3. Analyze engineering problems using problem-framing, brainstorming and lateral thinking techniques to generate innovative ideas.
4. Evaluate alternative design solutions through prototyping, testing and iterative improvement methods for user-centered applications.
5. Develop creative and sustainable engineering solutions using design thinking methodologies and collaborative practices for real-world problems.

Mapping with POs & PSOs											
COs\ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**
CO1	3	2	3	2	1	1	1	1	1	1	1
CO2	3	3	3	2	1	1	1	2	2	1	1
CO3	3	3	3	3	1	1	1	2	2	1	1
CO4	3	3	3	3	1	1	1	2	2	2	1
CO5	3	3	3	3	1	2	2	3	3	3	2

25ETSP109	PROGRAMMING FOR PROBLEM SOLVING 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.

List of Experiments:

1. Familiarization with programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving if-then-else structures
4. Iterative problems e.g., sum of series
5. 1D Arrays: searching, sorting
6. 2D arrays and Strings
7. Simple functions
8. Programming for solving Numerical methods
9. Pointers, structures and dynamic memory allocation
10. File handling

COURSE OUTCOMES

On successful completion of the course, students will be able to

1. Explain the fundamentals of programming concepts, data types, control structures and problem-solving techniques using computers.
2. Apply programming constructs, arrays, functions and file handling techniques to solve computational and engineering problems.
3. Analyze engineering and numerical problems using appropriate programming logic, recursion, pointers and data structures.
4. Evaluate suitable algorithms, numerical methods and programming approaches for efficient problem solving and software development.
5. Develop structured computer programs using modular programming concepts and dynamic memory techniques for engineering and scientific applications.

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

25ETBS201	PHYSICS	L	T	P/D	C
		3	0	0	3

COURSE OBJECTIVES

At the end of the course the students would be exposed to fundamental knowledge in various engineering subjects and applications

- To understand the ray of light to undergo the phenomenon of interference and diffraction.
- 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. Mechanical properties of solids, Oscillations and Optics

Introduction –Elastic behaviors of solids – Hooke's law – Young's Modulus – Applications of Elastic behaviors of materials –Rectilinear motion – Oscillations or Vibrations–Simple Harmonic motion –Reflection and Refraction of light waves – Total internal reflection – Interference – Newton's Rings – Michelson Interferometer – Theory of Air wedge and Experiment – Diffraction – Diffraction Grating.

UNIT -II. Lasers

Introduction – Basic Principles –Energy levels – Ionization and Excitation potentials – Absorption – Spontaneous emission – Stimulated emission – Einstein's Coefficients – Characteristics – Population inversion – Pumping – Methods of Pumping – Active medium – Active center – Types of lasers: Ruby laser – He-Ne laser – Basic applications of lasers in industry.

UNIT - III. Crystal Physics

Introduction to solid Materials – Crystal structure – Geometry of lattice UNIT cell – Bravai's lattice – crystal systems – Crystal structures of Materials –(Co - ordination 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 –Dual nature of Matter and radiation – Properties of Matter waves – De Broglie's Wave length –De Broglie wavelength of an electron – The Schrödinger 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).

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:

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

1. Explain the fundamental concepts of elasticity, oscillations, optics, crystal structures, quantum mechanics and energy sources relevant to engineering applications.
2. Apply the principles of oscillations, optics, laser technology and crystal physics to solve engineering and scientific problems.
3. Analyze the behavior of materials, wave phenomena, crystal structures and quantum mechanical systems using physical laws and mathematical models.
4. Evaluate the performance and applications of lasers, renewable energy systems and modern physical concepts in engineering practices.
5. Develop scientific approaches for applying modern physics concepts and sustainable energy technologies in engineering applications.

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

25ETBS202	MATHEMATICS – II	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To familiarize linear system of equation and matrices.
- To solve ordinary differential equations of first and second order.
- To make the student to learn vector differentiation and integration.
- To acquaint the student with the techniques in the theory of analytic functions.
- To Introduce the fundamentals of complex integrations.

UNIT I: Matrices

Linear Systems of Equations; Linear Independence; Rank of a Matrix; Determinant, Inverse of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Eigenvalues and eigenvectors; Orthogonal transformation; Diagonalization of matrices; Cayley-Hamilton Theorem.

UNIT II: Ordinary differential equations

Exact, linear and Bernoulli's equations. Second order linear differential equations with constant coefficients, Second order linear differential equations with variable coefficients: Euler-Cauchy equations, solution by variation of parameters

UNIT III: Vector Calculus

Vectors-Gradient, divergence and curl- Directional derivative-UNIT normal vector-Irrotational and Solenoidal vectors-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.

UNIT IV: Complex Variable – Differentiation

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

UNIT V: Complex Variable – Integration

Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof).

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, 36thEdition, 2010*

REFERENCE BOOKS

1. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9thEdition, Pearson publishers, Reprint,2002.
3. Erwin kreyszig, Advanced Engineering Mathematics,9thEdition, John Wiley &Sons,2006.
4. *Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi,11th Reprint, 2010.*
5. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

COURSE OUTCOMES:

On completion of this course, students will be able to

1. Describe the fundamental concepts of matrices, vector calculus, ordinary differential equations, Laplace transforms and complex variable theory applicable to engineering and scientific problems.
2. Apply the principles of matrices, vector differentiation and integration, differential equations, Laplace transforms and complex variables to formulate and solve engineering problems.
3. Analyze mathematical models involving matrices, vector fields, differential equations, Laplace transforms and complex functions to interpret engineering systems and obtain appropriate solutions.
4. Evaluate suitable mathematical techniques for solving engineering problems involving vector calculus, differential equations, Laplace transforms and complex analysis based on accuracy, efficiency and applicability.

5. Develop mathematical models by integrating concepts of matrices, vector calculus, differential equations, Laplace transforms and complex variable theory for multidisciplinary engineering applications.

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

25ETHS203	UNIVERSAL HUMAN VALUES	L	T	P/D	C
		2	0	0	2

COURSE OBJECTIVES

- To impart of a holistic perspective based on self-exploration about themselves (human being), family, society and nature / existence.
- To develop clarity about the harmony within the human being, as well as in the family, society and nature / existence.
- To strengthen the capacity of self-reflection.
- To foster commitment and courage to act to act in alignment with universal human values.
- To equip students with the knowledge and skills to address problems through sustainable and ethical solutions.

UNIT I

COURSE INTRODUCTION - NEED, BASIC GUIDELINES, CONTENT AND PROCESS FOR VALUE EDUCATION

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I.
2. Self-Exploration–what is it? - Its content and process; Natural Acceptance and Experiential Validation- as the process for self-exploration.
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations.
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfillment of aspirations of every human being with their correct priority.
5. Understanding happiness and Prosperity correctly-A critical appraisal of the current scenario.
6. 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!

1. Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’.
2. Understanding the needs of Self (‘I’) and ‘Body’ - happiness and physical facility.
3. Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer).
4. Understanding the characteristics and activities of ‘I’ and harmony in ‘I’.
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.
6. 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

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure. mutual happiness; Trust and Respect as the foundational values of relationship.
2. Understanding the meaning of Trust; Difference between intention and competence.
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship.
4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals.
5. 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 example, 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

1. Understanding the harmony in the Nature.
2. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self- regulation in nature.
3. Understanding Existence as Co-existence of mutually interacting UNITs in all-pervasive space.
4. 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

1. Natural acceptance of human values.
2. Definitiveness of Ethical Human Conduct.
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.
4. 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.
5. Case studies of typical holistic technologies, management models and production systems.
6. 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.
7. Sum up. 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.

TEXT / REFERENCES

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria,Excel Books, New Delhi,2010
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak,1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi,2004.
4. The Story of Stuff (Book).
5. The Story of My Experiments with Truth- by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful – Cecile Andrews
8. Economy of Permanence – JC Kumarappa
9. Bharat Mein Angreji Raj -Pandit Sunderlal
10. Rediscovering India – by Dharampal
11. Hind Swaraj or Indian Home Rule - by Mohandas K.Gandhi
12. India Wins Freedom - Maulana Abdul KalamAzad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

COURSE OUTCOMES.

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

1. Explain the concepts of human values, harmony, ethical living and professional responsibility for individual and societal well-being.
2. Apply the principles of self-exploration, harmony and human relationships to develop responsible personal and professional conduct.
3. Analyze the interrelationship between individuals, society, nature and existence for sustainable and harmonious living.
4. Evaluate ethical issues, professional responsibilities and societal challenges in engineering practices using human value-based approaches.
5. Develop socially responsible, eco-friendly and value-based engineering practices for sustainable development and universal human welfare.

Mapping with POs & PSOs											
COs\ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**
CO1	1	1	–	–	–	2	3	–	1	–	1
CO2	1	1	1	–	–	3	3	1	1	–	1
CO3	1	2	1	1	–	3	3	1	1	–	1
CO4	2	2	1	1	–	3	3	1	1	1	1
CO5	2	2	2	1	–	3	3	1	1	1	1

25ETHS204	TAMILS AND TECHNOLOGY	L	T	D	C
		1	0	0	1

UNIT I: Weaving and Ceramic Technology: Weaving Industry during Sangam Age - Ceramic technology - Black and Red Ware Potteries (BRW) - Graffiti on Potteries.

UNIT II: 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.

UNIT III: 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.

UNIT IV: Agriculture and Irrigation Technology: Dam, Tank, ponds, Sluice, Significance of KumizhiThoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries - Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT V: Scientific Tamil & Tamil Computing: Development of Scientific Tamil - Tamil computing - Digitalization of Tamil Books - Development of Tamil Software - Tamil Virtual Academy -Tamil Digital Library - Online Tamil Dictionaries - Sorkuvai Project.

TEXT-CUM-REFERENCEBOOKS:

Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL -(in print)

1. Social Life of the Tamils The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
2. Historical Heritage of theTamils (Dr.S.V.Subatamanian,Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
3. The Contributions of theTamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
4. Keeladi - 'Sangam City Civilizationon the bank so friver Vaigai'(Jointly Published by: Department of Archaeology &Tamil Nadu Text Book and Educational Service Corporation, Tamil Nadu)
5. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) Published by: The Author)
6. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
7. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) –Reference Book.

COURSE OUTCOMES

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

1. Explain the scientific, technological and architectural contributions of ancient Tamils in the fields of weaving, ceramics, construction, manufacturing and agriculture.
2. Apply the knowledge of traditional Tamil technologies, irrigation practices, material processing and scientific advancements to contemporary engineering and societal contexts.
3. Analyze the technological developments, construction methods, manufacturing techniques and maritime practices of ancient Tamil civilization using historical and engineering perspectives.
4. Evaluate the significance of Tamil scientific heritage, indigenous technologies and digital Tamil advancements in sustainable development and modern applications.
5. Develop awareness and innovative approaches for preserving, promoting and integrating traditional Tamil scientific knowledge with modern engineering practices.

Mapping with POs & PSOs											
COs\ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**
CO1	2	1	1	1	–	2	1	–	1	–	1
CO2	3	2	2	1	1	3	1	–	1	–	1
CO3	3	3	2	2	1	3	1	–	1	–	1
CO4	3	3	3	2	1	3	1	–	1	1	1
CO5	3	3	3	2	1	3	2	1	1	1	2

25ETES205	BASIC CIVIL ENGINEERING	L	T	P/D	C
		3	0	0	3

COURSE OBJECTIVES

- To inculcate a knowledge on essentials of Civil Engineering.
- To impart knowledge on construction materials and their properties.
- To expose the students on the role, significance and contributions of Civil Engineering in satisfying the social needs.
- To understand the basic knowledge on building construction.
- To understand various materials, methods and special structures in the field of Civil Engineering.

UNIT I: INTRODUCTION TO CIVIL ENGINEERING

Introduction to Civil Engineering - Various disciplines of Civil Engineering – Various components of Residential Building or Structure – Functions of a building - Types of buildings – NBC – Selection of site for buildings – Orientation of a building – Introduction to Surveying - Simple definitions – Plinth area, Carpet area, Built-up area, Floor area – Floor Space Index – Undivided Divided Share (UDS).

UNIT II: CONSTRUCTION MATERIALS

Introduction to various building materials - Stone – Bricks - Steel - Cement - Aggregates - Timbers - Plywood – Glass - Tiles - Paints - Other building materials – Properties, Characteristics, types and uses of materials – Merits and Demerits.

UNIT III: MASONRY, ROOF AND FLOOR

Definitions and terms used in masonry – Brick masonry - Characteristics requirements of good masonry – Bonds in brick work – Header, Stretcher, English, Flemish – Stone masonry - Characteristics requirements of stone masonry – Walls – Types of walls – Concrete block walls – Types of building blocks.

Types of roofs – Flat, Sloped and Curved – Types of Roof coverings – Aluminum and iron sheets – Drainage in roofs – Floors - Types of floors and finishes – Finishing materials and types - Advantages and Disadvantages

UNIT IV: BUILDING CONSTRUCTION

Building construction – Foundations – Bearing Capacity of Soil – Types of foundations -Centre line marking – Columns and Beams – Lintel and Sunshades – Functions – Structural systems - Load transfer mechanism - Plastering – Electrical works – Plumbing works - Finishing – Septic Tank – Water supply and Sanitation – Water treatment and Sewage disposal – Conservation of water and Rain water harvesting.

UNIT V: SPECIAL STRUCTURES IN CIVIL ENGINEERING

Introduction to different types of structures coming under Civil Engineering – Industrial structures - Irrigation structures - Highways and Railways - Harbour and Ports – Retaining walls – Underground and Overhead Water Tanks - Bridges and Dams - Underground and Multi-storeyed structures – Tunnels - etc.

TEXT BOOKS

1. Building Construction by Punmia et al., Laxmi publications Ltd., 2023
2. Building Construction by S.C.Rangwala, Charotar publishing Housr (P) Ltd., 2022
3. Building Materials by Duggal SK, New Age International (P) Ltd., 2019
4. Construction Materials by Vargheese PC, Prentice Hall India P.Ltd.,2015

REFERENCES

1. Palanichamy M.S., Basic Civil Engineering, Tata McGraw Hill Publishing Company Ltd, 2000.
2. Ramamrutham V, Basic Civil Engineering, DhanpatRai Publishing Co. (P) Ltd., 1999.
3. Natarajan K V, Basic Civil Engineering, Dhanalakshmi Publications, Chennai, 2005.
4. Civil Engineering Materials and Construction Practice by RK. Gupta and Jain, Charotar Publishing House, 2019
5. Building Materials by Surendra Singh, Vikas Publishing Company, 1996
6. Civil Engineering Materials by Neil Jhonson and Dhir, RK. Mcmillan Publishers Ltd., 1997
7. Building Construction by Vargheese PC, Prentice Hall India P.Ltd.,2017
8. Building Construction by SP.Arora and Sp.Bindra. Dhanpat Rai Publications, 2014
9. National Building Code.

COURSE OUTCOMES

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

1. Explain the fundamentals of civil engineering, building components, construction materials and structural systems used in engineering practice.
2. Apply the properties and selection criteria of construction materials, masonry techniques and building practices for residential and industrial structures.
3. Analyze the functions and performance of foundations, roofs, floors, water supply systems and sanitation facilities in building construction.
4. Evaluate different civil engineering structures, construction methods and water conservation techniques for sustainable infrastructure development.
5. Develop basic engineering solutions related to building planning, structural components and public utility systems considering safety, functionality and sustainability.

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

25ETES206	ENVIRONMENTAL STUDIES	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

- To realize the importance of environment for engineering students.
- To understand the basis of ECOs\POsystems
- 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: 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: ECOS/POSYSTEM S

Concept of an ECOs/POsystem - Structure and function of an ECOs/POsystem - Producers, consumers and decomposers - Energy flow in the ECOs/POsystem -Ecological succession - Food chains, food webs and ecological - pyramids - Introduction, types, characteristic features, structure and function of the following ECOs/POsystem - Forest ECOs/POsystem , Grassland ECOs/POsystem , Desert ECOs/POsystem , Aquatic ECOs/POsystem (ponds, streams, lakes, rivers, oceans, estuaries)

UNIT III: BIODIVERSITY AND ITS CONSERVATION

Introduction – Definition: genetic, species and ECOs/POsystem 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: ENVIRONMENTAL POLLUTION

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: HUMAN POPULATION AND THE ENVIRONMENT

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.

FIELD WORK

Visit to a local area to document environmental assets-river/forest/grassland hill/mountain - Visit to a local polluted site-Urban/Rural/Industrial/Agricultural - Study of common plants, insects, birds -Study of simple ECOs/POsystem s-pond, river, hill slopes, etc. **(Field work equal to 5 lecture hours)**

TEXT BOOKS

1. Agarwal, K.C. Environmental Biology, Nidi Publ, Ltd. Bikaner, 2001
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India.

REFERENCES

1. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p.
2. Clark R.S., Marine Pollution, Clanderson Press Oxford
3. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001,
4. Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
5. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
6. Down to Earth, Centre for Science and Environment
7. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev.,
8. Environment &Security. Stockholm Env.Institute Oxford Univ. Press. 473p.
9. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural
10. History Society, Bombay
11. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment.
12. Cambridge Univ. press 1140p.
13. Jadhav, H & Bhosale, V.M. 1995. Environmental Protection and Laws. HimalayaPub. House, Delhi 284 p.
14. Mckinney, M.L. & School, R.M. 1996. Environmental Science systems &Solutions,Web enhanced edition. 639p.
15. Mhaskar A.K., Matter Hazardous, Techno-Science Publication
16. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co.
17. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
18. Rao M N. & Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd. 345p.
19. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut Survey of the Environment, The Hindu (M)
20. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science.
21. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliancesand Standards, Vol I and II, Enviro Media.
22. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication.
23. Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia,USA 499p.

COURSE OUTCOMES

On completion of this course, students will be able to

1. Explain the concepts of ECOs/POsystem s, biodiversity, natural resources, environmental pollution and sustainable development relevant to environmental science and engineering.
2. Apply environmental management practices, conservation methods and pollution control measures for sustainable utilization of natural resources.
3. Analyze environmental issues related to ECOs/POsystem s, biodiversity loss, pollution, climate change and population growth using scientific and engineering approaches.
4. Evaluate environmental protection strategies, disaster management practices and legislative measures for maintaining ecological balance and public welfare.
5. Develop sustainable and eco-friendly solutions for environmental conservation, resource management and societal well-being through responsible engineering practices.

Mapping with POs & PSOs											
COs\ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**
CO1	3	2	2	2	1	2	1	–	–	–	1
CO2	3	3	3	2	1	3	1	1	–	–	1
CO3	3	3	2	3	1	3	1	1	–	–	1
CO4	3	3	3	3	1	3	2	1	1	1	1
CO5	3	3	3	3	1	3	3	1	1	1	2

25ETBP207	PHYSICS LABORATORY	L	T	P/D	C
		0	0	3	1.5

COURSE OBJECTIVES

- To develop a strong understanding of wave optics and interference phenomena by performing experiments such as Air Wedge, Newton's Rings, and Young's Double Slit.
- To gain hands-on experience with optical instruments like spectrometers and diffraction gratings for determining wavelengths and dispersive properties of light sources.
- To experimentally determine mechanical properties of materials, including Young's modulus, moment of inertia, and rigidity modulus using bending and torsion methods.
- To explore classical mechanics through pendulum-based experiments, enabling the calculation of time periods, acceleration due to gravity, and related physical constants.
- To investigate fluid and wave dynamics, including viscosity/porositymeasurements and ultrasonic velocity in liquids using acoustic diffraction methods.

