ANNAMALAI UNIVERSITY

Annamalainagar

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF CHEMICAL ENGINEERING

B.E. Chemical Engineering
Four Year Degree Programme
Choice Based Credit System
(Full - Time)

HAND BOOK

2018 – 2019
(Onwards)

ANNAMALAI UNIVERSITY

FACULTY OF ENGINEERING AND TECHNOLOGY

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

Choice Based Credit System (CBCS)

REGULATIONS 2018

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 plus 2 Higher Secondary Course with Mathematics, Physics and Chemistry as courses of study and candidates who have passed the Higher Secondary Examination through vocational stream under Engineering, conducted by the Board of Secondary Education, Government of 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 (listed in Annexure-I) 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	-	Chemical Engineering
BRANCH II	-	Civil Engineering
BRANCH III	-	Civil and Structural Engineering
BRANCH IV	-	Computer Science and Engineering
BRANCH V	-	Electrical and Electronics Engineering
BRANCH VI	-	Electronics and Communication Engineering
BRANCH VII	-	Electronics and Instrumentation Engineering
BRANCH VIII	-	Information Technology
BRANCH IX	-	Mechanical Engineering
BRANCH X	-	Mechanical Engineering (Manufacturing)

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 six components namely 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 have a blend of theory and practical courses. The total credits for the entire degree Programme is 166 (124 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

5.1 Earn a minimum of 166 credits (124 for lateral entry students).

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

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

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

(or)

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

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

5.3 B.E (Honours) Degree

A student shall be eligible to get Under Graduate degree with Honors, if he/she completes an additional 20 credits. Thus the total credits are 186. Out of 186 credits (144 credits for lateral entry students), 20 credits must be earned by studying additional course offered by the same or allied Departments (listed in Annexure-II) in sixth, seventh and eighth semesters. These additional 20 credits could be acquired through the MOOC courses of SWAYAM portal also.

5.4 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 186 credits, 20 credits must be earned from the courses offered by any one of the Departments (listed in Annexure-II) in the Faculty of Engineering and Technology in sixth, seventh and eighth semesters . These additional 20 credits could be acquired through the MOOC courses offered in SWAYAM portal also.

6. Assignment of Credits for Courses

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

7. Duration of the Programme

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

8. Registration for Courses

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

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

A student is required to earn 166 (124 for lateral entry students) credits in order to be eligible for obtaining the degree. However the student is entitled to enjoy an option to earn either more or less than the total number of credits prescribed in the curriculum of a particular semester on the following guidelines:

8.1 Slow Learners

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

8.2 Advance Learners

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

9. Mandatory Internship (Industrial Training)

To promote industrial internship at the graduate level in technical institutes and also to enhance the employability skills of the students passing out from Technical Institutions, the internship for the students at different stages of the programme, is included in the curriculum. The student has to undergo the internship during the summer vacation, after the II semester / IV semester / VI semester of the programme as per the details outlined below. Further the student has to submit a report on completion of the internship during the subsequent Odd semester that is in the III / V / VII semesters respectively.

9.1 During the summer vacation, after the II Semester,

The student must get involved in any of the following **Inter/ Intra Institutional Activities** for **4 weeks** duration:

(i) Training with higher Institutions; Soft skill training organized by Training and Placement Cell.
(ii) Contribution at incubation/ innovation /entrepreneurship cell of the institute.
(iii) Participation in conferences/ workshops/ competitions.
(iv) Learning at Departmental Lab/ Institutional workshop.
(v) Working for consultancy/ research project within the University.
(vi) Participation in activities like IPR workshop / Leadership Talks/ Idea/ Design/ Innovation/ Technical Expos.

9.2 During the summer vacation, after the IV Semester and also after the VI Semester,

The student may choose any of the following **Internship / Innovation / Entrepreneurship** related activities for **4 weeks** duration:

(i) Work on innovation or entrepreneurial activities resulting in start-up
(ii) Undergo internship with industry/ NGO's/ Government organizations/ Micro/ Small/ Medium enterprises
(iii) Undergo internship with National Employment Enhancement Mission (NEEM) Facilitator.

10. 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.

11. Mandatory Induction program

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

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

12. Electives

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

12.1 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.