List of Experiments

1. **Air-Wedge;** To determine the thickness(diameter) of a thin wire by forming interference fringes.
2. **Newtons rings;** To find the radius of curvature of the given plano convex lens by the Newton's rings.
3. **Dispersive power of the prism;** To find the dispersive power of the material of the prism using spectrometer.
4. **Spectrometer Grating;** To determine the wavelength of the prominent spectral lines of the Mercury (Hg) spectrum using grating.
5. **Laser Grating;** To determine the wavelength of a given laser source by using diffraction grating method
6. **Youngs Modulus - Non-Uniform bending;** To find the Young's modulus of the material of a uniform bar (metre scale) by non-uniform bending.
7. **Youngs Modulus -Uniform bending;** To determine the Youngs modulus of the beam (metre scale) by uniform bending
8. **Simple Pendulum;** To determine the time period of a simple pendulum for different lengths.
9. **Torsion Pendulum;** To determine (i) Moment of inertia of a disc and (ii) Rigidity modulus of a wire by torsional pendulum.
10. **Compound Pendulum;** To determine the value of acceleration due to gravity(g) using compound pendulum
11. **Acoustic diffraction grating;** To determine the ultrasonic velocity in liquid by acoustical grating method.
12. **Co-efficient of Viscosity/porosity by Stokes method;** To verify stokes law and hence to determine the co-efficient of viscosity/porosity of a highly viscous liquid.
13. **Youngs double slit experiment;** To determine the nature of the light by observing interference patterns using double slit.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to

1. Explain the fundamental principles of interference, diffraction, polarization, elasticity, oscillations, acoustics and fluid mechanics relevant to engineering measurements.
2. Apply appropriate experimental principles and procedures to determine physical parameters such as wavelength, thickness, radius of curvature, elastic modulus, acceleration due to gravity, rigidity modulus and viscosity/porosity.
3. Analyze experimental observations, measurements and graphical relationships to determine physical quantities and identify sources of experimental error.
4. Evaluate experimental results by comparing measured values with theoretical or standard values and assess the reliability, accuracy and limitations of the experimental methods.
5. Develop suitable experimental approaches for investigating optical, mechanical, acoustic and fluid-mechanical phenomena using appropriate instruments, data-analysis techniques and collaborative laboratory practices.

Mapping with POs & PSOs											
COs\ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**
CO1	3	2	1	2	1	–	–	1	–	–	1
CO2	3	3	2	3	1	–	–	1	–	–	1
CO3	3	3	2	3	1	–	–	2	1	–	1
CO4	3	3	2	3	1	–	–	2	1	–	1
CO5	3	3	3	3	1	–	–	3	1	–	2

25ETHP208	ENGLISH COMMUNICATION LAB	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.

Theoretical Session (Internal Assessment only)

1. English sound pattern and Sounds of English
2. Pronunciation, Stress and Intonation
3. Common Situations – Conversations and Dialogues
4. Communication at work place
5. Oral presentations – Prepared or Extempore
6. 'Just a Minute' sessions (JAM)
7. Interviews
8. Formal Presentations

Suggested Software Package: EWL and 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

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

1. Describe the principles of effective listening, speaking, reading, writing, interpersonal communication and presentation skills.
2. Demonstrate effective verbal and non-verbal communication skills in academic and workplace situations.
3. Analyze communication situations based on audience, language, verbal and non-verbal cues, and presentation strategies.
4. Evaluate oral and written communication for clarity, coherence, language proficiency, professional etiquette and effectiveness.
5. Develop professional communication skills through presentations, group discussions, interviews and workplace interactions.

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

25ETSP209	ELECTRICAL WIRING AND EARTHING PRACTICE LABORATORY	L	T	P/D	C
		0	0	2	1

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. Staircase 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 Parameter sin a Single-Phase AC Circuit
10. Measurement of Voltage, Current, Power and Power factor in a Resistive Circuit
11. SolderingPractice-Componentsdevicesandcircuits-usinggeneralpurposePCB
12. Corridor Wiring
13. Test the operation and control circuit for LED Fluorescent 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 the course, students will be able to

1. Identify various categories of fuses, insulators, and domestic appliances like automatic iron boxes and stabilizers to understand electrical safety components.
2. Demonstrate residential, industrial, and specialized wiring layouts—including staircase, go-down, corridor, and ceiling fan circuits—using appropriate wiring principles.
3. Analyze the operational parameters of series and parallel lamp circuits and single-phase AC circuits, including voltage, current, power, and power factor.
4. Test the performance of earth resistance, the control circuits of LED fluorescent lamps, and the buck/boost functions of domestic stabilizers to evaluate system safety and efficiency.
5. Build and solder electronic components and circuits on general-purpose PCBs by integrating practical knowledge of wiring and safety practices

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

25ETSP210	ENGINEERING GRAPHICS AND DESIGN	L	T	P/D	C
		1	0	4	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 Modelling; Solid Modelling; Introduction to Building Information Modelling (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. Bhatt, N.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

Upon completion of the course, learners 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 with POs & PSOs											
COs\ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	2	3	2	1	–	–	–	1	–	1
CO2	3	3	3	2	1	–	–	–	1	–	1
CO3	3	3	3	3	1	–	–	–	1	–	1
CO4	3	3	3	3	1	–	–	–	1	–	1
CO5	3	3	3	3	1	–	–	1	2	1	2

25CHBS301	MATERIAL TECHNOLOGY	L	T	P	C
		3	0	0	3

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, Vander 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. Analyze atomic and crystalline foundations of materials by applying principles of atomic bonding and crystallography to determine the density, thermal expansion, and elastic modulus of solids, establishing the primary structure property processing performance relationships.
2. Evaluate mechanical integrity and failure mechanisms by assessing how structural imperfections and deformation processes dictate the yield strength, ductility, and reliability of engineering materials.

3. Characterize advanced and complex material systems by distinguishing the structural configurations and viscoelastic behavior of semi-crystalline polymers, liquid crystals, amorphous silicates, and polymer nanocomposites, focusing on the role of reinforcement–matrix interfaces.
4. Formulate sustainable material solutions for functional applications by selecting and justifying materials for specialized roles, such as biomaterials and catalysts, while evaluating their resistance to corrosion and degradation and their potential for recycling.
5. Implement experimental methodologies for material analysis by utilizing modern characterization tools, including XRD, NMR, and PSA, to establish quantitative links between a material's molecular structure and its macroscopic engineering properties.

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

25CHES302	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

Phase rule – Application of phase rule, two component systems, Eutectic point, Thermal analysis and behaviour of molten liquids. three component systems involving three liquids and two salts and water – separation.
Colloids Electrical properties of colloids, electrokinetic phenomenon – zeta potential – Donnan membrane equilibrium – gels and emulsion.

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, 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 Bah
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 PulishingCompnay

COURSE OUTCOMES:

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

1. Apply the principles of chemistry to analyze the structure, properties, synthesis, and behavior of chemical compounds and materials relevant to chemical engineering applications.
2. Analyze chemical reactions, molecular transformations, and physicochemical phenomena to interpret the behavior of engineering systems and industrial processes.
3. Evaluate the influence of reaction kinetics, phase behavior, and transport-related physicochemical properties on the design and performance of chemical processes.
4. Develop scientific approaches for solving chemical engineering problems through the application of reaction mechanisms, equilibrium principles, and quantitative chemical analysis.

5. Investigate chemical engineering problems using scientific reasoning, modern analytical approaches, professional ethics, and lifelong learning to support sustainable industrial practices.

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

25CHPC303	CHEMICAL TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To teach the basic concept of Chemical Engineering Profession Overview of Indian Chemical Industry.
2. To impart the basic concepts of chemical technology
3. To impart clear description of manufacturing processes of organic and Inorganic Chemicals and its applications.
4. To understand UNIT operations involved in the physical separation of the products obtained during various UNIT processes.
5. To learn the process flow sheet drawing for the manufacturing chemical processes.

UNIT -I

Chemical Engineer and Chemical Engineering Profession, Overview of Indian Chemical Industry, Global trends of chemicals, Life cycle assessment and environmental impact, Modern Chemical Engineering Plants: Batch to Continuous processing

UNIT -II

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-III

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 - IV

Silicate industry: Ceramics, Glass and Cement, paint, Varnish, Enamel and Lacquer, White lead, Zinc oxide, Lithophone, Titanium di oxide, Sugar, starch, gluCOs/POse, 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, visCOs/POse 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. Recall the fundamentals of the chemical engineering profession, Indian chemical industries, industrial gases, fertilizers, silicate industries, polymers, fibers, and related chemical manufacturing processes.
2. Explain the principles, production methods, properties, and industrial applications of inorganic chemicals, fertilizers, silicate products, soaps, detergents, plastics, elastomers, and synthetic fibers.
3. Apply chemical engineering principles to analyze manufacturing processes, material balances, operational methods, and industrial applications involved in chemical and process industries.
4. Analyze the processing techniques, environmental impacts, life cycle assessment, and industrial performance of chemical products and manufacturing systems used in modern chemical industries.

5. Evaluate the efficiency, sustainability, economic importance, and industrial relevance of chemical manufacturing processes, products, and modern processing technologies in chemical engineering industries.

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

25CHPC304	CHEMICAL PROCESS CALCULATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The course aims to

- Introduce the foundational principles of chemical engineering calculations
- Develop the ability to perform mass and energy balances on chemical processes
- Perform stoichiometric calculations involving limiting/reactant excess, percent conversion, and selectivity
- Understand conservation laws and their application to reactive and non-reactive systems
- Develop problem-solving skills relevant to process design and analysis

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. Case studies on Material and Energy Balances for multistage processes and complete plants on sugar industry, sulphuric acid manufacture and chlor-alkali industry.

TEXT BOOKS:

1. Felder, R. M.; Rousseau, R. W., "Elementary Principles of Chemical Processes", Third Edition, 2000, John Wiley & Sons.
2. Bhatt, B. I., Vora, S. M., "Stoichiometry", Fourth Edition, 2004, Tata McGraw Hill Publishing Company Ltd.

REFERENCES:

1. Himmelblau, D. M., Riggs, J. B. "Basic Principles and Calculations in Chemical Engineering", Eighth Ed., 2015, Pearson India Education Services.
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. Understand and explain stoichiometry and composition relationships to perform fundamental material and energy balance calculations for chemical systems with and without reactions.
2. Apply fundamental laws to evaluate physical properties of gaseous and liquid mixtures and psychrometric properties of air using engineering tools such as humidity charts and solve combustion problems.

3. Analyze material balances for complex industrial operations, including crystallization, solvent extraction, and distillation, and solve systems involving recycle and purge streams.
4. Perform thermal energy balance calculations to estimate heat of reaction, mean specific heat of gaseous mixtures, and adiabatic flame temperature.
5. Develop integrated material and energy balance equations for multistage processes and create flow sheets to determine mass and energy requirements for chemical manufacturing and assess their impact on sustainability, environment, and societal health.

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

25CHPC305	PROCESS SAFETY	L	P	O	C
		3	0	0	3

COURSE OBJECTIVES:

By the end of this course, students will be able to:

1. Identify the type of hazards and its nature and control measures.
2. Understand the types of fire and its extinguishing technique.
3. Understand the procedures to be followed in maintenance and protocol during emergencies.
4. Understand the necessity of risk analysis.
5. Recognize the different acts pertaining to factories.

UNIT -I

Physical Hazards – Chemical Hazards – Mechanical Hazards – Electrical Hazards - Biological Hazards – Radiation Hazards and its control techniques

UNIT-II

Plant Layout for Safety – Fire –Chemistry of Fire – Classification of Fires – Types of fire extinguishers – Fire detection systems –Explosion - BLEVE – Confined and UVCE Maintenance of machines and equipment – Types of maintenance – Safety in Material Handling - Work Permit Systems – Onsite and Offsite Emergency Management and Plans

UNIT -III

Hierarchy of hazard controls - Primary Hazard Analysis – Hazop Study – Fault Tree Analysis – Event Tree Analysis – Job Safety Analysis – Quantitative Risk Analysis - Safety Inspection – Accident Reporting and Investigation

UNIT -IV

PPE – Need and Selection – Respiratory PPE – Non Respiratory PPE – Types – Usage instructions of PPE – IS Standards of PPE – Maintenance of PPE, MSDS – Storage, Transportation and Handling of Hazardous Chemicals – Flammable-Corrosive-Reactive - Toxic-Irritants– Colour coding and Labelling

UNIT-V

Analysis of major industrial accidents such as Bhobal, Flixborough, texas, Chernobial etc – Lesson learned form past incidents- Overview of relevant process safety regulations and enforcement (Factories act 1948, OSHA etc.,)

TEXT BOOKS:

1. Frank P Lees, Loss Prevention in Process Industries, Vol. 1, 2 & 3, Butterworth-Heinemann Ltd., London (1991)
2. R. K. Jain & Sunil S Rao, Industrial Safety, Health and Environment Management Systems, Khanna Publishers, New Delhi (2006)
3. Grimaldi & Simonds, Safety Management, AITBS Publishers, New Delhi (2001)

REFERENCES:

1. Dr. B.K. Bhaskara Rao, Er. R.K. Jain, and Vineet Kumar, Safety in Chemical Plants/Industry and its Management, Khanna Publishers, New Delhi, 2010
2. The Factories Act with Amendments 1987, Government of India Publications, DGFASLI, Mumbai

COURSE OUTCOMES:

1. Apply the principles of process safety, hazard identification, and chemical safety to analyze industrial operations and minimize risks associated with chemical process industries.
2. Analyze process safety issues using systematic hazard identification, risk assessment, and accident prevention methodologies to improve operational reliability.
3. Evaluate engineering controls, safety management systems, emergency preparedness, and protective measures for ensuring safe operation of chemical process facilities.
4. Develop safety-oriented engineering solutions by integrating process design, regulatory requirements, hazardous chemical management, and sustainable engineering practices.
5. Investigate industrial accidents using modern safety analysis tools, technical communication, ethical practices, and lifelong learning to enhance process safety performance.

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

25CHPC306	CHEMICAL ENGINEERING THERMODYNAMICS - I	L	T	P	C
		3	0	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.
- The PVT behavior and other laws of thermodynamics
- The concept of entropy and method of calculating ideal work and lost work
- The thermodynamics applications in pumps, pipes, compressor etc.,

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;

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. Industrial application of second law of thermodynamics.

UNIT-IV

Thermodynamic property of fluids, Maxwell relations, 2-phase systems, graphs and tables of thermodynamic properties, Residual properties, Industrial application of equation of state.

UNIT-V

Applications of Thermodynamics to flow processes-Pumps, Pipes, Nozzles, Compressors and Turbines. Principles of 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. Explain the basic concepts of thermodynamics, thermodynamic systems, properties, laws of thermodynamics, and perform mass and energy balance calculations for closed and open systems.
2. Apply equations of state, phase equilibrium concepts, and PVT relationships to evaluate thermodynamic behavior of pure fluids and gases.
3. Analyze entropy changes, second law applications, heat engines, and thermodynamic efficiency in engineering systems.
4. Evaluate thermodynamic properties of fluids using Maxwell relations, residual properties, and property tables/charts for engineering applications.
5. Apply thermodynamic principles to industrial flow processes such as pumps, compressors, turbines, nozzles, and liquefaction systems.

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

25CHCP308	ORGANIC & PHYSICAL CHEMISTRY LABORATORY	L	T	P	C
		0	0	3	1.5

COURSEOBJECTIVES:

1. To learn basic principles involved in analysis and synthesis of different organic derivatives.
2. To improve the practical knowledge on the properties and characteristics of solvents and mixtures

ORGANIC CHEMISTRY

Preparation of Compounds involving the following reactions:

1. Oxidation
2. Reduction
3. Bromination
4. Nitration
5. Sulfonation
6. Acetylation
7. Methylation
8. Hydrolysis
9. Diazotisation

Qualitative Analysis for the following compounds:

1. Aldehydes
2. Ketones
3. Acids
4. Esters
5. Amides
6. Amine
7. Ethers
8. Alcohol
9. hydrocarbons
10. 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 electropotentials, Concentration cells, Titrations, pH determination.
6. Surface tension
7. VisCOs/POsity

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. Perform the synthesis and purification of organic compounds involving oxidation, reduction, substitution, hydrolysis, and diazotization reactions using standard laboratory procedures and safety practices.
2. Identify and characterize organic compounds through systematic qualitative analysis and determine their physical constants using appropriate experimental techniques.

3. Conduct physical chemistry experiments to determine physicochemical properties such as molecular weight, phase equilibria, optical properties, conductivity, EMF, surface tension, and visCOs/POsity, and interpret the experimental results.
4. Apply laboratory instruments, modern analytical techniques, and engineering tools to perform experiments, analyze data, estimate experimental errors, and prepare technical laboratory reports.
5. Evaluate experimental observations and analytical results to solve chemistry-related engineering problems while adhering to laboratory safety, professional ethics, and lifelong learning practices.

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

25CHCP309	TECHNICAL ANALYSIS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

- To develop fundamental skills in qualitative and quantitative chemical analysis techniques.
- To understand and apply standard laboratory procedures for the identification and estimation of chemical substances.
- To gain proficiency in the use of analytical instruments such as spectrophotometers, pH meters, and conductivity meters.
- To interpret experimental data and calculate concentrations, purities, and other relevant parameters accurately.
- To ensure proper laboratory safety practices and chemical handling protocols are followed.

LIST OF EXPERIMENTS:

1. Proximate and Ultimate analysis of coal
2. Analysis of Water
3. Analysis of Common salt
4. Analysis of Bleaching powder
5. Analysis of Copper
6. Analysis of Mixed Acid
7. Analysis of Tannin
8. Analysis of Soap
9. Analysis of cement
10. Analysis of sugar
11. Viscosity/porosity Estimation.
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. Apply fundamental chemical engineering principles to determine the composition and purity of inorganic industrial chemicals and acids through titrimetric and gravimetric analysis.
2. Analyze and evaluate the quality of natural resources and environmental samples, including fuel characterization and water potability, using standardized analytical procedures.
3. Examine the quality parameters and specifications of complex industrial and consumer products to ensure compliance with process industry standards.
4. Utilize analytical instrumentation and physical measurement techniques to quantify material properties essential for process design and optimization
5. Interpret experimental data ethically and professionally to provide pragmatic solutions for resource utilization, sustainability, and process efficiency in diverse industrial environments.

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

25CHBS401	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)
- To equip students with the fundamental concepts and computational techniques of numerical methods, enabling them to model, analyze, and solve complex chemical engineering problems involving mass, energy, and momentum transfer.
- The course aims to develop proficiency in applying numerical tools for solving differential equations, linear and nonlinear systems, optimization problems, and data analysis relevant to chemical engineering processes.

UNIT-I

Introduction, Approximation and Concept of Error & Error Analysis, Linear Algebraic Equations: Methods like Gauss elimination, Gauss-Jordan, LU decomposition, 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. Apply mathematical and numerical principles to formulate engineering problems and obtain approximate solutions for complex chemical engineering systems.
2. Analyze the accuracy, convergence, stability, and suitability of numerical techniques for solving engineering and scientific problems.
3. Develop numerical models and computational algorithms for the analysis of engineering systems involving algebraic and differential equations.
4. Evaluate engineering data and process behavior using numerical methods to support modeling, prediction, and decision-making in chemical engineering applications.
5. Investigate and solve complex engineering problems using modern computational tools, critical thinking, and independent learning approaches.

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

25CHES402	PYTHON FOR CHEMICAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce data types, operators, input/output and assignment statements.
- To familiarize the conditional/decision-making and looping statements used in
- Python programming.
- To provide in-depth knowledge about the functions, lists, tuples, sets and dictionaries.
- To illustrate the use of open-source python packages NumPy, Pandas, and Matplotlib.
- To study the applications of open-source python packages like Cantera, IDEAS-PSE

UNIT I – Introduction to Python Programming

History of python-Getting started with python-Programming Style-Programming errors. Elementary Programming: Writing a simple program-Reading input from the console-Identifiers-Variables, Assignment statements, and expressions-Simultaneous Assignments-Named Constants-Numeric data types and operators-Evaluating expressions and operator precedence-Augmented assignment operators-Type conversion and rounding.