12.2 Open Elective courses

Apart from the various Professional elective courses, a student must study four open elective courses two of which offered by the Department concerned and the other open elective course offered by any other Department in the Faculty of Engineering & Technology during either sixth or seventh or eighth semester of study, with the approval of the Head of the Department and the Head of the Department offering the course.

12.3 MOOC (SWAYAM) Courses

Further, the student can be permitted to earn not more than 20 % of his total credits (that is 32 credits) by studying the Massive Open Online Courses offered through the SWAYAM Portal of UGC with the approval of the Head of the Department concerned. These courses will be considered as equivalent to the professional elective and/or open elective courses. Thus the credit earned through MOOC courses can be transferred and considered for awarding Degree to the student concerned.

12.4 Value added courses (Inter Faculty Electives)

Of the four open elective courses, a student must study one value added course that is offered by other Faculties in our University either in sixth or seventh semester of the B.E programme.

12.5 One Credit Courses

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

12.5.1 Industry Expert

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 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 one credit courses (one each in VI and VII semesters). They shall be allowed to take 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 one credit courses.

12.5.2 NSQF Courses

A student can be permitted to acquire additional credits not more than two by undergoing any two of the one credit courses conducted under the auspices of National Skills Qualification Framework (NSQF).

NSQF is a nationally integrated education and competency based skill and quality assurance framework that will provide for multiple pathways, horizontal as well as vertical, including vocational education, vocational training, general education and technical education, thus linking one level of learning to another higher level. This will enable a student to acquire desired competency levels, transit to the job market and at an opportune time, return for acquiring additional skills to further upgrade their competencies.

13. Assessment

13.1 Theory Courses

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

First assessment (Mid-Semester Test-I)	:	10 marks
Second assessment (Mid-Semester Test-II)	:	10 marks
Third Assessment	:	5 marks
End Semester Examination	:	75 marks

13.2 Practical Courses

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

13.3 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.

13.4 Industrial Internship

After attending the internship during the summer vacation of even semester (II / IV / VI semester), the student has to present a report at the start of the subsequent odd semester (III / V / VII semester) to the committee which will assess and award marks out of 100. The committee is constituted with an Internship Coordinator and a minimum of two members nominated by the Head of the Department for each class.

14. 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.

15. Student Counsellors (Mentors)

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

16. Class Committee

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

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

For each of the higher semesters, separate class committees will be constituted by the respective Head of the Departments. The composition of the class committees from third to eighth semester will be as follows:

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

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

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

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

17. 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.

18. 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.

19. 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.

20. Passing and declaration of examination results

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

21. Awarding Degree

After successful completion of the programme, the degree will be awarded with the following classification based on CGPA.

21.1 Honours Degree

To obtain **Honours Degree** a student must earn a minimum of **186 credits** within four years (144 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 CGPA of 8.25 or above.

21.2 First Class with Distinction

To obtain B.E Degree First Class with Distinction, a student must earn a minimum of 166 Credits within four years (124 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.

21.3 First Class

To obtain B.E Degree First Class, a student must earn a minimum of 166 credits within ***five*** years (124 credits within ***four*** years for lateral entry students) from the time of admission and obtain a 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).

21.4 Second Class

For Second Class, the student must earn a minimum of 166 credits within **seven** years (124 credits within **six** years for lateral entry students) from the time of admission.

21.5 B.E Degree with Minor Engineering

For Minor Engineering, the student must earn a minimum of 186 credits within four years (144 credits within three years for lateral entry students) from the time of admission, pass all the courses. The rules for awarding the B.E degree in First Class with Distinction or in First Class or in Second Class will be applicable for this also.

22. Ranking of Candidates

The candidates who are eligible to get the B.E. degree with Honours will be ranked together on the basis of 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 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 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.