UNIT II – Conditional and Looping Statements

Boolean types, values, and expressions - Generating random numbers, if statements – if-else statements – Nested if and multi-way if-elif-else statements – Logical operators – Conditional expressions – Operator precedence and associativity-while loop-for loop – Nested loops-break and continue keywords.

UNIT III - Functions, Lists, Tuples, Sets and Dictionaries

Common python function -Strings and characters-Introduction to objects and methods. Defining a function–Calling a function–Functions with/without return values – Positional and keyword arguments – Passing arguments by reference values- Modularizing Code-Returning multiple values-List Basics-Processing two dimensional lists-Introduction to tuples, sets and dictionaries.

UNIT IV - Standard Python Packages (NumPy, Pandas and Matplotlib)

NumPy (Numerical Computing): Basics-Array creation-printing arrays-basic operations-universal functions-indexing, slicing and iterating-shape manipulation-copies and views. Pandas (Data Manipulation and Analysis): Basic data structure in pandas-Object Creation-Viewing data-importing and exporting data. Matplotlib (Data visualization): Simple example-parts of a figure - types of inputs to plotting functions-coding styles-Styling artists-labeling plots-Axis scales and ticks.

UNIT V - Packages for Chemical Engineering

Chemicals – Physical and chemical property estimation library, **Cantera** – Chemical kinetics, thermodynamics, and transport processes, **IDAES-PSE** – Advanced process systems engineering framework for modeling, optimization, and control (built on Pyomo)

TEXT BOOKS AND USER GUIDES:

1. Y. Daniel Liang, Introduction to Programming using Python, Pearson Education, 2013.
2. NumPy documentation, user guide: https://numpy.org/doc/stable/
3. Pandas documentation, user guide https://pandas.pydata.org/docs/
4. Matplotlib, user guide https://matplotlib.org/stable/index.html

COURSE OUTCOMES:

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

1. Apply Python programming concepts and computational thinking to formulate and solve engineering problems encountered in chemical engineering practice.
2. Develop efficient and modular Python programs by integrating appropriate programming constructs, data structures, and computational techniques for engineering applications.
3. Analyze engineering data using scientific computing, data analysis, and visualization tools to interpret and communicate meaningful insights for process applications.

4. Evaluate and implement computational models using Python-based engineering libraries for simulation, thermodynamics, reaction engineering, transport phenomena, and process systems engineering.
5. Construct programs for solving real-life problems in chemical engineering using specialized Python packages.

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

25CHPC403	FLUID MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the students to the fundamentals of the mechanics of fluids pertaining to fluid behavior in various systems.
- To analyze, model, and solve problems involving fluid statics and dynamics, flow through pipes and channels, and transport phenomena relevant to chemical processes.
- To emphasis is placed on applying these concepts to real-world engineering systems involving pumps, compressors, reactors, and heat exchangers.
- To impart the techniques for flow measurement and instruments and equipment involved in transportation of fluids.

UNIT-I

Basic Concept of fluid mechanics

Definition of fluid - Classification of fluids – Newtonian fluid – Characteristic properties of fluids – Non -Newtonian Fluids and their classification. Kinematics of fluid flow-. Fluid statics: Pascal‟s law and Hydrostatic law of equilibrium Hydrostatic Equilibrium in a centrifugal field, Buoyancy and stability; Pressure and its measurement- Manometers

UNIT-II

Concept of Fluid Flow Phenomena

Equation of Continuity and its application, Introduction to boundary layer, boundary layer thickness under laminar and turbulent flow conditions. Equation of motion – Differential analysis: mass and momentum balances Derivation of Navier-Stokes equation, Euler‟s equation, Bernoulli‟s equation and its application in fluid flow.

Flow through Circular Pipes

Flow of fluids in Laminar regime – Velocity Profile, Shear Stress Distribution – Hagen–Poiseuille equation - Concept of average velocity – Concept of Kinetic energy correction factor, Concept of Fluid friction – Skin friction – Form friction – Factors affecting friction – Friction factor – Application of Moody‟s diagram, Minor losses and major losses during flow–Pipe, Fittings and Valves, Types of Fittings, valves characteristics and sizing of valves. Estimation of head loss from fittings and valves, Concept of minor losses and types of minor losses.

UNIT-III

Fluid Flow through Packed and Fluidized Bed

Flow past immersed bodies – Significance of form friction - Concept of Drag, Drag Coefficients and Particle Reynolds number - Drag Coefficient vs. Particle Reynolds number curves for regular and irregular shaped solid particles. Flow of fluids through packed beds – Packing and types of packing -Pressure drop across packed beds –Kozeny Carman equation – Ergun‟s equation - Loading and Flooding Packed Beds. Concept of Fluidization – Condition for Solid particles to be in a suspended condition in a flowing fluid – minimum fluidization velocity

UNIT-IV

Dimensional Analysis: Rayleigh method and Buckingham π theorem- Utility network in chemical process industries: Cooling water, Steam, Chilled water, Thermic fluid system

UNIT-V

Transportation and metering of Fluids:

Fluid Moving Machinery:

Pumps – Classification and working of Centrifugal Pumps and Positive Displacement Pumps Basic Principles of Centrifugal Pumps – Pump Characteristics – Concept of Specific Speed, Net Positive Suction Head – Factors influencing selection of pump. Fans, Blowers and Compressors. Vacuum pumps – jet ejectors.

Metering of fluids:

Full bore meters – Venturi meter, Orifice meter, Rotameters, Vortex-Shedding meters, Magnetic meters and Coriolis meters. Insertion meters – Pitot Tube, Thermal meters, notches and weirs.

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. Understand the characteristics of fluid, its types, concept of fluid flow, friction factor, pressure drop in flow passed immersed bodies and working principles of pumps and valves.
2. Analyze complex fluid flow phenomena and boundary layer behavior by formulating differential mass and momentum balances and applying dimensional analysis techniques (Rayleigh/Buckingham π) to model chemical process systems.
3. Investigate and evaluate energy losses and flow dynamics in circular pipes, fittings, and packed/fluidized beds to design efficient systems for immersed bodies with consideration for sustainable resource management.
4. Select and size appropriate fluid moving machinery and metering devices (pumps, compressors, and flow meters) by interpreting performance characteristics and specific speed to optimize industrial utility networks.
5. Demonstrate professional competence and collaborative teamwork by effectively communicating technical specifications of fluid systems, applying management principles to engineering projects, and recognizing the need for life-long learning in emerging technologies.

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

25CHPC404	HEAT TRANSFER	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the basic concepts of heat transfer pertaining with conduction in various geometry.
- To present the fundamentals of convection heat transfer and analogies between three types of transfer
- To understand the heat transfer coefficient and its calculation using the correlations for the design of various heat transfer equipment
- To understand the design aspects of finned tube heat exchanger, condenser and other compact heat exchangers.
- To learn about the radiative heat transfer, heat transfer evolved in agitated tanks, packed beds as well as fluidized bed and design aspects of evaporator and furnaces.

UNIT-I

HeatTransfer Fundamentals: Modes of heat transfer, Steady State conduction, Fourier's law, Heat transfer in cartesian, cylindrical and spherical coordinate system, One dimensional problem, Heat transfer from extended surfaces, Insulation, Two- and three-dimensional problems, Unsteady state conduction.

UNIT-II

Convective heat transfer - natural and forced convection, Concept of heat transfer coefficient, LMTD and resistance, Dimensional analysis, Thermal boundary layer, Correlation in heat transfer without phase change, Analogy between momentum transport and heat transport.

UNIT-III

Design of heat transfer equipment - Double pipe heat exchanger, Shell and tube heat exchanger, Kern method, NTU - epsilon method for exchanger evaluation, construction aspects in brief, Bell Delware Method.

UNIT-IV

Design aspects of finned tube and compact heat exchangers, Basics of Heat transfer with phase change– Heat transfer in boiling liquids, Regimes of boiling heat transfer, Condensation, Design aspects of condensers, reboilers.

UNIT-V

Basics of Radiative heat transfer, Laws of radiation, Black body, grey body, Emissive power, radiation between surfaces and non-black surfaces, Design aspects of Evaporators and Furnaces, Heat transfer in agitated tanks, packed beds and fluidised beds

TEXTBOOKS:

1. R.Welty, C.E. Wicks, R.E.Wilson, G. Rorrer, Fundamentals of Momentum, HeatandMassTransfer,4thEd.,2007,Wiley.
2. W. J. McCabe, J. Smith, P. Harriot, UNIT Operations of Chemical Engineering, Seventh Edition, 2005, McGrawHill.
3. Holman, J.P., S. Bhattacharya, Heat Transfer, 10th Ed.,2011, TataMcGraw-Hill.
4. D.Q. Kern, ProcessHeatTransfer,1997, Tata-McGrawHill.

REFERENCES:

1. Bejan, A., A.D. Kraus, HeatTransferHandbook,2003, JohnWiley.
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. Identify and formulate solutions for complex heat transfer problems involving steady and unsteady state conduction, convection, and radiation in various coordinate systems.
2. Analyze thermal boundary layers and transport analogies using dimensional analysis to predict heat transfer coefficients and performance in single-phase and phase-change regimes, including boiling and condensation, for industrial process applications.

3. Design and develop creative solutions for complex industrial heat transfer equipment, including shell-and-tube heat exchangers, condensers, and reboilers, using standardized methodologies such as Kern, NTU–ε, and Bell–Delaware while considering whole-life COs/POst and efficiency.
4. Conduct investigations of specialized process equipment, such as agitated tanks, packed beds, and fluidized beds, through modeling and data interpretation to ensure optimal utilization of resources.
5. Evaluate the impact of high-temperature thermal systems, including furnaces and evaporators, on sustainability, safety, and the environment while adhering to ethical professional standards and net-zero carbon goals.

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

25CHPC405	MASS TRANSFER - I	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The course is aimed to:

- introduce the fundamental principles of mass transfer and diffusion in chemical engineering processes.
- learn and determine mass transfer rates under laminar and turbulent conditions
- analyze and design systems involving molecular diffusion, interphase mass transfer, and mass transfer coefficients.
- practical operations such as gas absorption, humidification, drying, and distillation.
- 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 considerations: loading and flooding zones, pressure drop and column diameter – Principles of Absorption – Absorption from Rich Gases, Operating lines from material balances, Number of equilibrium stages, Kremser equation, Stage efficiency and column performance – Mass Transfer Correlations – Rate based methods for packed columns (HTU, NTU) - Absorption with Chemical Reaction.

UNIT – III

Humidification Operation – Definitions – Humidity Chart – Wet-bulb Temperature – Cooling Tower process design, mass and heat balance in bulk and interfaces, performance evaluation of cooling towers,

UNIT – IV

Drying of Solids – Principles of Drying – Cross-Circulation Drying – Through-Circulation Drying – Drying Equipments- Process design of dryers, material and energy balances in direct dryers – Drying of bio products.

UNIT – V

Crystallization - Crystal Geometry – Equilibria and Yields – Nucleation – Crystal Growth – Crystallization Equipment – Crystallizer Design-Crystal Size Distribution – Crystallization from Melts- Process design of crystallizers and their operation.

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.
4. Seader, J. D., Henley, E. J.,2005. Separation Process Principles, 2 ed. Wiley, Hoboken, N. I.

COURSE OUTCOMES:

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

1. Apply fundamental principles of diffusion, gas absorption, humidification, drying, and crystallization to solve complex chemical engineering problems by utilizing mathematical and scientific frameworks.
2. Analyze process parameters and design specialized equipment, including packed towers, cooling towers, dryers, and crystallizers, to develop efficient solutions for mass transfer operations with consideration for sustainability and resource management.
3. Conduct systematic investigations and experiments to evaluate the performance of mass transfer, absorption, humidification, drying, and crystallization systems, interpreting experimental data to provide valid conclusions.

4. Select and apply modern engineering tools and correlations to predict, model, and optimize the behavior of absorption, humidification, drying, and crystallization processes while evaluating their impact on safety and the environment.
5. Demonstrate professional responsibility by managing projects involving mass transfer, absorption, humidification, drying, and crystallization operations, effectively communicating technical designs and reports within multidisciplinary teams.

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

25CHPC406	CHEMICAL ENGINEERING THERMODYNAMICS - II	L	T	P	C
		3	0	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 – Raoult's law - VLE computations for ideal solutions; Modified Raoult's law – Positive and Negative Deviations.

UNIT-II

Free energy and chemical potential, partial properties, Gibbs Duhem equation – Criterion for phase equilibrium; Excess and residual properties; Fugacity and fugacity coefficient of pure species and species in solution, Activity and 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 and Wilson. NRTL, UNIQUAC and UNIFAC model, Henry's law; Infinite dilution activity coefficients. Heat effects and Property Change on Mixing.

UNIT-IV

Principles and Applications of Liquid-Liquid Equilibria and Solid-Liquid Equilibria.

UNIT-V

Chemical reaction equilibria: equilibrium criterion, equilibrium constant, evaluation of equilibrium constant at different temperatures, Equilibrium Conversion of Single Reactions, Phase rule and Duhem's theorem for reacting systems, introduction to 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. Analyze Vapor-Liquid Equilibrium (VLE) for both ideal and non-ideal solutions by applying fundamental property relations, the phase rule, and Raoult's laws to compute phase behavior and identify azeotropes.
2. Evaluate partial properties, fugacity, and activity coefficients using the Gibbs-Duhem equation and summability relations to establish criteria for phase equilibrium in multi-component systems.
3. Model the behavior of non-ideal liquid mixtures using Excess Gibbs energy models (such as Margules, Wilson, NRTL, and UNIFAC) and calculate thermodynamic property changes and heat effects during mixing.
4. Formulate and solve complex equilibrium problems involving multiple phases, including Liquid-Liquid (LLE), Solid-Liquid (SLE), and Vapor-Liquid-Liquid (VLLE) systems for industrial separation processes.
5. Predict the extent of chemical reaction equilibria by evaluating equilibrium constants and conversion for single and multiple reactions under varying temperatures.

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

25CHCP408	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. Reynolds apparatus
2. Bernoulis theorem apparatus
3. V- notch
4. Orifice meter
5. Pitot tube
6. Venturi meter
7. Friction in Pipeline
8. Friction in pipe fittings, sudden enlargement and contraction
9. Centrifugal pump
10. Variable speed centrifugal pump
11. Packed bed
12. Fluidized bed

COURSE OUTCOMES:

On completion of the course, the students are expected to

1. Apply the principles of fluid mechanics to experimentally determine flow behavior, pressure drop, flow regimes, and energy losses in fluid flow systems
2. Operate and evaluate the performance of fluid flow measuring devices and fluid transport equipment under varying operating conditions
3. Conduct experiments on pipe flow systems, packed beds, and fluidized beds to analyze transport phenomena and interpret engineering data systematically.
4. Investigate the operational characteristics and efficiencies of pumps and flow systems using appropriate experimental procedures, engineering tools, and data analysis techniques
5. Demonstrate professional laboratory practices through teamwork, technical reporting, effective communication, and independent learning in fluid mechanics applications.

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

25CHPC409	HEAT TRANSFER LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

- To experimentally investigate the fundamental modes of heat transfer—conduction, convection, and radiation—and to enhance understanding of heat transfer principles through hands-on experiments.
- The lab aims to develop students' skills in operating thermal equipment, analyzing experimental data, and relating theoretical concepts to practical applications in chemical and process industries.
- 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. Stefan-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. Conduct experiments to determine the modes of heat transfer and evaluate heat transfer coefficients under conduction, convection, and radiation using standard laboratory equipment.
2. Analyze the performance of heat transfer equipment such as heat exchangers, condensers, jacketed kettles, and finned tubes by interpreting experimental data and comparing the results with theoretical correlations.
3. Investigate the thermal properties of engineering materials and heat transfer phenomena, including thermal conductivity, emissivity, critical heat flux, and condensation characteristics using appropriate experimental techniques.
4. Apply modern engineering tools and laboratory techniques to perform experiments, analyze data, estimate experimental errors, and prepare technical reports for heat transfer systems.
5. Evaluate the performance of heat transfer systems through experimentation and data interpretation to recommend suitable engineering solutions considering efficiency, sustainability, and professional laboratory practices.

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

FIFTH SEMESTER

25CHPC501	PARTICLE MECHANICS & MECHANICAL OPERATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce the basic principles of mechanics of particles, including the study of forces, motions, and interactions at the particle level.
- To develop a strong understanding of kinematic and dynamic principles that govern the motion of individual particles and systems involving particles.
- To study the operation and analysis of mechanical systems involving particulate matter, including processes such as size reduction, screening, filtration, and mixing.
- To evaluate the significance of particle size distribution in various engineering applications, such as in powder handling, cement manufacturing, and pharmaceuticals.
- To develop problem-solving skills by working through real-world case studies and engineering problems related to particle mechanics and mechanical operations.

UNIT-I

Relevance of particle mechanics and mechanical operations in chemical engineering processes. Nano-particles and its properties. General characteristics of solids - Particle Shape, Size, Mixed Particle Sizes, Shape factor; Different techniques of size analysis - Cumulative and Differential Analysis; Various Mean Diameters; Surface area determination; Screening methods and equipment, screen efficiency, ideal and actual screens.

UNIT-II

Size reduction: Principles and Laws of size reduction, energy relationships in size reduction; Methods of size reduction - classification of equipment, crushers, grinders, cutting machines, disintegrators for coarse, intermediate and fine grinding, power requirement, work index; Open and Closed-Circuit Operation. Size enlargement - principle of granulation, briquetting, pelletisation, and flocculation.

UNIT-III

Settling - Motion of a Particle through a Fluid – Terminal Velocity–Free and Hindered Settling.
Sedimentation: Gravity Sedimentation – Mechanism – Continuous Sedimentation – Thickener – Classifier and Clarifier –Equipment – Gravity Settling Tank –Elutriator – Cone Classifiers – Bowl Classifier – Centrifugal Classifier, Settling Area – Centrifuges. Industrial dust removing equipment, cyclones and hydro cyclones, bag filters, electrostatic and magnetic separators: Heavy media separations, floatation, jigging.

UNIT-IV

Filtration– Filter Media – Filter Aids – Principles of Cake Filtration – Constant Pressure Filtration – Constant Rate Filtration - Pressure Drop Through Filter Cake –Compressible and Incompressible Filter Cakes - Specific Cake Resistance - Filter Medium Resistance. Filtration Equipment – selection, operation of Filter Press, Leaf Filter, Rotary Continuous Filters. Principles of Centrifugal Filtration-Washing of Filter Cakes.

UNIT-V

Agitation and Mixing of Liquids – Principles of Agitation – Agitation Equipment –Impellers – Flow Pattern in Agitated Vessel - Power Consumption in Agitated vessel. Flow number – Power Correlation - Calculation of power consumption. Blending and mixing - Jet mixers – Motionless Mixers. Mixing of Solids: Mixtures for Cohesive solids – Power requirements Criteria for mixer effectiveness. Mixers for free flowing granular solids - Rate of mixing. Storage and conveying of solids - Bunkers, silos, bins and hoppers, transportation of solids in bulk, conveyer selection, different types of conveyers and their performance characteristics

TEXTBOOKS

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

REFERENCES:

1. Badger and Banchero, Introduction to Chemical Engineering,
2. Rhodes,M.J., Introduction to Particle Technology, 2nd edition, 2008, John Wiley, Chichester; New York.
3. UNIT Operations-I, Fluid Flow & Mechanical Operation, Gavhane, Nirali Prakashan
4. UNIT Operations Vol.-I, K.A.Gavhane, Nirali Prakashan

COURSE OUTCOMES:

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

1. Apply the principles of particle mechanics and transport phenomena to analyze the physical characteristics and behaviour of particulate materials encountered in chemical process industries.
2. Analyze the performance of mechanical operations involving particulate solids using engineering principles, mathematical models, and design correlations to improve process efficiency.
3. Evaluate solid handling, separation, filtration, mixing, and particulate processing systems based on operational characteristics, energy requirements, and product quality.
4. Develop engineering solutions for the selection, design, and optimization of particle processing equipment considering process requirements, sustainability, safety, and industrial constraints.
5. Investigate complex particulate processing problems using modern engineering tools and experimental data to support industrial decision-making.

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

25CHPC502	CHEMICAL REACTION ENGINEERING – I	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand the basic concepts of kinetics (homogeneous reactions) and rate laws
- To design and rating of ideal flow reactors
- To analyze and correlation of rate data
- To design the rate kinetics of multiple reactions
- To analyze the non-ideal flow Behavior in real reactor

UNIT-I

Kinetics of Homogeneous reactions: 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

Introduction to Reactor Design: Generalized material and energy balance- Sizing and analysis of ideal batch, mixed, plug flow and recycle reactors - design equations, graphical interpretation - solving design equations for constant and variable density systems, reactors in series and parallel-Isothermal, adiabatic and non-isothermal operation modes.

UNIT-III

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

UNIT-IV

Design for Parallel Reactions: Types of Multiple Reactions- Conversion, Selectivity and Yield-Maximizing the Desired Product in Parallel and Series Reactions.

UNIT-V

Non-idealities in chemical reactors: RTD-Axial dispersion models.

TEXT BOOKS

1. Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, 2001, John Wiley & Sons.
2. Scott Fogler, H., Elements of Chemical Reaction Engineering, 2nd Edition, 2001, Prentice Hall.

REFERENCE BOOKS:

1. Lanny D. Schmidt, The Engineering of Chemical Reactions, 1998, (Oxford University Press)
2. Dawande S.D., Principles of Chemical Reaction Engineering, Central Techno Publications, Nagpur.
3. Gavhane, K. A., Chemical Reaction Engineering, volume-I, Nirali Prakashan.

COURSE OUTCOMES

Students will be able to

1. Analyze the kinetics of homogeneous reactions by applying stoichiometry, the extent of reactions, steady-state approximations, and rate-limiting step theory to determine reaction rates.
2. Evaluate and design ideal reactors, including batch, mixed-flow, plug-flow, and recycle reactors, using graphical interpretation of design equations under isothermal, adiabatic, and non-isothermal conditions.
3. Interpret and correlate experimental kinetic data using differential and integral methods of analysis and advanced linearization techniques.
4. Optimize multiple reaction systems, including parallel and series reactions, by applying the concepts of conversion and selectivity to maximize the yield of desired products.
5. Model non-ideal flow behavior and complex mixing patterns in chemical reactors using Residence Time Distribution and axial dispersion models.

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

25CHPC503	MASS TRANSFER – II	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The course is aimed to

- Understand the principles of mass transfer
- Applications of conventional and less conventional separation techniques.
- Develop knowledge, ability to work and operate on different types of downstream processes
- 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

Fractionating column and multistage column- Number of theoretical stages by McCabe - Thiele method and Lewis - Sorel method- Operating and feed lines, Total reflux, minimum reflux ratio, optimum reflux ratio, Tray and column efficiency -Packed column distillation, Rate based methods: HETP, HTU- Azeotropic and Extractive distillation – Methods for multi-component distillation: Fenske- Underwood- Gilliland method.

UNIT – III

Liquid - liquid extraction – Equilibria - Solvent Characteristics - Stage Wise and Continuous Contact - Design Calculations – Extraction Equipment's. Introduction to reactive extraction, aqueous two phase extraction, extraction of biomolecules, supercritical extraction - Leaching – Unsteady State and Steady State operation - Equipment's for leaching.

UNIT – IV

Adsorption and Ion exchange- Types of adsorptions, nature of adsorbents, adsorption and ion exchange equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers, break through curves – Scale- up and process alternatives, Adsorptive membranes, simulated- moving bed operation, modes of operation.

UNIT – V

Introduction to less conventional separation process and its applications –Types of separations: Dialysis - Osmosis - Reverse Osmosis - Ultra Filtration – Gas separation, vapour permeation and pervaporation– Electro Dialysis - Nano filtration. Transport through porous membranes, Resistance models, Liquid diffusion through pores, Gas diffusion through porous membranes - Transport through non-porous membranes- solution diffusion for liquid mixtures, gas mixtures, Concentration polarization and Fouling. Membrane modules, arrangement of modules in cascades, performance criteria and design considerations.

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, 2007, Prentice Hall of India.
4. Seader, J. D., Henley, E. J.,2005. Separation Process Principles, 2 ed. Wiley, Hoboken, N. I

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. Apply comprehensive knowledge of mathematics, natural sciences, and engineering fundamentals to solve complex problems in distillation, liquid-liquid extraction, leaching, adsorption equilibria, and membrane transport models.
2. Analyze complex engineering problems to design and develop efficient separation systems—including fractionating columns, extraction equipment, fixed-bed adsorbers, and membrane modules—while considering process efficiency, safety, and life-cycle COs/POsts.
3. Design and conduct systematic investigations of separation processes and interpret experimental data to provide valid conclusions for process optimization.
4. Select and apply appropriate techniques and modern tools, such as McCabe-Thiele and Fenske-Underwood methods or resistance models, to evaluate the environmental and societal impact of separation technologies like supercritical extraction and reverse osmosis.
5. Function effectively as an individual or team leader to manage projects involving diverse separation technologies, adhering to ethical principles and communicating technical designs through professional reports and presentations.

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

25CHPC504	PROCESS INSTRUMENTATION	L	P	0	C
		3	0	0	3

COURSE OBJECTIVES

By the end of this course, students will be able to:

1. Understand the Fundamentals of Process Instrumentation
2. Explore Advanced Measurement Techniques and Smart Transmitters and the working principles of modern temperature, pressure, flow, and level sensors.
3. Apply Process Analytical Instrumentation and IIoT Concepts
4. Analyze Industrial Communication Protocols and Smart Data Acquisition
5. Implement Smart Instrumentation for Process Control and Automation

UNIT I: Introduction to Process Instrumentation

Basics of Measurement & Instrumentation -Static and Dynamic Characteristics of Instruments - Classification of Instruments - Standards and Calibration - Error Analysis and Uncertainty in Measurements - Digital vs. Analog Sensors

UNIT II: Sensors and Transducers

Principles of Sensors and Transducers - Temperature Measurement: Thermocouples, RTDs, Thermistors, and Pyrometers - Pressure Measurement: Manometers, Bourdon Tubes, Strain Gauges, and Piezoelectric Sensors - Ultrasonic and Electromagnetic Flowmeters - Level Measurement: Float, Conductivity, Ultrasonic, and Radar Level Sensors

UNIT III: Analytical and Composition Measurements and IIoT Integration

pH Measurement and Conductivity Sensors - Gas and Liquid Chromatography - Spectroscopic Techniques (UV-Vis, IR, Mass Spectrometry) - Oxygen and Humidity Sensors - Industrial Applications of Analytical Instruments - Industrial IoT (IIoT) in Process Instrumentation

UNIT IV: Signal Conditioning and Data Acquisition Systems

Signal Conditioning: Amplification, Filtering, and Isolation - Analog-to-Digital and Digital-to-Analog Converters - Data Acquisition Systems (DAQ) - Introduction to Process Control Systems (SCADA, DCS, and PLC) - Industrial Communication Protocols (HART, MODBUS, Fieldbus) - Fieldbus Systems and Industrial Ethernet for Smart Instrumentation

UNIT V: Smart Instrumentation for Process Automation and Control

Smart Control Valves, Actuators, and Pneumatic Systems - AI-Enabled Instrumentation for Predictive Maintenance - Digital Twin Technology and Virtual Sensors in Process Industries - Case Studies: Smart Instrumentation in Refining, Petrochemical, and Pharmaceutical Industries

Textbooks:

1. B.G. Lipták, Instrument Engineers' Handbook: Process Measurement and Analysis, CRC Press.
2. R. Singh, Industrial Instrumentation and Control, McGraw-Hill.
3. R.K. Jain, Mechanical and Industrial Measurements, Khanna Publishers.

REFERENCE BOOKS:

1. W. Bolton, Instrumentation and Control Systems, Elsevier.
2. J. G. Webster, Measurement, Instrumentation, and Sensors Handbook, CRC Press.
3. B. G. Lipták, Process Control and Optimization, CRC Press.
4. K. F. Man, Smart Instrumentation and IIoT for Process Industries, Wiley.
5. F. Tao, Digital Twin Technologies and Smart Manufacturing, Academic Press.

COURSE OUTCOMES :

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

1. To explain the static and dynamic characteristics, operating principles, and calibration of diverse industrial measurement systems, including physical (temperature, pressure, flow, level) and digital sensors.
2. To analyze in process measurement and analytical instrumentation (pH, chromatography, spectroscopy) to formulate substantiated conclusions for industrial monitoring and the integration of IoT architectures.
3. To utilizing smart control valves, actuators, and industrial communication protocols, while evaluating societal impacts, public safety, and environmental sustainability.
4. To model, analyze and interpret data from signal conditioning circuits and data acquisition systems (SCADA, DCS, PLC) to ensure reliable industrial communication.
5. To manage instrumentation projects (involving AI and Digital Twins) and communicating technical findings through comprehensive reports and presentations.

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

25CHCP507	PARTICLE MECHANICS & MECHANICAL OPERATIONS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSEOBJECTIVES:

Objectives of this course is to

- Impart knowledge on different types of crushers and grinders
- Understand the fundamentals of fluid-particle mechanics
- Understand the concepts in industrial processes like packed bed operation, fluidized operation
- Understand the separation of particulates using processes using sedimentation, filtration, and cyclone separator

LIST OF EXPERIMENTS

1. Sieve Analysis
2. Vibrating Screen
3. Drop weight crusher
4. Double Roll Crusher
5. Jaw Crusher
6. Ball Mill
7. Settling
8. Sedimentation
9. Leaf Filter
10. Cyclone Separator
11. Froth Floatation apparatus

COURSE OUTCOMES:

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

1. Apply the principles of particle mechanics and mechanical operations to conduct experiments and analyze the behavior of particulate systems using standard laboratory equipment.
2. Analyze experimental data to evaluate the performance and operational characteristics of particle size reduction, classification, separation, and solid–fluid processing equipment.
3. Evaluate the efficiency of particulate processing operations using engineering principles, experimental observations, and quantitative data interpretation.
4. Demonstrate proficiency in selecting, operating, and troubleshooting laboratory equipment while following standard operating procedures, laboratory safety, and good engineering practices.
5. Investigate particulate processing problems through experimentation, technical reporting, teamwork, effective communication, and independent learning using modern engineering tools.

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

25CHCP508	MASS TRANSFER LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVE:

To provide practical understanding and experimental validation of mass transfer operations commonly used in chemical engineering. The laboratory focuses on enhancing students' knowledge of mass transfer principles by:

- Studying diffusion, mass transfer coefficients, and interphase mass transfer.
- Analyzing key operations such as distillation, absorption, extraction, drying, and leaching.
- Understanding the design and performance of mass transfer equipment like packed columns, tray columns, and dryers.
- Applying theoretical mass transfer models to interpret experimental results.

LIST OF EXPERIMENTS

1. Air Drying
2. Rotary Dryer
3. Simple Distillation
4. Steam Distillation
5. HETP Determination
6. Leaching Cross Current
7. Leaching Counter Current
8. Leaching Stage Wise
9. Adsorption-Isotherms
10. Adsorption in a Packed Bed
11. Surface Evaporation
12. Liquid-Liquid Extraction
13. LLE in Packed Bed
14. Vapor in Air Diffusion

TEXT BOOKS:

1. Binay K.Dutta, Principles of Mass Transfer and Separation Processes, 2nd edition,2007. Prentice Hall of India
2. R.E.Treybal, Mass Transfer Operations, 3rd Edition, 1993, McGraw Hill, New Delhi.
3. AS. Foust, Principles of UNIT Operations, 2nd Edition, 1980, Wiley, New York.
4. 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:

The students will be able to:

1. Apply engineering fundamentals and specialist knowledge to execute UNIT operations, including drying, distillation, and leaching experiments.
2. Analyze and interpret experimental data using numerical and analytical methods to determine mass transfer coefficients, HETP, and adsorption isotherms.
3. Conduct investigations of complex processes, such as stage-wise leaching and extraction in packed beds, through designed experiments and interpretation of results.
4. Function effectively in collaborative teams to conduct experiments and communicate technical findings through structured laboratory reports and presentations.

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

25CHPC601	PROCESS DYNAMICS & CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce the fundamentals concepts of process control and then to develop mathematical models based on transfer function approach for single input single output (SISO) systems along with the dynamic response to different disturbances along with the ability.
- The course will teach the students to perform the stability analysis in transient and frequency domains, to select and utilize P, PI, and PID controllers for the control of process and to select proper controller tuning methods.
- The course will introduce more advanced concepts like Cascade control, feed-forward control, ratio control, etc. along with the concept of digital control system.

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. feed forward), 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. Introduction to frequency response, notion of stability. Bode diagrams and stability criterion, Bode and Nyquist plots, Nyquist stability criterion.

UNIT-V

Controller tuning: Ziegler-Nichol's method and Cohen-Coon method. Introduction to advanced controllers: cascade control, feed forward control, ratio control, Dead time compensation and Internal model control. Introduction to digital control system, Programmable logic controller (PLC), Supervisory Control and Data Acquisition (SCADA) and Distributed Control System (DCS).

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 edition, 2003, John Wiley.
2. Stephanopoulos, G. Chemical Process Control: An Introduction to Theory and Practice, 1984 Pearson Education.
3. D.C. Sikdar , Instrumentation and Process Control, Khanna Publishing House Instrumentation, Measurement and Analysis, Nakra, TMH

COURSE OUTCOMES

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

1. Explain the fundamentals of process dynamics and control, characteristics of measuring elements, control structures, process instrumentation diagrams, and apply Laplace transforms to solve ordinary differential equations.
2. Analyze the dynamic response of first-order, second-order, higher-order, and dead-time processes using transfer function models and evaluate their time-domain responses.
3. Develop and analyze closed-loop control systems, simplify block diagrams, evaluate controller performance, and explain the operation of final control elements in process industries.
4. Evaluate the stability and frequency response of process control systems using the Routh stability criterion, Bode plots, and Nyquist plots for engineering decision-making.

5. Apply controller tuning techniques and advanced process control strategies, including cascade, feed-forward, ratio, dead-time compensation, PLC, SCADA, DCS, and digital control systems for industrial process automation.

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

25CHPC602	CHEMICAL REACTION ENGINEERING - II	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand and analyze the kinetics aspects of catalysts.
- To analyze internal and external transport processes in gas-solid catalytic reactions.
- To apply rate equations for non-catalytic reactions in different reactor configurations.
- To design a multiphase Reactors.
- To calculate operating regime for a given fluid-fluid reaction.

UNIT-I

Introduction to Catalysis-homogeneous and heterogeneous catalysis-Characteristics and Preparation of catalysts - Physical and chemical adsorption-Adsorption Isotherms: Langmuir, Freundlich and Temkin- Physical properties of catalysts: Determination of BET surface area, pore volume and solid density of catalyst.

UNIT-II

Steps in a catalytic reaction-Kinetics of gas-solid catalyzed reaction: Langmuir-Hinshelwood and Eley-Rideal mechanism -Laboratory reactors for catalytic gas solid reactions: Batch reactor for both gas and solid, Basket type mixed flow reactor and Tubular flow reactors operated in a differential, integral and/or recycle manner-Design concepts

UNIT-III

Internal and External transport processes in gas-solid catalytic reaction-Effectiveness Factor- Performance of gas-solid catalytic reactors: Fixed bed and Fluidized bed reactors- Design concepts - G/L Reactions on Solid Catalyst: Trickle Beds -qualitative description-industrial importance.

UNIT-IV

Non-catalytic gas-solid reactions-Kinetic model for gas-solid reactions: Progressive conversion model and Shrinking unreacted-core model-Rate of reaction for shrinking spherical particles.

UNIT-V

Fluid-Fluid reactions: The Rate Equation for Straight Mass Transfer (Absorption) of A - The Rate Equation for Mass Transfer and Reaction -Enhancement factor and Interface behaviour - Performance of fluid-fluid reactors: spray column, packed column, plate column, static mixer and rotating disc contactor – qualitative description-industrial importance.

TEXT BOOKS:

1. Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, 2001, John Wiley & Sons.
2. Scott Fogler, H., Elements of Chemical Reaction Engineering, 2nd Edition, 2001, Prentice Hall.
3. Smith, J. M., Chemical Engineering Kinetics, 3rd Edition, 1981, Mc Graw Hill

REFERENCE BOOKS:

1. Lanny D. Schmidt, The Engineering of Chemical Reactions, 1998, (Oxford University Press)
2. Dawande S.D., Principles of Chemical Reaction Engineering, Central Techno Publications, Nagpur.
3. Gavhane, K. A., Chemical Reaction Engineering, volume-I, Nirali Prakashan.
4. Gilbert F. Froment, Kenneth B. Bischoff, Juray De Wilde, Chemical Reactor Analysis and Design, 2010, John Wiley & Sons.
5. Heterogeneous Reactions, Vol. I and II – L. K. Doraiswamy, M. M. Sharma
6. Fluid Mixing and Gas Dispersion in Stirred Reactors – G. B. Tatterson
7. Fluidisation – D. Kunni and O. Levenspiel
8. Gas Liquid Reactions – P. V. Danckwerts
9. Fluidisation – J. F. Davidson and D. Harrison
10. Random Packings and Packed Tower Design – R. F. Strigel

COURSE OUTCOMES:

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

1. Determine the physical and chemical properties of catalysts by calculating BET surface area, pore volume, and solid density, and apply adsorption isotherms to characterize catalyst–reactant interactions.
2. Develop and apply kinetic models for catalytic gas–solid reactions using Langmuir–Hinshelwood and Eley–Rideal mechanisms, and for non-catalytic gas–solid reactions using Shrinking Unreacted-Core and Progressive Conversion models.
3. Evaluate the effects of internal and external transport processes by calculating effectiveness factors for gas–solid systems and enhancement factors for fluid–fluid reactions to identify rate-limiting steps in multiphase reaction environments.
4. Formulate reactor design concepts and analyze the performance of reactors ranging from laboratory-scale systems to industrial-scale configurations, including fixed-bed, fluidized-bed, trickle-bed reactors, and contactors such as static mixers and spray columns.
5. Assess the industrial significance and sustainability of various reactor configurations and catalytic processes by optimizing resource efficiency and minimizing environmental impact in large-scale manufacturing.

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

25CHHS603	MANAGEMENT FOR ENGINEERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To provide engineers with an understanding of business and management principles.
- To develop skills in leadership, decision-making, and strategic planning.
- To integrate management knowledge into technical and engineering projects.
- To introduce concepts of entrepreneurship, innovation, and business ethics.