23. Transitory Regulations

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

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

Annexure-I

Diploma Programmes Eligible for the B.E (Lateral Entry) Programmes offered in FEAT (from 2019-2020)

Sl.No.	Branches of Study	Eligible Diploma Programme (FT / PT / SW)
1.	**Chemical Engineering**	i. Petrochemical Engineering ii. Chemical Engineering iii. Environmental Engineering and Pollution Control iv. Leather Technology (Footwear) v. Leather Technology vi. Plastic Technology vii. Polymer Technology viii. Sugar Technology ix. Textile Technology x. Chemical Technology xi. Ceramic Technology xii. Petro Chemical Technology xiii. Pulp & Paper Technology xiv. Petroleum Engineering
2.	**Civil Engineering**	i. Civil Engineering ii. Civil Engineering (Architecture) iii. Environmental Engineering and Pollution Control (Full Time)
3.	**Civil and Structural Engineering.**	iv. Architectural Assistantship v. Civil Engineering (Rural Tech.) vi. Civil and Rural Engineering vii. Agricultural Engineering
4.	**Computer Science and Engineering**	i. Electronics and Communication Engineering ii. Computer Technology iii. Computer Science and Engineering iv. Information Technology v. Computer Engineering vi. Computer Networking vii. Electronics(Robotics) viii. Mechatronics Engineering
5.	**Electrical and Electronics Engineering**	i. Electrical and Electronics Engineering ii. Electronics and Communication Engg. iii. Electronics and Instrumentation Engg iv. Electronics Engineering(Instrumentation) v. Instrument Technology vi. Instrumentation and Control Engineering vii. Electrical Engineering (Instruments and Control) viii. Electrical Engineering ix. Instrumentation Technology x. Electronics (Robotics) xi. Mechatronics Engineering
6.	**Electronics and Communication Engineering**	i. Electronics and Communication Engineering ii. Computer Technology iii. Computer Science and Engineering iv. Information Technology v. Computer Engineering

		vi. Computer Networking vii. Electronics(Robotics) viii. Mechatronics Engineering ix. Electrical and Electronics Engineering x. Electronics and Instrumentation Engg
7.	**Electronics and Instrumentation Engineering**	i. Electrical and Electronics Engineering ii. Electronics and Communication Engg. iii. Electronics and Instrumentation Engg iv. Electronics Engineering(Instrumentation) v. Instrument Technology vi. Instrumentation and Control Engineering vii. Electrical Engineering (Instruments and Control) viii. Electrical Engineering ix. Instrumentation Technology x. Electronics (Robotics) xi. Mechatronics Engineering
8.	**Information Technology**	i. Electronics and Communication Engineering ii. Computer Technology iii. Computer Science and Engineering iv. Information Technology v. Computer Engineering vi. Computer Networking vii. Electronics(Robotics) viii. Mechatronics Engineering
9.	**Mechanical Engineering**	i. Mechanical Engineering ii. Mechanical and Rural Engineering iii. Mechanical Design and Drafting iv. Production Engineering v. Production Technology vi. Automobile Engineering vii. Automobile Technology viii. Metallurgy ix. Mechatronics Engineering x. Machine Tool Maintenance and Repairs xi. Tool and Die making xii. Tool Engineering xiii. Tool Design xiv. Foundry Technology xv. Refrigeration and Air Conditioning xvi. Agricultural Engineering xvii. Agricultural Technology xviii. Marine Engineering xix. Mechanical Engineering(Production) xx. Mechanical Engineering(Tool &Die) xxi. Mechanical Engineering (Foundry) xxii. Mechanical Engineering(R & A.C.) xxiii. Electronics(Robotics) xxiv. Mining Engineering xxv. Agricultural Engineering and Farm Machinery xxvi. Equipment Technology
10.	**Mechanical Engineering (Manufacturing Engineering)**	

Annexure-II

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

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

DEPARTMENT OF CHEMICAL ENGINEERING

Vision

"Strive to be widely acknowledged as a department imparting Chemical Engineering with a strong three pronged commitment to education, research and extension to effectively address the societal needs fostered by a culture encompassing innovation, ethics and excellence and by embracing the good practices in education".

Mission

- Impart quality Chemical Engineering education through a carefully devised program garnered by a curriculum meeting the global benchmarks with an extensive exposure to fundamentals and industrial applications.
- Transform the students and render them to take up successful careers in Chemical Engineering and prepare them to be leaders and responsible citizens in order to contribute to the society by exhibiting highest degree of professional standards, integrity and ethics.
- Expose the students to real time industrial problems and imbibe entrepreneurship by engaging them with interactions involving experts from the industry and the alumni.
- Infuse the students with social responsibility to meet the future challenges to provide pertinent solutions for sustainable development through professional competency.

Program Educational Objectives (PEOs)

PEO 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.
PEO 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.