UNIT-I

Definition, Nature, and Scope of Management - Functions of Management: Planning, Organizing, Leading, Controlling - Evolution of Management Thought: Scientific Management, Administrative, Human Relations, and Modern Approaches - Roles of a Manager in Engineering and Technology Sectors

UNIT-II

Basics of Organizational Behavior: Personality, Perception, Attitudes, Motivation - Leadership and Decision-Making in Organizations - Teamwork and Group Dynamics in Engineering Projects - Basics of Human Resource Management: Recruitment, Training, Performance Appraisal - Work Ethics and Employee Relations

UNIT-III

Basics of Financial Accounting: Balance Sheet, Profit & Loss Statement - COs/POst Accounting for Engineers: Fixed, Variable, and Overhead COs/POsts - Break-even Analysis and Budgeting - Capital Investment Decision-Making: NPV, IRR, Payback Period - Financial Planning in Engineering Projects

UNIT-IV

Basics of Marketing: Market Segmentation, Product Life Cycle, Branding - Marketing Strategies for Engineering Products - Basics of Operations Management: Supply Chain, Inventory Control, Lean Manufacturing - Quality Control and Six Sigma in Engineering

UNIT-V

Fundamentals of Entrepreneurship and Business Planning - Innovation and Design Thinking in Business - Legal Aspects of Starting a Business: Company Registration, Intellectual Property Rights (IPR) - Government Policies for Startups in Engineering - Case Studies of Successful Engineering Entrepreneurs

TEXT BOOKS:

1. Robbins, S. P., & Coulter, M. (2021). Management (14th ed.). Pearson.
2. Koontz, H., &Weihrich, H. (2010). Essentials of management (8th ed.). McGraw-Hill Education.
3. Tripathi, P. C., & Reddy, P. N. (2012). Principles of management (5th ed.). Tata McGraw-Hill.
4. Robbins, S. P., & Judge, T. A. (2019). Organizational behavior (18th ed.). Pearson.
5. Dessler, G. (2020). Human resource management (16th ed.). Pearson.
6. Chandra, P. (2019). Financial management: Theory and practice (10th ed.). McGraw-Hill Education.
7. Pandey, I. M. (2015). Financial management (11th ed.). Vikas Publishing House.
8. Kotler, P., & Keller, K. L. (2016). Marketing management (15th ed.). Pearson.
9. Heizer, J., Render, B., & Munson, C. (2020). Operations management: Sustainability and supply chain management (13th ed.). Pearson.
10. Khanka, S. S. (2013). Entrepreneurship development (1st ed.). S. Chand Publishing.
11. Additional References
12. Griffin, R. W. (2022). Management (13th ed.). Cengage Learning.
13. Daft, R. L. (2020). Management (13th ed.). Cengage Learning.

REFERENCES:

1. Luthans, F. (2021). Organizational behavior (14th ed.). McGraw-Hill Education.
2. Noe, R. A., Hollenbeck, J. R., Gerhart, B., & Wright, P. M. (2021). Fundamentals of human resource management (8th ed.). McGraw-Hill Education.
3. Ross, S. A., Westerfield, R. W., & Jaffe, J. (2021). Corporate finance (13th ed.). McGraw-Hill Education.
4. Gitman, L. J., & Zutter, C. J. (2019). Principles of managerial finance (15th ed.). Pearson.

5. Lamb, C. W., Hair, J. F., & McDaniel, C. (2022). Marketing (14th ed.). Cengage Learning.
6. Chase, R. B., Jacobs, F. R., &Aquilano, N. J. (2020). Operations and supply chain management (15th ed.). McGraw-Hill Education.
7. Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2020). Entrepreneurship (11th ed.). McGraw-Hill Education.
8. Scarborough, N. M., & Cornwall, J. R. (2019). Essentials of entrepreneurship and small business management (9th ed.). Pearson.
9. Gopalaswamy, A. K. (2020). Management case studies with Indian perspectives. Cengage Learning.
10. Subramanian, R. (2021). Business laws and management. Tata McGraw-Hill.
11. Dutta, A. K. (2019). Cases in financial management. Pearson India.
12. Reddy, Y. V. (2020). Economic policies and India's reform agenda: New thinking. Oxford University Press.

COURSE OUTCOMES:

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

1. Explain and apply management principles, organizational behavior, leadership practices, and human resource management concepts for effective functioning in engineering organizations and multidisciplinary teams.
2. Analyze engineering business environments using financial, COs/POst, operational, and marketing management tools for effective planning, decision-making, and resource optimization.
3. Evaluate managerial strategies related to quality control, supply chain management, lean manufacturing, investment planning, and engineering operations considering sustainability, ethics, and societal needs.
4. Develop innovative and entrepreneurial solutions by integrating design thinking, business planning, legal frameworks, intellectual property rights, and government policies relevant to engineering startups and industries.
5. Demonstrate professional competence in communication, teamwork, leadership, ethical practices, and lifelong learning for successful engineering management and organizational development.

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

25CHCP607	CHEMICAL REACTION ENGINEERING & THERMODYNAMICS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

The laboratory aims to provide hands-on experience with reactors and thermodynamic systems, enabling students to:

- Understand the kinetics of chemical reactions and reactor performance.
- Study different types of chemical reactors (batch, CSTR, PFR, etc.).
- Determine reaction rate constants and order of reactions.
- Analyze energy balances and thermodynamic parameters (e.g., enthalpy, entropy, and Gibbs free energy changes).
- Apply theoretical concepts to real-world chemical processes and enhance problem-solving skills through experimental data interpretation.

LIST OF EXPERIMENTS (THERMO)

1. Excess Property Determination
2. Heat of Solution by Solubility Method
3. Equilibrium Constant Determination
4. Liquid – Liquid Equilibrium
5. Vapour – Compression Refrigeration Test rig
6. Cottrel, Brown Boiling Point Apparatus
7. Isobaric VLE Data (Txy diagram)
8. Othmer VLE Still – Margules or Vanlaar Constant Determination
9. Test For Thermodynamic Consistency
10. Air water heat pump
11. Bomb Calorimeter
12. Junkar's Gas Calorimeter

LIST OF EXPERIMENTS (CRE)

1. Batch Reactor
2. Semibatch Reactor I
3. Semibatch Reactor II
4. Plug Flow Reactor
5. Continuous Stirred Tank Reactor
6. PFR & CSTR in series
7. Adiabatic Reactor
8. Residence Time Distribution Studies in CSTR
9. Residence Time Distribution Studies in Packed Bed Reactor

TEXT BOOK

1. Y. V. C. Rao, Introduction to Thermodynamics, 2004th Edition, Universities Press.
2. P.K.NagEngineering Thermodynamics, 2013, 5th Edition, Tata McGraw Hill.
3. Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, 2001, John Wiley & Sons.
4. Scott Fogler, H., Elements of Chemical Reaction Engineering, 2nd Edition, 2001, Prentice Hall.

REFERENCE

1. D.B. Spalding & E.H. Cole " Engg. Thermodynamics". Edward Arnold.
2. G.A. Hawkins,." Engg. Thermodynamics" .John Wiley & Sons.
3. G.H. Van Wylen, & R.E. Sonntag, "Fundamentals of Classical Thermodynamics". .John Wiley & Sons.
4. Hollman ,J.P. " Thermodynamics". McGraw Hill
5. Lanny D. Schmidt, The Engineering of Chemical Reactions, 1998, (Oxford University Press)
6. Dawande S.D., Principles of Chemical Reaction Engineering, Central Techno Publications, Nagpur.
7. Gavhane, K. A., Chemical Reaction Engineering, volume-I, Nirali Prakashan.

COURSE OUTCOMES:

The students will be able to

1. Apply fundamental principles of chemical thermodynamics and reaction kinetics to formulate solutions for complex problems involving phase equilibria (VLE/LLE), thermal properties, and diverse reactor configurations found in both THERMO and CRE experiments.
2. Conduct systematic investigations of thermodynamics and reaction engineering systems—ranging from calorimeters and VLE stills to batch and flow reactorsby designing experiments and interpreting raw data to provide valid conclusions.
3. Analyze experimental results, such as Txy diagrams, thermodynamic consistency tests, and residence time distributions (RTD), to reach substantiated conclusions regarding the behavior and efficiency of chemical processes.
4. Utilize modern engineering tools and methodologies to evaluate the performance and efficiency of energy conversion systems (heat pumps, refrigeration) and chemical reactors while considering resource optimization and environmental sustainability.
5. Demonstrate professional competence by managing experimental projects in a team environment, adhering to ethical principles, and effectively communicating technical findings through reports and presentations.

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

25CHCP608	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. Apply the principles of process instrumentation, calibration techniques, dynamic system analysis, and control system fundamentals for conducting experiments related to thermal systems, flow measurement, and process control.
2. Analyze the behavior and performance of first-order, second-order, interacting, and non-interacting systems using experimental data, mathematical models, and modern instrumentation techniques.
3. Evaluate the characteristics and performance of control elements such as pneumatic valves, I/P converters, PLCs, flow meters, and PID controllers for effective process monitoring and control applications.
4. Develop and implement control strategies using controller tuning methods, ladder programming, simulation software, and stability analysis for chemical process systems considering safety and industrial requirements.
5. Demonstrate professional competency in experimentation, teamwork, technical communication, ethical laboratory practices, interpretation of process data, and lifelong learning in process instrumentation and control engineering.

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

25CHES701	RESEARCH METHODOLOGY	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

1. To introduce the fundamentals of research and its importance in engineering and technology.
2. To develop the ability to review existing literature and identify research gaps and problems.
3. To equip students with skills to design and conduct research, including data collection and sampling techniques.
4. To enable students to analyze data statistically and interpret research findings effectively.
5. To train students in research documentation, technical writing, and understanding intellectual property rights and publication ethics.

UNIT 1: Introduction to Research

Definition, importance and objectives of research. Types of research - Basic, applied, and experimental. Steps in the research process - Identification of problem, literature review, hypothesis formulation, data collection, analysis. Qualities of good research. Research ethics – Avoiding plagiarism and misconduct

UNIT 2: Literature Review and Problem Identification

Importance of reviewing existing work. Finding research materials - Journals, patents, online libraries. Bibliometric analysis and citation indexing (SCI, Scopus, Web of Science) Identifying research gaps. Defining a research problem. Skeleton of research paper

UNIT 3: Research Design and Data Collection

Research design types: Exploratory, descriptive, experimental and case study. Primary data collection methods - Surveys, interviews, and experiments. Secondary data collection methods - Government reports, industry data, archival research. Sampling methods: Probability and non-probability. Tools used in engineering research (e.g., LaTeX, MATLAB, Excel, Origin Pro and Python)

UNIT 4: Data Analysis and Interpretation

Fundamentals of data analysis - Data preprocessing, cleaning, visualization. Basic statistics - Mean, median, standard deviation, variance. Inferential statistics - Hypothesis testing, confidence intervals, p-values. Correlation and regression analysis. Introduction to data visualization - charts, graphs, heat maps and dash board

UNIT 5: Research Writing, Intellectual Property, Publication Ethics

Writing a technical report or research paper. Referencing styles and citation tools such as Zotero and Mendeley. Publication process and peer review. Intellectual Property Rights - Patents and copyrights. Publication Ethics- Plagiarism, duplicate submission, authorship conflicts, peer review process, predatory journals.

TEXTBOOKS:

1. C.R. Kothari and Gaurav Garg, 'Research Methodology: Methods and Techniques', 4th Edition, New Age International.
2. Ranjit Kumar, 'Research Methodology: A Step-by-Step Guide for Beginners', 5th Edition, SAGE Publications.
3. John W. Creswell and J. David Creswell, 'Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 5th Edition., SAGE Publications.

REFERENCES:

1. Leedy, P.D., and Ormrod, J.E., 'Practical Research: Planning and Design', 11th Edition, Pearson.
2. Greenfield, T., and Greener, S., 'Research Methods for Postgraduates', 3rd Edition, Wiley.
3. Montgomery, D.C., 'Design and Analysis of Experiments', 9th Edition, Wiley.
4. Cohen, L., Manion, L., & Morrison, K., 'Research Methods in Education', 8th Edition, Routledge.
5. Deborah E. Bouchoux, 'Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets', 5th

COURSE OUTCOMES:

By the end of the course, students will be able to:

1. Apply the systematic steps of the research process—including problem identification, literature review, and hypothesis formulation to develop solutions for complex engineering problems using principles of mathematics and engineering fundamentals.
2. Analyze existing literature and bibliometric data to identify research gaps and formulate exploratory, descriptive, or experimental research designs that consider sustainability and societal impact.
3. Conduct investigations into complex research problems by selecting appropriate sampling methods and utilizing statistical techniques to interpret primary and secondary data effectively.
4. Utilize modern engineering tools (such as LaTeX, MATLAB, Python, Origin Pro and Excel) for data preprocessing and visualization to provide valid conclusions for innovative process or product development.
5. Demonstrate professional responsibility by adhering to research ethics and intellectual property rights, while communicating findings effectively through technical reports and presentations within the global engineering community

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

25CHPC702	TRANSPORT PHENOMENA	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To study the concept of transport phenomena, laws pertaining with transport properties, Newtonian and non-Newtonian fluids and rheological models
2. To know about the Shell balance approach, to find out the momentum flux and velocity distribution for the fluids
3. To learn about heat flux and temperature distribution for heat sources, additionally to study about mass flux and concentration profile of diffusion, system involving reaction
4. To understand the role of conservation laws and equation of change in single and multicomponent systems
5. To acquire the knowledge of turbulent phenomena and time smoothed equation of change in turbulent flow, furthermore to read the analogies between momentum, heat and mass transfer

UNIT - I

Importance of transport phenomena; analogous nature of transfer process; basic concepts, conservation laws; continuum concept, field, reference frames, substantial derivative and boundary conditions; differential, integral and experimental methods of analysis. Phenomenological laws of transport properties, Newtonian and non-Newtonian fluids; rheological models, theories of transport properties of gases and liquids, effect of pressure and temperature on transport properties.

UNIT – II

General method of shell balance approach to transfer problems; Choosing the shape of the shell; most common boundary conditions; momentum flux and velocity distribution for flow of Newtonian and non-Newtonian fluids in pipes for flow of Newtonian fluids in planes, slits and annulus.

UNIT – III

Heat flux and temperature distribution using shell balance method for heat sources such as electrical, nuclear viscous and chemical; forced and free convection. Mass flux and concentration profile using shell balance method for diffusion in stagnant gas, systems involving reaction and forced convection.

UNIT – IV

Conservation laws and equations of change; Development of equations of continuity, motion and energy in single & multi-components systems in rectangular co-ordinates. Forms of continuity, motion and energy equations in curvilinear co-ordinates; simplified forms of equations for special cases, solutions of momentum mass and heat transfer problems by applications of equation of change, scale factors & their applications in scale-up.

UNIT – V

Turbulent phenomena; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent; analysis of hydrodynamic, thermal and concentration boundary layer and their thicknesses over a flat surface. Development and applications of analogies between momentum and heat, momentum and mass transfer; Reynolds, Prandtl, Von Karman and Colburn analogies.

TEXT BOOKS:

1. R.B. Bird, W.E. Stewart and E.W. Lightfoot, “Transport Phenomena”, John Wiley, Second
2. Edition 2006.
3. Robert, S Brodkey, Harry C. Hershey, “Transport Phenomena A Unified Approach”,Brodkey Publishing 2003.

REFERENCES:

1. J.R. Welty, R.W. Wilson, and C.W. Wicks, Rorer G.E, Wilson R.W. “Fundamentals of Momentum Heat and Mass Transfer”, V Edition. John Wiley, New York, 2007.
2. L.S. Sissom, and D.R. Pitts, “Elements of Transport Phenomena”, McGraw Hill, New York, 1972.
3. R.W. Fahien, “Elementary Transport Phenomena”, McGraw-Hill, New York, 1983.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Apply fundamental conservation laws, phenomenological principles, and the continuum concept to characterize transport properties and the rheological behavior of Newtonian and non-Newtonian fluids.
2. Formulate and solve shell balance equations to determine velocity, temperature, and concentration distributions for momentum, heat, and mass transfer across various geometries and boundary conditions.
3. Develop and simplify equations of change (continuity, motion, and energy) for single and multi-component systems to solve complex engineering problems and apply scale factors for process scale-up.
4. Analyze turbulent flow phenomena and boundary layer characteristics using time-smoothed equations and transfer analogies to predict heat, mass, and momentum profiles.
5. Evaluate analogous transport processes and interpret experimental data to provide pragmatic, innovative solutions for sustainable industrial processes while demonstrating an ability for lifelong learning

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

25CHPC703	PROCESS ENGINEERING ECONOMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The course is aimed to:

- To understand 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.
- To analyze and compare alternatives for equipment, processes and economic evaluation.
- To 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 operations.

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 will be able to:

1. Understand the basic concepts of the time value of money, equivalence, amortization, depreciation, capital requirements, cost estimation, and economic balance used in engineering economics.
2. Apply the principles of economic analysis, including balance sheet preparation, break-even analysis, COs/POst accounting, cost allocation, and methods of economic evaluation in process industries.
3. Analyze different engineering economic methods to solve industrial economic problems.
4. Examine the economic feasibility of engineering projects by evaluating various economic parameters.
5. Evaluate investment decisions, economic performance, and optimal process alternatives using engineering economic principles and decision-making techniques for industrial applications.

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

25CHCP707	CHEMICAL PROCESS SIMULATION LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

To develop proficiency in the use of simulation tools for modelling, analysing and optimizing chemical processes. This laboratory aims to:

1. Introduce students to industry-standard process simulation software
2. Simulate UNIT operations such as reactors, distillation columns, heat exchangers, and separators.
3. Perform steady-state and dynamic simulations of complete process flow-sheets.
4. Analyse mass and energy balances, thermodynamic properties, and process efficiencies.

LIST OF EXPRIMENTS:

1. Gauss Elimination
2. Eigen Value and Eigen Vector
3. Thermodynamic Property Estimations
4. Simulation of Flash Drum for Binary Mixture
5. Estimation of Pressure drop
6. Sizing of Pump
7. Simulation of Heat Exchanger
8. CSTR / PFR
9. Comparing The Conversion Efficiency of Various Reactors Using Aspen Simulation
10. Simulation of an Ideal Binary Distillation Column
11. Multicomponent Distillation Column
12. Absorption Column
13. Extraction

COURSE OUTCOME:

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

1. Apply numerical methods and mathematical foundations to solve linear and non-linear systems essential for chemical engineering modelling.
2. Model and simulate the performance of various chemical reactors to analyse open-loop and closed-loop behaviour under varying thermal conditions.
3. Evaluate UNIT operations and thermodynamic properties by simulating heat exchangers, gravity flow tanks, and vapor-liquid equilibria
4. Utilize modern engineering software and toolboxes to conduct investigations, interpret simulation data, and provide pragmatic solutions for complex process problems.
5. Demonstrate professional competence by preparing structured technical reports on simulation findings, adhering to ethical practices, and recognizing the need for lifelong learning in emerging simulation technologies.

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

25CHCP708	CHEMICAL PLANT DESIGN & DRAWING LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

To equip students with the foundational skills required for the design and layout of chemical process plants through manual and computer-aided drafting. The laboratory aims to:

1. Understand the principles of process plant design, layout, and equipment arrangement.
2. Learn the design criteria for process equipment such as reactors, heat exchangers, distillation columns, and storage tanks.
3. Foster an understanding of safety, operability, and economic considerations in plant layout and design.

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 will be able to:

1. Analyze the operational principles and design requirements of process equipment (Experiments 1–9) and case studies (1–5) by applying specialist engineering knowledge and mathematical models.
2. Create detailed design specifications for UNIT operations, including mass transfer (distillation, absorption) and heat transfer (heat exchanger, evaporator) equipment, while optimizing resource efficiency.
3. Evaluate performance data from experimental setups and case studies (cooling towers, separators) to investigate complex engineering problems and validate theoretical models.
4. Apply professional ethics and collaborative teamwork while executing design projects and case studies, ensuring adherence to safety, health, and environmental standards.
5. Demonstrate professional competence by communicating design documentation and reports for process equipment while showing adaptability to modern engineering tools for lifelong learning.

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

EIGHTH SEMESTER

25CHPV803	PROJECT WORK AND VIVA-VOCE	L	PR	S	C
		0	10	2	6

COURSE OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification, literature review till the successful solution of the same
- To train the students in preparing projects based on the knowledge

METHOD OF EVALUATION

1. The project work could be done in the industry or R&D Institute or an experimental project in the university. Participation in any technical event/competition to design, fabricate and demonstrate an innovative equipment or product could be encouraged under this course
2. The students in a group of 2 or alone works on a topic approved by the Head of the Department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor
3. The progress of the project is evaluated based on a minimum of three reviews. The review committee will be considered by the Head of the Department
4. A project report is submitted at the end of the semester
5. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

COURSE OUTCOME:

1. Formulate and solve chemical engineering and its allied field problems
2. Relate the concepts of science, engineering and technology for innovation
3. Perform experiments individually, handle sophisticated instruments and write technical documents for their work
4. Built team spirit and healthy relationship among team members
5. Know the professional ethics, responsibilities and project management

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

25CHPESCN	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
- Develop problem-solving skills relevant to real-world refinery engineering challenges.