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

B.E. (Chemical Engineering)

PO 1 Engineering Knowledge:

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

PO 2 Problem Analysis:

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

PO 3 Design/Development of Solutions:

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

PO 4 Conduct Investigations of Complex Problems:

Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5 Modern Tool Usage:

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

PO 6 The Engineer and Society:

Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering

practice.

PO 7 Environment and Sustainability:

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

PO 8 Ethics:

Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9 Individual and Team Work:

Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10 Communication:

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

PO 11 Project Management and Finance:

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

PO 12 Life-Long Learning:

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

PROGRAM SPECIFIC OUTCOMES (PSOs)

Graduates of Chemical Engineering Programme at Annamalai University will

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.

ANNAMALAI UNIVERSITY

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

FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF CHEMICAL ENGINEERING

Choice Based Credit System (CBCS)

COURSES OF STUDY AND SCHEME OF EXAMINATIONS (REGULATION -2019)

SEMESTER I									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
ETBS101	**BS-I**	Physics	3	1	0	25	75	100	4
ETBS102	**BS-II**	Mathematics – I	3	1	0	25	75	100	4
ETES103	**ES-I**	Basic Electrical Engineering	3	1	0	25	75	100	4
ETBP104	**BSP-I**	Physics Laboratory	0	0	3	40	60	100	1.5
ETSP105	**ESP-I**	Electrical Engineering Laboratory	0	0	2	40	60	100	1
ETSP106	**ESP-II**	Engineering Graphics and Design	1	0	4	40	60	100	3
						Total Credits			**17.5**

SEMESTER II									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
ETHS201	**HS-I**	English	2	0	0	25	75	100	2
ETBS202	**BS-III**	Chemistry	3	1	0	25	75	100	4
ETES203	**ES-II**	Programming for Problem Solving	3	0	0	25	75	100	3
ETBS204	**BS-IV**	Mathematics – II	3	1	0	25	75	100	4
ETHP205	**HSP-I**	Communication Skills and Language Laboratory	0	0	2	40	60	100	1
ETBP206	**BSP-II**	Chemistry Laboratory	0	0	3	40	60	100	1.5
ETSP207	**ESP-III**	Computer Programming Lab	0	0	4	40	60	100	2
ETSP208	**ESP-IV**	Engineering Workshop/ Manufacturing Practices	1	0	4	40	60	100	3
						Total Credits			**20.5**
Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming III Semester.									

THIRD SEMESTER

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
ETBS301	BS-V	Engineering Mathematics III	3	1	0	25	75	100	4
ETES302	ES-III	Environmental Studies	3	0	0	25	75	100	3
ETES303	ES-IV	Engineering Mechanics	3	0	0	25	75	100	3
CHES304	ES-V	Chemistry for Chemical Engineers	3	0	0	25	75	100	3
CHPC305	PC-I	Transport Phenomena	3	0	0	25	75	100	3
CHPC306	PC-II	Chemical Process Calculations	3	1	0	25	75	100	4
CHSP307	ESP-V Lab	Organic & Physical Chemistry Laboratory	0	0	4	40	60	100	2
CHCP308	PCP-I Lab	Technical Analysis Laboratory	0	0	3	40	60	100	1.5
	IT-I	Internship Inter/ Intra Institutional Activities*	***Four*** *weeks during the summer vacation at the end of* ***II Semester***				100	100	**4.0**
For the ***Lateral entry students total credit for III Semester is ***23.5*** as they are exempted from internship during summer vacation of II semester.*			**Total Credits**						**27.5**

FOURTH SEMESTER

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
CHBS401	BS-VI	Numerical Methods	3	0	0	25	75	100	3
CHES402	ES-IV	Material Science	2	0	0	25	75	100	2
CHPC403	PC-III	Fluid Mechanics	3	0	0	25	75	100	3
CHPC404	PC-IV	Chemical Engineering Thermodynamics - I	3	0	0	25	75	100	3
CHPC405	PC-V	Heat Transfer	3	1	0	25	75	100	4
CHPC406	PC-VI	Mass Transfer – I	3	0	0	25	75	100	3
CHCP407	PCP-II Lab	Fluid Mechanics Laboratory	-	-	3	40	60	100	1.5
CHCP408	PCP-III Lab	Heat Transfer Laboratory	-	-	4	40	60	100	2
						Total Credits			**21.5**
Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming V Semester.									