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. Recall the principles, processes, equipment, products, and terminology associated with petroleum exploration, crude oil processing, refining, conversion processes, and manufacture of petroleum products.
2. Explain the concepts, operating principles, and significance of petroleum refining processes, product manufacturing, catalyst systems, and refinery product treatment methods.
3. Apply the principles of petroleum refining, crude oil processing, conversion technologies, and product treatment to obtain desired petroleum products with improved quality and performance.
4. Analyze the influence of feed characteristics, process parameters, catalysts, operating conditions, and treatment methods on refinery performance, product quality, and process efficiency.
5. Evaluate petroleum refining technologies, refinery operations, product quality, environmental compliance, sustainability, and techno-economic aspects to recommend suitable refining strategies for industrial applications.

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

25CHPESCN	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.
- To provide a thorough understanding of the principles and applications of biochemical processes, focusing on the design, analysis, and optimization of systems involving biological organisms or molecules for the production of valuable products in industries such as pharmaceuticals, food, and biofuels.

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 microorganism - 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. Identify and characterize biological materials and microorganisms to determine chemical requirements for growth media and enzyme immobilization techniques while analyzing how performance is affected by environmental variables such as pH, temperature, and pressure.
2. Apply mathematical principles to model microbial reproductive cycles, fermentation kinetics, enzyme inhibition mechanisms, and microbial death kinetics to optimize both sterilization systems and industrial scale-up criteria.
3. Design holistic fermentation systems by integrating strain breeding strategies with industrial sterilization protocols and fermenter design parameters, including aeration and agitation requirements for diverse product recovery goals.

4. Implement operational management for fermentation equipment, utilizing stock culture maintenance and real-time measurement and control systems to manage immobilized enzyme columns and downstream purification processes.
5. Evaluate modern fermentation trends and mechanical cell disintegration techniques to synthesize efficient downstream recovery and purification strategies that mitigate the effects of inhibition and environmental stressors on final product yield.

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

25CHPESCN	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. Apply principles of the biosphere, hydrologic, and nutrient cycles to identify and analyze the sources and impacts of air, water, soil, and physical pollution (noise, thermal, radioactive).
2. Evaluate the physical, chemical, and bacteriological characteristics of wastewater, air emissions, and solid waste using standardized sampling and measurement techniques to ensure compliance with quality standards.

3. Design engineered solutions for wastewater treatment (primary, secondary, and tertiary) and solid waste processing (composting, biological processing) to facilitate material recovery and environmental protection.
4. Formulate Control and Dispersion Strategies: Formulate technical strategies for air pollution control (particulate and gaseous) and utilize dispersion modeling and solid waste management techniques (incineration, landfills) to mitigate ecological risks.
5. Implement Legal and Sustainable Frameworks: Integrate environmental laws, standards, and ethical practices into the management of waste as a resource material to develop sustainable engineering solutions that align with societal needs.

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

25CHPESCN	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 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

UNIT III

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. Analyze interfacial phenomena and mass transfer constraints to predict the behavior of industrial reactors and energy systems while accounting for corrosion-induced degradation.
2. Evaluate the impact of current distribution and over-potential on metal finishing and refining processes (UNIT IV) using specialized electrode materials and fundamental electrochemical laws (UNIT I) to mitigate various forms of corrosion.
3. Design efficient industrial cell configurations for energy storage and surface engineering by integrating Nernstian thermodynamics, diffusion-controlled kinetics and advanced corrosion protection strategies.

4. Model the performance and scale-up of electrochemical reactors such as filter press and Swiss roll cells by applying mass transfer correlations, Faraday's laws, and material selection criteria to optimize industrial deposition and corrosion resistance.
5. Formulate sustainable engineering solutions for industrial practices by synthesizing knowledge of green energy systems, reactor design equations, and corrosion control measures grounded in interfacial science and limiting current theories.

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

25CHPESCN	NUCLEAR ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop a strong foundation in the principles of nuclear reactions, radiation physics, and reactor design.
- To develop skills to safely and efficiently apply nuclear technology in energy production, medicine, and industry.
- To provide in-depth knowledge of the fundamental principles, methodologies, and safety considerations involved in the design, analysis, and optimization of nuclear reactors for efficient and reliable energy production.
- To gain fundamental knowledge of nuclear physics, nuclear reactors, nuclear fuels, and the safe disposal of nuclear wastes.
- To understand the fundamental mechanisms of nuclear fission and fusion, including the physical principles, energy release, reaction conditions, and their applications in power generation and other nuclear technologies.

UNIT I

Nuclear Physics: Nuclear model of an atom – Equivalence of mass and energy – Binding energy – Radioactivity – Half-life – Neutron interactions – Cross sections.

UNIT II

Nuclear Reactors: 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 Reactor Materials: Mechanism of nuclear fission and fusion – Radioactivity – Chain reactions – Critical mass and composition – Nuclear fuel cycles and their characteristics – Uranium production and purification – Zirconium – Thorium – Beryllium.

UNIT IV

Properties of Irradiated Fuel and Separation of Reactor Products: 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 accidents – Criteria for safety – Nuclear waste – Types of waste and its disposal – Radiation hazards and their prevention – Weapons proliferation.

TEXTBOOKS:

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

REFERENCES:

1. Wakil, M. M. El., *Power Plant Technology*, McGraw-Hill International, 1984.

COURSE OUTCOMES:

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

1. Recall the fundamental concepts of nuclear physics, nuclear reactors, nuclear reactions, radiation detection, radiation protection, nuclear waste management, and associated nuclear engineering systems.
2. Explain the principles of nuclear structure, reactor design and operation, nuclear reactions, radiation measurement, shielding, waste management, and nuclear safety practices.
3. Apply the principles of nuclear physics, reactor engineering, fuel cycle analysis, radiation detection and protection, and radioactive waste management to solve nuclear engineering problems.
4. Analyze the performance of nuclear reactors, nuclear fuels, radiation detection systems, shielding methods, and radioactive waste management techniques with respect to efficiency, safety, and environmental impact.

5. Evaluate nuclear engineering technologies, reactor systems, radiation protection strategies, and radioactive waste management practices for safe, sustainable, and efficient nuclear power generation.

Mapping with POs & PSOs														
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	–	–	–	–	–	–	–	–	–	2	–	2
CO2	3	2	1	–	–	–	1	1	–	–	–	3	1	–
CO3	3	3	2	1	2	–	1	1	–	–	–	2	–	1
CO4	3	3	2	2	2	2	3	2	1	0	1	2	3	–
CO5	3	3	3	2	2	2	3	3	1	2	2	–	2	1

25CHPESCN	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/porositywith 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 visCOs/POsity. 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

- Apply the fundamental principles of polymer science and engineering to analyze the structure–property relationships and behavior of polymeric materials for engineering applications.
- Analyze polymerization processes, reaction engineering principles, and material characterization techniques to evaluate the synthesis and performance of polymer systems.
- Evaluate the rheological, viscoelastic, thermal, and processing characteristics of polymers to support material selection and process optimization in industrial applications.
- Develop engineering solutions for polymer manufacturing by integrating reactor design, polymer processing technologies, product quality requirements, and sustainability considerations.

- Investigate polymer engineering problems using modern analytical techniques, computational tools, professional ethics, and lifelong learning to address emerging industrial challenges.

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

25CHPESCN	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. Recall the fundamental concepts of air pollution, atmospheric meteorology, pollutant dispersion, air quality monitoring, pollution control equipment, environmental legislation, and air quality management.
2. Explain the principles of air pollutant generation, atmospheric dispersion, sampling and monitoring techniques, air pollution control technologies, environmental regulations, and air quality management practices.
3. Apply the principles of air pollution control to analyze pollutant sources, predict pollutant dispersion, perform air quality monitoring, select appropriate pollution control equipment, and ensure compliance with environmental standards.

4. Analyze the effects of atmospheric conditions, pollutant characteristics, monitoring data, control device performance, and environmental regulations on air quality and industrial emission control.
5. Evaluate air pollution control technologies, monitoring strategies, regulatory frameworks, and air quality management practices to recommend efficient, economical, and sustainable solutions for industrial and environmental applications.

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

25CHPEXX	CHEMICAL PLANT UTILITIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

This course will enable the students to understand the knowledge about the types and functioning of various mechanical devices used in process industries such as boilers, steam engines, turbines compressors, pumps, boiler water preparation, steam generation, refrigeration and cryogenic systems.

UNIT-I

Boilers-Classification: Boilers-Fittings and Accessories.

UNIT-II

Steam engines and Turbines - Properties of steam, tables and charts- gas turbines.

UNIT-III

Compressed air and Vaccum-Compressors and Vaccum pumps and their performance characteristics. Boosters, Use of air in process industries for conveying, drying and instrumentation, air receivers, Design of pipelines and piping networks for water, steam, condensate and air, piping systems, air leaks, lubrication oil removal.

UNIT-IV

Treatment of water, cooling water, boiler water, cooling tower operation, desalination process, co-generation, steam generation for power and processes.

UNIT-V

Refrigeration, cryogenic systems, Principle, types, selection and operations of pump, fans and compressor selection.

REFERENCE BOOKS

1. Mujawar, B.A. Plant Utilities, III edn, Nirali Prakashan Publication, 2007.
2. Dhona, D.B., Plant Utilities, I Edn, Nirali Prakashan Publication, 2018.
3. Khurmi, R.S., Thermal Engineering, S.Chand& Co., 1993
4. Ballaney, Heat Engines, Khanna Publishers
5. Ballaney, Thermal Engineering, Khanna Publishers
6. Rase, H. F., Barrow, M. H., Project Engineering for Process Plants, John Wiley & Sons, 1957.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. **Foundations & Problem Analysis:** Apply the principles of thermodynamics and fluid mechanics to evaluate the characteristics of boilers, steam turbines, refrigeration, and cryogenic systems to analyze and solve complex process industry requirements.
2. **Design & Modern Tool Usage:** Design and model pipelines and piping networks for water, steam, compressed air, and condensate using appropriate engineering practices, with strong consideration for public health, safety, and net-zero carbon
3. **Sustainability, Environment & Ethics:** Analyze water treatment facilities, cooling towers, and desalination processes to ensure sustainable development, optimal resource utilization, and adherence to professional ethics and environmental legal frameworks.
4. **Investigation & Data Analysis:** Conduct detailed investigations to evaluate the performance and selection criteria for compressors, vacuum pumps, fans, and regular pumps using research-based literature and critical data analysis
5. **Project Management, Teamwork & Lifelong Learning:** Develop technical reports and economic assessments for co-generation and power generation systems as an individual or team member, demonstrating adaptability to emerging technologies and engineering management principles

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

25CHPESCN	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. Recall the fundamentals of the petrochemical industry, including feedstocks, hydrocarbon classifications, petrochemical manufacturing processes, intermediates, derivatives, polymers, and major petrochemical products.
2. Explain the principles, production methods, industrial significance, and economic aspects of petrochemical feedstocks, intermediates, derivatives, polymers, and value-added petrochemical products.
3. Apply the principles of petrochemical technology to select appropriate feedstocks, manufacturing processes, and processing techniques for the production of petrochemicals and their derivatives.
4. Analyze the influence of feedstock characteristics, reaction pathways, process conditions, and operating parameters on the efficiency, quality, and sustainability of petrochemical manufacturing processes.

5. Evaluate petrochemical production technologies based on process efficiency, product quality, economic feasibility, environmental sustainability, and industrial applications to recommend suitable manufacturing strategies.

Mapping with POs & PSOs													
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	1	–	–	–	–	–	–	–	–	–	3	1	–
CO2	3	2	1	–	–	–	1	1	–	–	–	3	2	1
CO3	3	3	3	2	2	–	2	1	–	–	–	3	3	2
CO4	3	3	2	3	2	2	3	2	1	–	1	3	3	2
CO5	2	3	3	2	2	2	3	3	1	2	2	3	3	3

25CHPESCN	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. Apply the principles of pulp and paper technology to analyze raw material characteristics, fibre processing, and their influence on pulp and paper manufacturing.
2. Analyze pulping, papermaking, and fibre processing operations using engineering principles to evaluate process performance and product quality.
3. Evaluate manufacturing operations, product properties, quality control techniques, and process variables for the production of pulp, paper, and paperboard products.
4. Develop engineering solutions for efficient pulp and paper manufacturing by integrating process optimization, pollution control, resource conservation, and sustainable industrial practices.
5. Investigate challenges in pulp and paper industries using modern engineering tools, process data, quality assurance techniques, professional ethics, and lifelong learning to enhance industrial productivity and environmental performance.

Mapping with POs & PSOs														
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	1	1	–	–	–	–	–	1	3	2	–
CO2	3	3	2	2	2	–	–	–	–	1	1	3	3	1
CO3	3	3	3	2	2	2	1	–	1	1	1	3	3	2
CO4	2	3	3	2	3	3	3	1	1	2	1	2	3	3
CO5	2	3	2	3	3	2	2	2	3	2	3	2	3	3

25CHPESCN	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 bioremediations, *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 biology.

1. Apply fundamental concepts of biological systems, microorganisms, and cellular functions to analyze biotechnology-based industrial processes
2. Analyze microbial growth, cultivation strategies, and bioprocess requirements for the development and operation of biotechnology-based systems
3. Evaluate biotechnology approaches for environmental management, waste treatment, and sustainable resource recovery using scientific and engineering principles.
4. Develop and assess biotechnological solutions for bioenergy production, bioremediation, biomining, and other industrial applications considering technical and sustainability constraints.
5. Investigate emerging industrial biotechnology technologies through data interpretation, technical communication, ethical considerations, and lifelong learning practices.

Mapping with POs & PSOs														
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	1	–	1	–	–	–	–	–	1	3	1	–
CO2	3	3	2	1	2	–	–	–	–	–	1	3	2	1
CO3	2	3	2	2	2	3	1	–	1	–	1	2	3	1
CO4	2	3	3	2	2	3	1	–	1	1	1	2	3	2
CO5	1	2	2	3	3	2	2	1	3	–	3	1	2	3

25CHPESCN	WASTEWATER TREATMENT TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the fundamental concepts and scope of wastewater engineering, including the sources, characteristics, treatment methods, and disposal of wastewater, with an emphasis on protecting public health and the environment.
- To provide comprehensive knowledge of the principles, processes, and technologies used in the treatment of wastewater,
- To understand the emphasis on environmental sustainability, regulatory compliance, and the design and operation of treatment systems for safe water discharge or reuse.
- To focus on the wastewater transport system and the theoretical techniques for the wastewater treatment process.
- To understand the principles and applications of biological processes in wastewater treatment, focusing on the role of microorganisms in the removal of organic and inorganic pollutants, and the design and operation of biological treatment systems such as activated sludge, biofilms, and lagoons.

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. Solve complex problems involving wastewater characteristics, physical/chemical UNIT operations, biological mechanisms, and advanced separation technologies.
2. Identify and analyze complex wastewater engineering problems to design creative, sustainable treatment processes—including physical, chemical, and biological reactor systems—while considering public health, safety, and environmental impact.
3. Conduct systematic investigations of wastewater treatment UNITs and advanced technologies, utilizing research-based knowledge to design experiments, interpret data, and provide valid conclusions for process optimization.
4. Select and apply appropriate modern engineering techniques and tools to model and predict the performance of diverse wastewater reactors and advanced treatment methods, evaluating their impact on sustainability and the global environment.
5. Demonstrate professional engineering competence by managing wastewater treatment projects with ethical responsibility, functioning effectively in diverse teams, and communicating technical designs through inclusive reports and presentations

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

25CHPESCN	MODERN SEPARATION PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. 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. Explain the fundamental mechanisms, rate laws, and theories governing non-conventional separation processes such as thermal diffusion, zone melting, and foam separation.
2. Analyze controlling factors and equilibrium data to formulate conclusions and solve complex engineering problems in sorption techniques and ionic separation processes.
3. Design and develop membrane-based systems and specialized apparatus, considering whole-life COs/POst, safety, and environmental impact.
4. Evaluate the economic feasibility and commercial viability of advanced separation processes using engineering management principles and economic decision-making.
5. Investigate recent advances in separation technology through research literature to demonstrate adaptability to emerging technologies and lifelong learning.

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

25CHPESCN	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 the hydrodynamic behavior of particulate systems and fluidized beds using principles of fluid flow, pressure drop, and fluidization phenomena.
2. Analyze the operating characteristics and flow regimes of gas-solid and liquid-solid fluidization systems using engineering correlations and transport principles
3. Evaluate the performance of fluidized bed systems considering bed expansion, heat and mass transfer, solids movement, and operational non-idealities
4. Design and optimize industrial fluidized bed operations and associated separation systems with consideration for process efficiency and sustainability
5. Investigate modern fluidization technologies and industrial applications through technical analysis, engineering communication, and independent learning practices.

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

25CHPESCN	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 noncarbonated beverages.
- To illustrate the concepts of the processing of fruits and vegetables, meat, poultry and fishery products.
- To characterize different types and importance of packaging materials for food

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. Solve complex problems related to food microbiology, nutritive values, dairy chemistry, and the physical principles of preservation and packaging.
2. Identify and analyze food deterioration mechanisms to design and develop creative processing solutions—including heat/cold preservation, canning cycles, and dairy manufacturing—while considering public health, safety, and shelf-life requirements.
3. Conduct systematic investigations and experiments, such as quantitative milk analysis, package testing, and canning performance evaluations, using research-based knowledge to interpret data and provide valid conclusions for process optimization (WK8, PO4).

4. Select and apply modern engineering tools and innovative technologies—such as food irradiation, microwave/ohmic heating, and advanced packaging forms—to optimize food processing systems for resource efficiency and sustainability.
5. Demonstrate professional responsibility by adhering to food safety standards, packaging regulations, and ethical principles, effectively communicating technical findings through reports and managing food processing projects in diverse teams.

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

25CHPESCN	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. Solve complex problems related to the production methods, characteristics, and storage of nitrogenous, phosphatic, potassic, mixed, and miscellaneous fertilizers.
2. Raw material selection and production processes to design creative, sustainable solutions for manufacturing diverse fertilizer grades (including NPK and biofertilizers) while considering public health, safety, and environmental impact.
3. Conduct systematic investigations into fertilizer specifications, production efficiency, and storage behavior across all units by designing experiments and interpreting data to provide valid conclusions for process optimization.
4. Model and predict the performance of fertilizer production processes, evaluating their societal and environmental impact with a focus on resource optimization and sustainability.
5. Demonstrate professional engineering competence by managing fertilizer technology projects with ethical responsibility, functioning effectively in diverse teams, and communicating technical designs and specifications through inclusive reports and presentations.

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

25CHPESCN	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:

Packed bed: Velocity – Pressure drops relations – Derivation of Ergun, Kozneykarman, Burke Plummer equation – Problems in packed bed. Definition and Importance of Fluidization. On set of fluidizations – Properties of fluidized beds –Development of fluidization from fixed bed. Stages of fluidization. Advantages and Disadvantages of Fluidization

UNIT-II: Types of fluidizations: smooth and bubbling. Minimum fluidization velocity – Derivation and calculation. Pressure drops– velocity – bed expansion profile - Bed expansion in liquid – Solid and gas – Solid fluidization. Kuni-Levenspiel model

UNIT-III: Particle size, terminal settling velocity – Geldart classification of particles. Voidage in Fluidized Beds – Entrainment and Elutriation: Transport Disengaging Height, TDH. Design of fluidized bed reactor. Gas distributor and its types.

UNIT-IV: Introduction to heat transfer in fluidized beds -Mechanisms of heat transfer in FBR: conduction, convection, radiation. Heat transfer coefficients in fluidized beds. Introduction to mass transfer in fluidized beds. Types of fluidized bed reactor - Circulating fluidized bed reactor, Inverse fluidized bed reactor – principle, working, applications.