FIFTH SEMESTER

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
CHPC501	PC-VII	Chemical Reaction Engineering - I	3	0	0	25	75	100	3
CHPC502	PC-VIII	Mass Transfer – II	3	0	0	25	75	100	3
CHPC503	PC-IX	Particle & Fluid-particle processing	3	0	0	25	75	100	3
CHPC504	PC-X	Chemical Engineering Thermodynamics II	3	0	0	25	75	100	3
CHPE505	PE-I	Professional Elective –I	3	0	0	25	75	100	3
CHPE506	PE-II	Professional Elective –II	3	0	0	25	75	100	3
CHCP507	PCP-IV Lab	Particle & Fluid particle processing Laboratory	-	-	3	40	60	100	1.5
CHCP508	PCP-V Lab	Mass Transfer Laboratory	-	-	3	40	60	100	1.5
CHCP509	PCP – VI	Chemical Engineering Thermodynamics Laboratory	-	-	3	40	60	100	1.5
ETIT510	**IT-II**	Industrial Training / Rural Internship/Innovation / Entrepreneurship	***Four** weeks during the summer vacation at the end of **IV Semester***				100	100	**4.0**
						Total Credits			**26.5**

SIXTH SEMESTER

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
CHPC601	PC-XI	Chemical Reaction Engineering – II	3	0	0	25	75	100	3
CHPC602	PC-XII	Process Instrumentation Dynamics & Control	3	0	0	25	75	100	3
CHPE603	PE-III	Professional Elective –III	3	0	0	25	75	100	3
CHPE604	PE-IV	Professional Elective –IV	3	-	-	25	75	100	3
CHPE605	PE-V	Professional Elective –V	3	-	-	25	75	100	3
CHOE606	OE-I	Open Elective-I	3	0	0	25	75	100	3
CHCP607	PCP-VII Lab	Chemical Reaction Engineering Laboratory	-	-	3	40	60	100	1.5
CHCP608	PCP-VIII Lab	Process Control Laboratory	-	-	3	40	60	100	1.5
						Total Credits			**21.0**
Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming VII Semester.									

SEVENTH SEMESTER

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
ETHS701	HS-II	Engineering Ethics	2	0	0	25	75	100	2
CHPC702	PC-XIII	Process Technology & Economics	3	-	-	25	75	100	3
CHPE703	PE-VI	Professional Elective –VI	3	-	-	25	75	100	3
CHPE704	PE-VII	Professional Elective –VII	3	-	-	25	75	100	3
CHOE705	OE-II	Open Elective-II	3	-	-	25	75	100	3
CHCP706	PCP-IX	Chemical Plant Equipment Design & Drawing Laboratory	-		3	40	60	100	1.5
ETIT707	IT-III	Industrial Training / Rural Internship/ Innovation / Entrepreneurship	***Four*** *weeks during the summer vacation at the end of* ***VI Semester***				100	100	**4.0**
						Total Credits			**19.5**

EIGHTH SEMESTER

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
CHOE801	OE-III	Open Elective-III	3	-	-	25	75	100	3
CHOE802	OE-IV	Open Elective-IV	3	-	-	25	75	100	3
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

1. Process Modelling & Simulation
2. Polymer Engineering
3. Biochemical Engineering
4. Electrochemical Engineering
5. Nuclear Engineering
6. Nanotechnology
7. Chemical Works Organization and Management
8. Air Pollution & Control
9. Wastewater Treatment Technology
10. Environmental Engineering
11. Fluidization Engineering
12. Computational Fluid Dynamics
13. Mixing Theory and Practice
14. Petrochemical Technology
15. Petroleum Refining Engineering
16. Distillation
17. Membrane Science and Engineering
18. Food Processing Technology
19. Industrial Biotechnology
20. Modern Separation Processes
21. Fertilizer Technology
22. Pulp and Paper Technology
23. Total Quality Management
24. Operational Research
25. Optimization of Chemical Processes

OPEN ELECTIVES

1. Industrial Safety and Occupational Health
2. Solid Waste Management
3. Project Engineering
4. Materials of Construction in the Process Industries
5. Fuel Technology
6. Bioconversion and Processing of Waste
7. Hazardous Waste Management
8. Renewable Energy Technology
9. Biology for Engineers
10. Disaster Management

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

I SEMESTER

ETBS101	CHEMISTRY	L	T	P	C
		3	1	0	4

Unit – I : Water Chemistry and Surface Chemistry

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

Unit – II : Electrochemistry and Corrosion

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

Unit – III : Fuels and Storage Devices

Fuels – Classification – Calorific values – HCV and LCV – Analysis of coal – Proximate and ultimate analysis – Refining of petroleum. Cracking – Fixed bed – Synthetic petrol – Fischer – Tropsch process – Flue gas analysis by Orsat apparatus. Batteries – Primary and secondary – Dry cell – Lead acid storage battery –Ni-Cd battery – Lithium battery – H_2-O_2 fuel cell.

Unit – IV : Polymers and Nano Materials

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

Unit – V : Engineering Materials and Spectroscopic Techniques

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

Suggested Tex 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

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

1. Develop innovative methods in soft water production for industrial uses and Adsorption analysis.
2. Describe the concept of electrochemistry and its applications; corrosion and its controlling Methods.
3. Demonstrate the properties of fuels and applications of energy storage devices.
4. Evaluate the synthetic method of various polymers and the applications of Nano-chemistry.
5. Describe the principles of UV,IR techniques and properties of Refractories and Lubricants.

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

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

Unit 1: Calculus: (6 lectures)

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 2: Calculus: (6 lectures)

Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima.

Unit 3: Sequences and series: (10 lectures)

Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

Unit 4: Multivariable Calculus (Differentiation): (8 lectures)

Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.

Unit 5: Matrices (10 lectures)

Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.

Suggested Text/Reference Books

i. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
ii. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
iii. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
iv. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
v. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
vi. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
vii. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Course Outcomes

At the end of this course, students will able to

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

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

ETES103	BASIC ELECTRICAL ENGINEERING	L	T	P	C
		3	1	0	4

Unit 1: DC Circuits (8 Hours)

Electrical circuit elements (R,L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Nortton theorems. Time domain analysis of first order RL and RC circuits.

Unit 2: AC Circuits (8 Hours)

Representation of sinusoidal waveforms, peak and rms values, phasorrepresentation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L,C,RL, RLC combinations (Series and Parallel), resonance, Three phase balanced circuits, voltage and current relations in star delta connections.

Unit 3: Transformers (6 Hours)

Magnetic Materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

Unit 4: Electrical Machines (8 Hours)

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, significance of torque-slip characteristics. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristics and speed control of separately excited dc motor. Construction and working of synchronous generators.

Unit 5: Power Converters and Electrical Installations (12 Hours)

DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation.Components of LT switchgear: Switch Fuse Unit(SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics of Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Suggested Text/ Reference Books

i. D.P.Kothari and I.J.Nagrath “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
ii. D.C.Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009.
iii. L.S.Borow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.
iv. E.Hughes, “Electrical and Electronics Technology”, Pearson, 2010.
v. V.D.Toro,”Electrical Engineering Fundamentals”, Prentice Hall India, 1989.

Course Outcomes

1. Describe and analyze the behavior of various DC circuits.
2. Recall the different terminologies associated with AC circuits to analyze their response.
3. Illustrate the construction and working principle of single and three-phase Transformers.
4. Classify the different types of Electrical Machines and explain their construction and working principle.
5. Familiarize with various protective devices and safety measures in electrical installations.

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

ETBP104	CHEMISTRY LABORATORY	L	T	P	C
		0	0	3	1.5

List of Experiments:

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

Course outcomes:

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

1. Determine the physical properties like surface tension and viscosity.
2. Determine rate of reactions and soapnification of oil.
3. Calculate the quantity of adsorbate adsorbed by charcoal.
4. Determine the impurity from Pharmacheutical products and hardness of water.
5. Determine exact concentration of acid and bases present in the industrial wastes.