UNIT-V: Industrial applications and case studies of fluidized bed systems – FCC, Combustion, Gasification, Fischer-Tropsch Synthesis, Drying, Adsorption, coating and size separation.

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 packed bed and fluidization phenomena, correlations of Ergan and Kozney-karman equations.
2. Identify the fluidization bed types and describe fluidization phenomena
3. Classify particles using the Geldart diagram and analyze parameters such as terminal settling velocity, voidage, entrainment, and Transport Disengaging Height (TDH) for the design of fluidized bed reactors.
4. Demonstrate understanding of heat and mass transfer mechanisms in fluidized beds and describe the working principles and applications of different fluidized bed reactors
5. Evaluate the industrial applications of fluidized bed systems in various industrial processes through case studies.

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

25CHPESCN	DISTILLATION	L	P	T	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart the fundamentals of phase diagrams and equilibria
- To understand the principles of vapor-liquid equilibrium and apply them to simple distillation processes for the effective separation of binary mixtures, focusing on phase behavior, operating conditions, and process efficiency.
- To make the students evaluate the concepts of equilibrium and simple distillation, multi component distillation ternary distillation and azeotropic distillation.
- To understand the behavior, phase relationships, and separation techniques of ternary and multi-component systems, with emphasis on their applications in chemical process design, distillation, and extraction operations.
- 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. Recall the fundamental concepts of phase equilibrium, vapor–liquid equilibrium, distillation processes, multicomponent separation methods, azeotropic and extractive distillation, and fractionation equipment used in chemical engineering industries.

2. Explain the principles of phase equilibrium, vapor–liquid equilibrium, distillation operations, multicomponent separation techniques, azeotropic and extractive distillation processes, and the working of fractionation equipment used in chemical industries.
3. Apply the principles of phase equilibrium, vapor–liquid equilibrium, distillation techniques, ternary and multicomponent separation methods, azeotropic and extractive distillation, and fractionation column design to solve chemical engineering separation process problems.
4. Analyze the behavior of phase equilibrium systems, distillation operations, multicomponent separations, azeotropic and extractive distillation processes, and the performance of fractionation equipment in chemical engineering applications.
5. Evaluate the design, efficiency, and industrial applicability of vapor–liquid separation processes, distillation columns, trays, packed columns, and advanced distillation techniques for chemical process industries.

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

25CHPESCN	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 - IV

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/porosity- Power curve for non-Newtonian liquids - Viscometry - shear in stirred tanks -Shear in stirred tanks related to shear in pipes, apparent viscosity/porosityin 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/porosityranges, 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. Apply the principles of fluid mechanics, dimensional analysis, and dimensionless groups to analyze mixing processes and predict agitator power requirements.
2. Analyze solid, liquid, immiscible-liquid, and semisolid mixing operations, including batch and continuous systems, residence time distribution (RTD), and the effects of mixing on chemical reactions.
3. Design and evaluate heat and mass transfer operations in mixing vessels using appropriate correlations, interfacial phenomena, and transfer models.
4. Analyze the rheological behavior of Newtonian and non-Newtonian fluids and evaluate shear, power consumption, and mixing performance in stirred systems.
5. Select, design, and scale up industrial mixing equipment considering flow patterns, process requirements, safety, sustainability, energy efficiency, and economic constraints.

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

25CHPESCN	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, costs 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. Analyze the mechanisms, performance, and characterization of various catalysts (heterogeneous, homogeneous, and bio-catalysis) in fine chemical synthesis.
2. Design creative and sustainable solutions for waste minimization and safer chemical technologies.

3. Scale-up and Separation Systems Investigate and design complex scale-up procedures for chemical reactors and integrated separation systems (including membrane and distillation) to provide pragmatic engineering solutions for specialty chemical processing.
4. Analyze production costs and plant scheduling while adhering to professional ethics and Good Manufacturing Practice (GMP) in multi-product manufacturing facilities.
5. Advanced Process Manipulation Utilize modern engineering techniques to manipulate micro and macro environments for selectivity improvement, demonstrating adaptability to emerging technologies in continuous fine chemical processes.

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

25CHPESCN	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the fundamental concepts, governing equations, and basic numerical techniques of Computational Fluid Dynamics (CFD), enabling learners to understand and simulate simple fluid flow and heat transfer problems.
- To provide brief introduction of Computational Fluid Dynamics along with chemical engineering application specifically, analysis of fluid mechanics and heat transfer related problems.
- To understands the mathematical representation and physical significance of the pressure gradient term and the continuity equation in fluid dynamics, and to apply these principles in the formulation and analysis of fluid flow problems.
- To analyze and understand the behavior of steady one-dimensional convection and diffusion processes, and to apply governing equations for modeling mass, momentum, and heat transfer in fluid systems.

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. Formulate and analyze the governing equations (Continuity, Momentum, Energy, and Species Transport) of fluid dynamics and categorize the mathematical behavior of PDEs (Elliptic, Parabolic, and Hyperbolic) to establish appropriate physical boundary conditions for solving complex engineering problems.
2. Develop and implement finite difference and finite volume schemes for steady and unsteady diffusion and conduction problems, utilizing explicit, implicit, and Crank-Nicolson methods to achieve numerical accuracy, stability, and solution convergence.
3. Evaluate and apply discretization schemes (Central, Upwind, Hybrid, and QUICK) for convection-diffusion problems based on their physical properties—such as conservativeness, boundedness, and transportiveness—to ensure valid results.
4. Execute pressure-velocity coupling algorithms (such as SIMPLE) and model turbulent flows using k-ε and mixing length models to simulate real-world industrial flow processes while recognizing the limitations of these modern engineering tools.
5. Appraise the environmental and societal impact of CFD-based engineering solutions, demonstrating professional communication of technical findings and a commitment to independent lifelong learning in emerging simulation technologies.

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

25CHPESCN	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. Identifying decision variables, objective functions, constraints, bounds, and appropriate performance measures for chemical engineering.
2. Using appropriate concepts of feasibility, convexity, sensitivity, and optimality conditions to assess engineering alternatives.
3. Using computational tools to obtain and assess solutions for constrained and unconstrained engineering problems.
4. Interpreting computational results, sensitivity information, process constraints, and economic performance to support engineering decisions.
5. Process design and operation while considering technical feasibility, economic performance, sustainability, and responsible engineering practice.

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

25CHPESCN	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; Nonlinear 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. Formulate and solve linear programming and transportation problems using optimization techniques to support engineering decision-making.
2. Analyze engineering optimization problems using simplex, duality, dynamic programming, and nonlinear programming techniques.
3. Evaluate decision-making problems under certainty, uncertainty, and risk using decision theory and game theory concepts.
4. Apply Operations Research techniques, mathematical models, and optimization tools to solve complex engineering and industrial problems.
5. Analyze and optimize project scheduling and resource allocation using PERT and CPM techniques for effective project management.

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

25CHPESCN	PROCESS MODELING & SIMULATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand knowledge of fundamental principles and basic laws of modeling.
- Formulation of a mathematical model for various chemical Engineering processes.
- To apply the mathematical model inChemical Reaction Engineering.
- To apply the mathematical model to simulate mass and heat transfer processes.

UNIT-I: Introduction, uses of mathematical models, Scope of coverage, Principles of formulations, Fundamental Laws, Continuity equations, Energy equations, Equation of motions, Transport equation, Equation of State, Equilibrium and Chemical Kinetics, Simple Examples. Introduction of Matlab.

UNIT-II: Mathematical Modeling in Fluid Mechanics - Simple hydraulic Tank, Variable flow, Hydraulic Tank, Enclosed Tank, Adiabatic compression in Gas space, Gas flow system, Example, Three volume gas flow system, pipeline Gas flow, Hydraulic transient between two reservoirs, Pumping system

UNIT–III Mathematical Modeling in Chemical Reaction Engineering: Basic Modeling, Mixing Vessel, Mixing with reaction, Reaction kinetics- Reversible reaction CSTR, PFR, Batch reactor, Series of isothermal CSTR, CSTR's with variable hold ups, non-isothermal CSTR, Radical kinetics, Elementary radical of mechanics, Rate limits steps, Heterogeneous kinetics, Example Auto Clave.

UNIT-IV: Mathematical Modeling in Heat transfer: Steam jacketed vessel, two heated tanks, single component vaporizer, continuous flow boiling system double pipe heat exchanger, shell and tube heat exchanger, multicomponent flash drum, cooling towers. forward and backward feed triple effect evaporator

UNIT-V: Mathematical Modeling in Mass Transfer: Batch liquid- liquid extraction, continuous extraction, multistage countercurrent extraction, Ideal binary distillation column, multicomponent non ideal distillation column, pipe line flash process, Absorption, Adsorption.

TEXT BOOKS:

1. Lubyen W. L., Process Modeling, Simulation and Control for Chemical Engineers, McGraw- Hill, New York, 1989.
2. Franks RGE, Modeling and Simulation in Chemical Engineering, 1971, Wiley Inter - Science, New York.
3. Elements of Chemical Reaction Engineering by Fogler, Prentice Hall of India.
4. Mickley H. S., Sherwood T. S., Reed C. E., Application of Mathematical Modeling in Chemical Engineering, Tata-McGraw-Hill, New Delhi, 2002.
5. 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. Formulate mathematical models for basic chemical engineering systems based on continuity, energy, and motion equations.
2. Analyze complex engineering problems in fluid mechanics and heat transfer, such as hydraulic transients and triple-effect evaporators, to reach substantiated conclusions.
3. Design and develop modeling solutions for chemical reaction engineering systems, including non-isothermal CSTRs and heterogeneous kinetics, considering process constraints.
4. Create and apply modern engineering tools, specifically MATLAB, to simulate, predict, and interpret the behavior of complex transport and separation processes.
5. Conduct investigations of complex multi-stage processes, such as non-ideal distillation and extraction columns, using modeling and data interpretation to provide valid conclusions.

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

25CHPESCN	GREEN CHEMISTRY AND TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To promote an understanding of environmentally benign chemical practices and technologies by emphasizing the principles of green chemistry, with the aim of minimizing waste, reducing the use of hazardous substances, and developing sustainable processes for chemical manufacturing and industrial applications.
- To explore and develop eco-friendly reagents using the principles of green chemistry, aiming to minimize environmental impact, enhance atom economy, and replace hazardous substances with safer, sustainable alternatives in chemical synthesis.
- To study environmentally sustainable oxidation and photochemical reaction processes that utilize green reagents, catalysts, and energy sources, with the aim of reducing hazardous byproducts and improving the efficiency and safety of chemical transformations.

UNIT – I: Green Chemistry

Twelve principles of green chemistry, green technology-definition, importance, factors affecting green technology. Introduction to Life Cycle Assessment. Role of industry, government and institutions; industrial ecology, role of industrial ecology in green technology.

UNIT - II

Synthesis of Green Reagents, Green Solvents and Volatile Organic Compounds, Solvent-free Systems, Super critical fluids - extraction, process and applications. Supercritical Carbon Dioxide, Supercritical Water, Water as a Reaction Solvent, Water-based Coatings, Ionic Liquids, Ionic Liquids as Catalysts, Ionic Liquids as Solvents, FluorousBiphase Solvents.

UNIT III:

Green oxidation and photochemical reactions, Microwave and Ultrasound assisted reactions, Photochemical Reactions, Advantages of and Challenges Faced by Photochemical, Processes, Examples of Photochemical Reactions, Chemistry Using Microwaves, Microwave Heating, Microwave-assisted Reactions, Sonochemistry, Sonochemistry and Green Chemistry, Electrochemical Synthesis, Examples of Electrochemical Synthesis.

UNIT-IV

Renewable energy technologies like solar, wind, hydropower, geothermal and biomass energy, phytoremediation, eco-restoration, issues and challenges.

UNIT V

Green materials, -biomaterials, biopolymers, bioplastics, composites, Sensors, Biomimetic Sensors.

Green nanotechnology - Nanomaterials for fuel cells and hydrogen generation and storage. Nanostructures for efficient solar hydrogen production, solar thermal Energy and Photovoltaic. Smart nanomaterials, Nano Catalysts, Nano-sensors.

COURSE OUTCOMES (COs/POs)

By the end of the course, student will be able to:

1. Apply principles of basics to analyze the twelve principles of green chemistry and industrial ecology, reaching substantiated conclusions for sustainable development.
2. Design creative chemical synthesis pathways using green reagents, supercritical fluids, and advanced energy-assisted methods to meet identified needs for atom economy and net-zero carbon goals.
3. Conduct investigations into renewable energy technologies and green nanotechnology—including fuel cells and solar hydrogen production—by interpreting experimental data and research literature.
4. Analyze the societal and environmental impact of green materials, phytoremediation, and eco-restoration through Life Cycle Assessment (LCA) while adhering to national and international environmental laws.
5. Exhibit professional competence in evaluating smart nanomaterials and biomimetic sensors while demonstrating the ability for lifelong learning and effective technical communication regarding emerging process technologies.

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

25CHPESCN	HAZARDOUS CHEMICAL STORAGE AND HANDLING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Identify and classify hazardous chemicals
2. Assess and manage the hazards associated with chemicals.
3. Handle chemicals and operate chemical plant safely
4. Implement proper procedures for storage and transportation of hazardous chemicals
5. Identify potential emergency incidents of toxic and hazardous materials

UNIT - I

Introduction to Toxic and Hazardous Materials (HAZMAT) - Classification of toxic and hazardous substances - Types of hazards - Material safety data sheets - Toxicity and health effects - Control of sources of exposure - Environmental effects on health- Safety and health Standards - Indian Standards & Codes for safety & health - International standard: OHSAS 18001

UNIT - II

Chemical hazards - Classification of Chemical Hazards and their control - Occupational diseases and Poisoning - Prevention of diseases due to chemical effect - Safety aspects in plant layout – Ventilation and Lighting - Color codes and symbols for Safety in chemical plants - Classification of Color codes and Symbols - Color codes for gas cylinders and pipelines - Personal Protective Devices (PPDs) - Non-Respiratory – Respiratory

UNIT - III

Safe Handling of Hazardous Chemicals - Safe Handling of Toxic and Hazardous Materials - Safe Work Systems and Essential practices for handling hazardous chemicals - Personal protection clothing and equipment (selection and use) - Provision of training and information on chemical risks - General and local exhaust ventilation methods - Maintenance of engineering control measures - Monitoring and Measuring methods and record-keeping - Laboratory waste management - Transportation of hazardous chemicals

UNIT - IV

Operational Control Measures - Risk assessment techniques for identifying chemical hazards - Analyzing risk assessment findings and evaluating risk levels - Control measures for chemicals hazardous to health - Control measures of flammable, dangerously reactive or explosive chemicals - Control measures for the storage of hazardous chemicals - Hazardous waste audit and disposal and treatment of waste chemicals - Fire Hazards and their Prevention

UNIT - V

Emergency Management and Response Plans - Identifying potential emergency incidents of toxic and hazardous materials - Emergency response procedures - On-site and Off-site Emergency plans - Emergency training, exercises and drills- Medical first aid, health surveillance and medical records - Investigation of incidents and lessons learned

TEXT BOOKS

1. Manual of Chemical Technology, Chemtech-I D.Venkateswarlu, K.R.Upadrashta, K.D. Chandrasekaran Chemical Engineering Education Development Centre, IIT, Madras, 1975
2. Fundamentals of Industrial Safety & Health Dr. K. U. Mistry Siddharth Prakashan, Ahmadabad
3. Chemical Process Safety: Fundamentals with Application Daniel A. Crowl, Joshef F. Louvar, 3rd Edition, 2011, Prentice Hall, USA,
4. Industrial Safety Management N. K. Tarafdar, K. J. Tarafdar Dhanpatrai and Co.Ltd, New-Delhi, 1st Edition, 2012
5. Industrial Safety Management L M Deshmukh Tata McGraw Hill, New Delhi, 2006
6. Industrial Safety, Health & Environment Management Sunil S. Rao, R.K.Jain Khanna Publishers, New Delhi, 2006

COURSE OUTCOMES:

After learning the course, the students will be able to

1. Apply chemical safety and toxicological principles to identify hazards, assess potential health and environmental effects, and determine appropriate safety requirements for hazardous chemical operations.
2. Analyze hazardous chemical handling and storage systems using risk assessment principles, engineering controls, safe work practices, and appropriate personal protective measures to minimize exposure and operational risks.
3. Evaluate the adequacy of chemical safety controls for storage, transportation, workplace operations, hazardous waste management, fire prevention, and environmentally responsible handling of hazardous substances.
4. Develop integrated safety and emergency response strategies for hazardous chemical incidents by considering containment, emergency procedures, medical response, training, communication, and applicable safety standards and codes.
5. Investigate hazardous chemical incidents and safety performance using risk assessment findings, monitoring records, incident analysis, and lessons learned to recommend continual improvements while demonstrating professional and ethical responsibility.

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

25CHPESCN	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 MATLAB/ Simulink, Aspen Plus and Aspen Hysys.

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. Apply numerical methods and computing tools to solve complex material and energy balances, thermodynamic phase equilibria, and fluid flow problems in pipes and pumping systems.
2. Simulate and design UNIT operations, including shell and tube heat exchangers and fluid transport equipment, to determine heat duty, pressure drops, and power requirements using modern engineering software.
3. Model and analyse the performance of various chemical reactors and multi-stage separation processes to optimize sizing and operational efficiency.
4. Utilize professional process simulation suites to predict physical properties and perform integrated process calculations for binary and multi-component systems.

5. Evaluate process designs with respect to sustainability, economic viability, and ethical standards, while communicating technical findings through professional reports and design documentation.

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

25CHPESCN	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 – COs/POst 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. Analyze complex quality problems by evaluating Total Quality Management (TQM) frameworks, traditional quality tools, and Six Sigma methodologies to implement effective quality auditing systems.
2. Create innovative solutions for process improvement using advanced techniques such as Quality Function Deployment (QFD), Taguchi methods, and Business Process Reengineering (BPR), supported by modern engineering tools.
3. Analyze societal and environmental impacts (ISO 14000) by managing quality COs/POsts and technical risks to ensure sustainable and economical process operations.
4. Apply professional ethics and human values while functioning as a leader or member of Quality Circles to implement Kaizen and 5S principles.

5. Apply effective communication methods for audit results and adapt to emerging management trends through critical reflection and lifelong learning.

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

25CHPESCN	CHEMICAL WORKS ORGANIZATION AND MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To Provide foundational knowledge of organizational structures, roles, and functions within chemical industries to understand how engineering and management intersect in real-world operations.
2. To equip students with the ability to plan projects effectively, including site selection, plant layout, equipment arrangement, and workflow optimization specific to chemical process industries.
3. To familiarize students withessential concepts of production planning, process scheduling, materials management, and quality control to improve operational efficiency in chemical plants.
4. To impart knowledge on the importance of industrial safety standards, environmental regulations, and risk management practices to ensure sustainable and compliant chemical plant operations.
5. To provide students with skills to conduct COs/POst estimation, budgeting, and economic evaluation of chemical engineering projects for informed decision-making and resource optimization.

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- size of industrial UNITs. Plant layout - Choice of equipment various types of layouts - 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 group development. Properties and Characteristics of Highly effective groups

TEXT BOOKS:

1.Sukla, M.C., Business Organization and Management, 2010.
2.Uma sekaran – "Organisational Behaviour – Text and Cases" 2004, Tata McGraw Hill New Delhi.

REFERENCES:

1.Tripathi – "Personnel Management & Industrial Relations" 2013, Sultan Chand and Sons New 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. Evaluate various forms of business ownership and plant design parameters (location and layout) to optimize resource management and operational safety in industrial settings.
2. Analyze industrial relations and labor laws, specifically the Industrial Disputes Act, 1947, to manage workplace disputes ethically while adhering to legal and societal frameworks.

3. Apply scientific management principles and material management techniques, including time and motion studies and inventory control, to improve industrial productivity and economic decision-making.
4. Examine personality predispositions and motivation theories to enhance individual work performance and foster professional development within a chemical works environment.
5. Utilize the dynamics of communication and group behavior strategies to lead multidisciplinary teams, ensure organizational synergy, and facilitate effective technical reporting.