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

ETSP105	ELECTRICAL ENGINEERING LABORATORY	L	T	P	C
		0	0	2	1

List of experiments/ demonstrations:

- Basic safety precautions, Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
- Measuring the steady – state and transient time-response of R-L,R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope). Sinusoidal steady state response of R-L and R-C circuits – impedance calculation and verification. Observation of phase difference between current and voltage. Resonance in R-L-C circuits.
- Transformers: Observation of the no-load current waveform on an oscilloscope (non- sinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonies. Loading of a transformer: measurement of primary and secondary voltages and currents and power.
- Three-phase transformers: Star and Delta connections, Voltage and Current relationships (line-line voltage, phase –to – neutral voltage, line and phase currents). Phase-shifts between the primary and secondary sides. Cumulative three-phase power in balanced three-phase circuits.
- Demonstration of cut-out sections of machines: de machine (commutator -brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging – slip ring arrangement) and single–phase induction machine.
- Torque Speed Characteristic of separately excited de motor.
- Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections. Torque-Slip Characteristic of an induction motor. Generator operation of an induction machine driven at super synchronous speed.
- Synchronous Machine operating as a generator: stand-alone operation with a load.
- Control of voltage through field excitation.
- Demonstration of (a) dc-dc convertors (b) dc-ac convertors – PWM waveform (c) the use of dc-ac convertor for speed control of an induction motor and (d) Components of LT switchgear

Laboratory Outcomes

1. Identify common electrical components and their ratings.
2. Familiarize with the usage of common electrical measuring instruments.
3. Examine the responses of AC circuits
4. Analyze the basic characteristics of transformers and electrical machines
5. Demonstrate the working of power electronic converters.

Mapping of Course Outcomes with Programme Outcomes

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

ETSP106	ENGINEERING GRAPHICS AND DESIGN	L	T	P	C
		1	0	4	3

Traditional Engineering Graphics:
Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.
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)
Unit 1: Introduction to Engineering Drawing covering,
Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales;
Unit 2: Orthographic Projections covering,
Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes;
Unit 3: Projections of Regular Solids covering,
those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.
Unit 4:Sections and Sectional Views of Right Angular Solids covering,
Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)
Unit 5:
Isometric Projections **covering,**
Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;
Overview of Computer Graphics covering,
listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: 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 Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids];
Customization & CAD Drawing
consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;
Annotations, layering & other functions covering
applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing

lines (extend/lengthen); Printing documents to paper 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, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;

Demonstration of a simple team design project *that illustrates*

Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).

Suggested Text/Reference Books:

Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House

Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education

Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication

Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers

(Corresponding set of) CAD Software Theory and User Manuals

Course Outcomes

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

1. Utilize drawing instruments effectively and present engineering drawings and sketches
2. Construct basic and intermediate geometries.
3. Understand the concept of orthographic, isometric projections of points, lines and regular solids, component drawing, building drawing.
4. Acquire visualization skills to develop new products.
5. Develop their technical communication skills and promote life-long learning.

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

II SEMESTER

ETHS201	ENGLISH	L	T	P	C
		2	0	0	2

Unit 1: **Vocabulary Building**

1.1 The concept of Word Formation
1.2 Root words from foreign languages and their use in English
1.3 Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.
1.4 Synonyms, antonyms, and standard abbreviations.

Unit 2:**. Basic Writing Skills**

2.1 Sentence Structures
2.2 Use of phrases and clauses in sentences
2.3 Importance of proper punctuation
2.4 Creating coherence
2.5 Organizing principles of paragraphs in documents
2.6 Techniques for writing precisely

Unit 3: **Identifying Common Errors in Writing**

3.1 Subject-verb agreement
3.2 Noun-pronoun agreement
3.3 Misplaced modifiers
3.4 Articles
3.5 Prepositions
3.6 Redundancies
3.7 Clichés

Unit 4: **Nature and Style of sensible Writing**

4.1 Describing
4.2 Defining
4.3 Classifying
4.4 Providing examples or evidence
4.5 Writing introduction and conclusion

Unit 5: **Writing Practices & Oral Communication**

5.1 Comprehension
5.2 Precis Writing
5.3 Essay Writing

Suggested Readings:

(i) Practical English Usage. Michael Swan. OUP. 1995.

(ii) Remedial English Grammar. F.T. Wood. Macmillan.2007

(iii)On Writing Well. William Zinsser. Harper Resource Book. 2001

(iv) Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press.2006.

(v) Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.