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

25CHPESCN	PILOT PLANT AND SCALE UP METHODS IN CHEMICAL ENGINEERING	L	T	P	C
		3	0	0	3

UNIT – I

Scale up: Description and evolution of a process system, Introduction to Scale up procedures, Dimensional analysis, Similitude.

UNIT – II

Reactors for Fluid Phase Processes Catalyzed by Solids: Pseudo-homogeneous and heterogeneous models, Two-dimensional models, Scale up considerations.

UNIT – III

Fluid-fluid Reactors: Scale-up considerations in packed bed absorbers and bubble columns, Applicability of models to scale-up.

UNIT – IV

Mixing Processes: Scale-up relationships, Scale-up of polymerization UNITs, Continuous stages gas liquid slurry processes, Liquid-liquid emulsions.

Fluidized Beds: Major scale-up issues, Prediction of performance in large equipment, Practical commercial experience, Problem areas.

UNIT – V

Solid-Liquid Separation Processes: Fundamental considerations, small scale studies for equipment design and selection, Scale-up techniques, Uncertainties.

Continuous Mass Transfer Process: Fundamental considerations scale-up procedure for distillation, Absorption, Stripping and extraction UNITs.

TEXT BOOKS:

1. Marko Zlokarnik, Scale-up in chemical engineering, Wiley-VCH (2006).
2. R.E. Johnstone and M.W. Thring, Pilot Plants, Models and Scale-up Methods in Chemical Engineering, McGraw-Hill (1957).

REFERENCE BOOKS:

1. Colin Divall, Sean Johnston, Scaling up: the Institution of Chemical Engineers and the rise of a new profession, Springer (2000).
2. Bisio, A. and Kabel, R.L., Scale-up of Chemical Processes, John Wiley (1985).

COURSE OUTCOMES:

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

1. Apply engineering principles, dimensional analysis, and similitude concepts to formulate scale-up problems and establish meaningful relationships between laboratory, pilot, and industrial process systems.
2. Analyze scale-dependent process behavior using appropriate mathematical models, transport phenomena, operating parameters, and experimental information to predict the performance of chemical process equipment.
3. Evaluate the applicability and limitations of scale-up models and experimental data by considering process uncertainties, equipment characteristics, operating constraints, and deviations between laboratory, pilot, and commercial systems.
4. Develop scale-up strategies for chemical process systems by integrating equipment selection, process design, performance prediction, safety, economic considerations, and practical industrial constraints.
5. Investigate scale-up challenges and propose technically feasible improvements using experimental evidence, engineering tools, critical analysis, effective communication, and sustainable engineering practices.

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

25CHOESCN	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 Tamil Nadu- 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. Apply disaster management principles and risk concepts to identify hazards, assess vulnerability, and determine potential impacts on commUNITies, infrastructure, and the environment.
2. Analyze disaster risks and vulnerabilities using appropriate scientific, technical, socio-economic, and geographical information to support risk-informed decision-making and disaster risk reduction.
3. Evaluate preparedness, mitigation, warning, response, and recovery strategies for natural, environmental, chemical, biological, and technological hazards considering local and regional conditions.
4. Develop integrated disaster management strategies incorporating early warning, emergency planning, resilient infrastructure, resource coordination, humanitarian considerations, and sustainable development principles.
5. Investigate disaster events and management practices using case studies, risk analysis, technical evidence, and stakeholder perspectives to recommend resilient and ethically responsible measures for reducing future disaster impacts.

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

25CHPESCN	ENTREPRENEURSHIP & INNOVATION: BUILDING THE FUTURE	L	P	0	C
		3	0	0	3

COURSE OBJECTIVES:

1. To provide students with a clear understanding of the entrepreneurial mindset, types of entrepreneurs, and the role of innovation in identifying and developing business opportUNITies.
2. To equip students with the ability to prepare business plans, conduct market research, evaluate feasibility, and structure new ventures relevant to the chemical and allied industries.
3. To familiarize students with the legal structures for startups, intellectual property rights, licenses, and environmental regulations specific to chemical-based enterprises.
4. To teach students key concepts of funding, budgeting, COs/POst analysis, and resource optimization essential for launching and sustaining a chemical-based business.
5. To inspire students to apply chemical engineering knowledge to develop innovative, sustainable, and socially responsible solutions through entrepreneurship.

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 entrepreneurs – 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. Explain the fundamentals of management, planning, organizing, staffing, and directing functions in industrial and entrepreneurial environments.

2. Understand entrepreneurial characteristics, leadership qualities, communication skills, and the role of entrepreneurship in economic development.
3. Apply management principles and decision-making techniques for effective organizational and business operations.
4. Prepare project reports and evaluate project feasibility for innovative, sustainable, and socially responsible business ventures.
5. Analyze opportUNITies, barriers, and feasibility aspects involved in establishing entrepreneurial ventures, particularly in chemical and allied industries.

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

25CHPESCN	INDUSTRIAL RELATIONS & ORGANIZATIONAL DEVELOPMENT	L	P	0	C
		3	0	0	3

COURSE OBJECTIVES:

1. To provide students with a foundational understanding of employer-employee relationships, labor laws, trade unions, and dispute resolution mechanisms in industrial settings.
2. To enable students to understand individual and group behavior in organizations, including motivation, communication, leadership, and conflict management.
3. To introduce the concepts, models, and interventions used in organizational development to improve effectiveness, adaptability, and employee engagement.
4. To prepare students to manage and adapt to organizational change, especially in the context of technological advancements and global competition in chemical industries.
5. To provide insights into recruitment, training, performance appraisal, and employee welfare with a focus on enhancing productivity and maintaining positive industrial relations.

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. Analyze industrial relations frameworks and conflict anatomy by interpreting labor legislation and group dynamics to evaluate overall organizational effectiveness and culture.
2. Apply statutory labor acts and leadership theories to design grievance settlement procedures and industrial relations programs that facilitate structured organizational change.
3. Evaluate the impact of industrial disputes and state policies within the legal framework of factory acts to manage organizational stress, diversity, and economic stability through effective leadership.
4. Demonstrate professional ethics and collaborative leadership while navigating industrial relations policies and prerequisites to foster team building and interpersonal communication.
5. Apply effective communication strategies to interpret legislative updates and behavioral patterns while adapting to changing industrial relations perspectives and dispute resolution for lifelong learning.

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

25CHPESCN	AI AND ML IN CHEMICAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- Understand foundational AI and ML concepts relevant to chemical engineering.
- Apply machine learning tools to solve problems in process systems, molecular design, and optimization.
- Interpret and validate data-driven models used in chemical processes.
- Use AI techniques in control, fault detection, and predictive maintenance.
- Analyze real-world case studies where AI and ML have been successfully applied in chemical engineering, fostering critical thinking and innovation in solving engineering problems.

UNIT I: Introduction and Foundations

Overview of AI/ML in chemical engineering. Types of ML: Supervised, Unsupervised, Reinforcement Learning. Tools & Libraries: Python, Scikit-learn, TensorFlow/PyTorch, Pandas. Data preprocessing and feature engineering

UNIT 2: Supervised Learning

Regression: Linear, Ridge, Lasso, SVR. Classification: Decision Trees, Random Forests, SVM, k-NN. Model performance metrics: RMSE, R^2, Confusion Matrix, ROC-AUC. Case Study: Predicting reaction yields or product quality

UNIT III: Unsupervised Learning and Dimensionality Reduction

Clustering: k-Means, Hierarchical, DBSCAN. Dimensionality Reduction: PCA, t-SNE, Autoencoders. Application: Process monitoring, anomaly detection

UNIT IV: Deep Learning

Neural Networks: Architecture, activation functions, back-propagation. Convolutional Neural Networks (CNNs): For image-based reactor monitoring. Recurrent Neural Networks (RNNs), LSTM: For time-series data in process control. Application: Fault detection, predictive maintenance

UNIT V: Process Systems Engineering Applications

Soft sensors and virtual metrology. Surrogate modeling for process simulation. Optimization with ML-based models. Hybrid modeling: Combining first-principles with ML.

Molecular and Materials Design

ML in computational chemistry and materials discovery. Property prediction (e.g., solubility, boiling point). Generative models for molecular design (VAEs, GANs)

Textbooks:

1. Machine Learning: A Probabilistic Perspective by Kevin P. Murphy
2. Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville

COURSE OUTCOMES:

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

1. Explain key concepts, algorithms, and workflows in artificial intelligence and machine learning relevant to engineering problems.
2. Recognize processes and operations within chemical engineering that can benefit from AI/ML-based solutions.
3. Prepare chemical process data for ML modeling, including handling missing data, scaling, and feature selection.
4. Implement supervised and unsupervised learning models using tools like Python, Scikit-learn, Tensor Flow, etc., and evaluate their performance using appropriate metrics.
5. Critically evaluate real-world examples where AI/ML has been applied in areas like reaction engineering, materials discovery, and process monitoring.

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

25CHOESCN	HUMAN FACTORS ENGINEERING, BBS& OCCUPATIONAL HEALTH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

By the end of the course, students should be able to:

- Understand the fundamentals of human factors contributing to accidents
- Know the importance of ergonomics
- Implement programmes on BBS
- Understand the notifiable diseases
- Understand the physiological requirements in work place

UNIT- I

Concept of Man-Machine System – Applications of human factors engineering – Man as a Sensor – Man as an Information Processor – Man as a Controller

Human factors contributing to accidents-Unsafe action factors – Psychological Factors – Psychosocial Factors - Theories of Motivation and their application to Safety

UNIT II

Ergonomics – Principles – Approach Solutions – Ergonomic Programme – Principles of Motion Economy – Anthropometry – Biomechanics Lighting, noise, and thermal comfort

Shift work and circadian rhythms

UNIT III

Behaviour based safety –The ABC Model: Antecedent-Behavior-Consequence- Behaviour observation and data collection - Implementing Behavior-Based Safety Programs - Feedback and Positive Reinforcement - Measuring and Sustaining BBS Performance - Case Studies and Industrial Applications

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 siliCOs/POsis, asbestosis, pneumoconiosis, siderosis, anthraCOs/POsis, 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 - 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. Geller, E. S. – Behavior-Based Safety: A Guide to Achieving Safe Behavior in the Workplace
3. Krause, T. R. – The Behavior-Based Safety Process: Managing Involvement for an Injury-Free Culture
4. Handbook of Occupational Health and Safety, NSC Chicago, 1982
5. 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. Explain the principles of human factors engineering, man–machine systems, ergonomics, occupational physiology, and occupational health in industrial environments.
2. Analyze human, behavioral, physiological, ergonomic, and environmental factors influencing workplace safety, health, and productivity.
3. Evaluate occupational hazards, work conditions, and occupational diseases using ergonomic, physiological, and health assessment techniques.

4. Apply Behavior-Based Safety (BBS) principles, motivation theories, and human-centered interventions to improve safety performance and reduce workplace risks.
5. Design and recommend engineering and administrative control measures to enhance occupational safety, health, well-being, and sustainable work systems.

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

25CHOESCN	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 NGOs.

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 Equipment; Resource recovery from solid waste – composting and bio-methanation; 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.

TEXTBOOKS

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. Williams, *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 the treatment of solid wastes.

5. Explain the landfill in solid waste management.

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

25CHOESCN	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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	-	-	2	2	-	-	-	3	2	3
CO2	3	2	2	2	-	-	2	2	-	-	-	3	2	3
CO3	3	-	3	-	-	-	2	2	-	-	-	3	2	3
CO4	3	-	2	-	-	-	2	2	-	-	-	3	2	3
CO5	3	-		3	-	-	2	2	-	-	-	3	2	3

25CHOESCN	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.NewDelhi.
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 RiskAssessment, 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. Identify hazard and to conduct hazard analysis, safety audit, hazard survey & hazard evaluation.

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

.

25CHOESCN	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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	-	2	2	3	3	3	2	3	2	3
CO2	3	2	3	2	-	2	2	3	3	3	2	3	2	3
CO3	**3**	2	2	2	3	3	2	3	3	3	2	3	2	3
CO4	3	2	3	2	-	2	3	3	3	3	2	3	2	3
CO5	3	2	3	2	-	3	3	3	3	3	2	3	2	3

25CHOESCN	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.

UNITV

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 McGrawHill,.
4. Twidell, J.W. and Weir, A., Renewable Energy Sources,1986, EFN SponLtd..

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, IIEdn.
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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	3	-	-	-	-	2	3	3
CO2	3	2	2	-	2	-	2	-	-	-	-	2	3	3
CO3	3	3	3	2	2	-	2	-	-	-	-	2	3	3
CO4	3	3	3	3	3	-	2	-	-	-	2	2	3	3
CO5	3	2	2	2	3	-	3	-	-	-	-	2	3	3

25CHOESCN	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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	3	3	2	-	-	-	3	-	2
CO2	3	2	1	-	-	2	3	2	-	-	-	3	3	2
CO3	3	3	3	2	3	2	2	-	-	-	-	3	3	2
CO4	3	2	2	2	3	2	2	-	2	2	2	2	3	2
CO5	3	2	2	1	-	3	3	3	-	2	2	2	3	2

25CHOESCN	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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	2	3	-	-	-	-	2	1	-
CO2	3	3	2	2	2	2	3	-	-	-	-	1	1	-
CO3	3	2	3	2	3	-	2	-	-	-	-	2	1	1
CO4	3	2	2	-	2	-	3	-	-	-	-	2	1	-
CO5	3	3	3	3	3	2	3	-	-	-	-	2	2	-

25CHOESCN	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 learn about how to manage IP rights and legal aspects.

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 will be able to

1. Demonstrate understanding of basic concepts of IPR.
2. Differentiate between Trademarks, Trade secrets and GI of goods.
3. Understand Copyrights, Patents and Industrial Designs and analyze various forms of IPR protections.
4. Evaluate collaborative agreements and legal contacts in managing IP rights effectively.
5. Evaluate the international legal aspects and implications of computer and online crimes.

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

25CHOESCN	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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	2	3	-	-	-	-	2	2	-
CO2	3	3	2	2	-	-	2	-	-	-	-	2	2	-
CO3	3	2	2	1	2	2	3	-	-	-	-	2	2	-
CO4	3	3	2	2	1	-	2	-	-	-	-	2	2	1
CO5	3	2	3	2	2	2	3	1	-	1	-	2	2	-

25CHOESCN	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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	-	-	-	-	-	3	2	3	2	2	2	3	3	1
CO2	-	2	-	-	-	2	-	2	3	3	3	3	3	1
CO3	-	2	-	-	-	3	2	3	2	2	-	3	3	2
CO4	2	2	-	-	-	2	-	1	-	1	-	3	3	3
CO5	1	2	-	-	2	3	-	2	3	2	2	3	3	3

25CHOCSCN	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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	3	-	2	3	-	-	-	-	3	-	-
CO2	3	2	3	3	1	2	3	-	2	2	3	3	-	-
CO3	3	3	3	3	1	2	3	-	2	2	3	3	-	-
CO4	2	2	2	3	-	2	3	3	-	1	-	3	-	-
CO5	2	2	2	3	-	2	3	3	3	3	3	3	-	-

25CHOCSCN	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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	2	1	2	3	2	2	2	3	3	-	-
CO2	3	3	3	2	1	2	3	2	2	2	3	3	-	-
CO3	3	1	2	1	-	2	3	3	1	2	3	3	-	-
CO4	3	3	2	3	1	2	3	2	2	2	3	3	-	-
CO5	3	3	3	3	1	2	3	2	2	2	3	3	-	-

25CHHE601	ADVANCED HEAT TRANSFER	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES:

- To apply scientific and engineering principles to analyze thermo fluid 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 fluid dynamic 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. Acquire knowledge and design compact heat exchangers for industrial applications

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

25CHHE602	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 /POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	3	-	-	-	-	-	-	-	3	2	2
CO2	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO4	3	-	2	2	3	-	-	-	-	-	-	3	2	2
CO5	3	-	2	3	-	-	-	-	-	-	-	3	2	3

25CHHE701	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, linear-ization 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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	2	-	2	-	-	-	-	3	2	3
CO2	3	3	2	2	-	-	2	-	-	-	-	3	2	3
CO3	3	3	2	2	-	-	2	-	-	-	-	3	2	3
CO4	3	3	2	2	-	-	2	-	-	-	-	3	2	3
CO5	3	3	2	2	2	-	2	-	-	-	-	3	2	3

HHE702	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/porosityand 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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	2	2	-	-	-	-	2	-	3	2	3
CO2	2	3	2	-	-	-	2	-	-	2	2	3	3	3
CO3	3	3	3	2	-	-	-	-	-	-	2	3	3	3
CO4	3	2	-	3	-	-	-	-	2	-	-	3	2	3
CO5	3	-	2	3	3	2	2	2	2	-	3	3	2	3

25CHHE801	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 nano emulsion. 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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	2	1	2	3	2	2	2	3	3	2	3
CO2	3	3	3	2	1	2	3	2	2	2	3	2	3	2
CO3	3	1	2	1	-	2	3	3	1	2	3	3	3	2
CO4	3	3	2	3	1	2	3	2	2	2	3	3	2	3
CO5	3	3	3	3	1	2	3	2	2	2	3	2	2	3

25CHHE802	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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	-	-	-	-	-	-	-	-	3	2	3
CO2	3	2	2	1	-	-	-	-	-	-	-	3	2	3
CO3	3	3	3	2	2	-	-	-	-	-	2	3	2	3
CO4	3	3	3	2	2	-	-	-	-	-	2	3	2	3
CO5	3	3	3	2	3	-	-	-	2	2	3	3	2	3

25CHMI601	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:

1. 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. 3rded
2. Himmelblau,D.M.,Basic Principles and Calculations in chemical Engineering. 2nded.1967
3. Mayers and seider, Introduction to chemical Engineering and computer calculations, 3rd ed. 1982, PrenticeHall.
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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**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	-

25CHMI602	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, gluCOs/POse, 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, visCOs/POse 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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	-	-	-	-	-	-	-	-	3	-	-
CO2	3	1	1	-	1	-	-	-	1	2	-	3	-	-
CO3	3	1	1	1	1	-	-	-	1	2	-	3	-	-
CO4	3	3	3	3	1	-	-	-	1	2	2	3	-	-
CO5	3	3	3	2	2	-	-	-	2	2	3	3	-	-

25CHMI701	CHEMICALENGINEERING 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.

TEXTBOOKS:

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.,PrinciplesofMassTransferandSeparationProcess.2007,Prentice-Hallof India Pvt. Ltd, New Delhi.

COURSEOUTCOMES:

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

25CHMI702	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/porosity
- 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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	-	-	-	-	-	1	-	3	2	-
CO2	3	3	2	2	1	-	-	-	-	1	-	3	3	2
CO3	3	2	2	2	1	-	-	-	-	1	-	3	3	2
CO4	3	3	3	2	2	-	-	-	1	2	2	3	3	2
CO5	3	3	3	2	2	-	-	-	1	2	2	3	2	3

25CHMI 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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	-	2	-	-	-	-	-	3	3	3
CO2	3	3	3	3	-	-	2	-	-	-	-	3	3	3
CO3	3	3	3	3	3	-	3	-	-	2	-	3	2	3
CO4	3	3	3	3	-	2	-	-	-	-	-	3	2	3
CO5	3	3	3	3	-	3	2	-	-	-	-	3	2	3

25CHMI802	PROCESS ENGINEERING & ECONOMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Explain the principles of COs/POst 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

COs/POst accounting -Pre construction COs/POst estimation - allocation of COs/POst.

UNIT - IV

Economics of selecting alternatives

Annual COs/POst 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 COs/POst 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/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	3	-	-	-	3	3	3	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

25ECHEVAC01	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

25ECHEVAC02	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).

25ECHEVAC03	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

25ECHEVAC04	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.