(vi) Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

Course Outcomes

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

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

ETBS 202	PHYSICS	L	T	P	C
		3	1	0	4

Oscillations, waves and optics

Pre-requisites (i) Mathematics course on Differential equations
(ii) Introduction to Electromagnetic theory

Unit 1: Simple harmonic motion, damped and forced simple harmonic oscillator (7 lectures)

Mechanical and electrical simple harmonic oscillators, complex number notation and phasor representation of simple harmonic motion, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators, electrical and mechanical impedance, steady state motion of forced damped harmonic oscillator, power absorbed by oscillator.

Unit 2: Non-dispersive transverse and longitudinal waves in one dimension and introduction to dispersion (7 lectures)

Transverse wave on a string, the wave equation on a string, Harmonic waves, reflection and transmission of waves at a boundary, impedance matching, standing waves and their eigen frequencies, longitudinal waves and the wave equation for them, acoustics waves and speed of sound, standing sound waves.

Waves with dispersion, water waves, superposition of waves and Fourier method, wave groups and group velocity.

Unit 3: The propagation of light and geometric optics (10 lectures)

Fermat's principle of stationary time and its applications e.g. in explaining mirage effect, laws of reflection and refraction, Light as an electromagnetic wave and Fresnel equations, reflectance and transmittance, Brewster's angle, total internal reflection, and evanescent wave. Mirrors and lenses and optical instruments based on them, transfer formula and the matrix method

Unit 4: Wave optics (6 lectures)

Huygens' principle, superposition of waves and interference of light by wavefront splitting and amplitude splitting; Young's double slit experiment, Newton's rings, Michelson interferometer, Mach-Zehnder interferometer.

Farunhofer diffraction from a single slit and a circular aperture, the Rayleigh criterion for limit of resolution and its application to vision; Diffraction gratings and their resolving power

Unit 5: Lasers (8)

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

Suggested Reference Books

I. Ian G. Main, Oscillations and waves in physics
II. H.J. Pain, The physics of vibrations and waves E. Hecht, Optics
III. A.Ghatak, Optics
IV. O. Svelto, Principles of Lasers

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

1. Analyze the various types of damping force.
2. Develop the wave equation for longitudinal and transverse wave motion.
3. Compare the different properties of light
4. Realize the importance of list phenomena in interference and diffraction.
5. State the principle and working of various laser system.

Mapping of Course Outcomes with Program Outcomes

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

ETES203	PROGRAMMING FOR PROBLEM SOLVING	L	T	P	C
		3	0	0	3

Unit 1: Introduction to Programming, Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.), Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudo code with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code. **(8 lectures)**

Unit 2: Arithmetic expressions and precedence, Conditional Branching and Loops, Writing and evaluation of conditionals and consequent branching, Iteration and loops. **(14 lectures)**

Unit 3: Arrays: Arrays (1-D, 2-D), Character arrays and Strings, Basic Algorithms: Searching, Basic Sorting

Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required). **(12 lectures)**

Unit 4: Function: Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference, Recursion: Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort. (10 lectures)

Unit 5: Structure: Structures, Defining structures and Array of Structures, Pointers: Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation). File handling (only if time is available, otherwise should be done as part of the lab). **(6 lectures)**

Suggested Text Books

(i) Byron Gottfried, Schaum's Outline of Programming with C,McGraw-Hill
(ii) E. Balagurusamy, Programming in ANSI C, TataMcGraw-Hill

Suggested Reference Books

(i) Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

Course Outcomes :

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

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

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

ETBS204	**MATHEMATICS - II**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Unit 1: Multivariable Calculus (Integration): (10 lectures)

Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and

variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

Unit 2: First order ordinary differential equations: (6 lectures)

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Unit 3: Ordinary differential equations of higher orders: (8 lectures)

Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

Unit 4: Complex Variable – Differentiation: (8 lectures)

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 5: Complex Variable – Integration: (8 lectures)

Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

Suggested Text/Reference Books

(i) G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.

(ii) Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

(iii) W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.

(iv) S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.

(v) E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.

(vi) E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.

(vii) J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004.

(viii) N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

(ix) B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Course Outcomes

At the end of this course, students will able to

1. Solve double and triple integrals in finding area and volumes.
2. Solve first order ordinary differential equations
3. Solve Second order linear differential equations with constant coefficients.
4. Construct analytic function and analyze conformal mappings.

5. Evaluate the complex integrals and contour integration.

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

ETHP205	COMMUNICATION SKILLS AND LANGUAGE LABORATORY	L	T	P	C
		0	0	2	1

List of Topics

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

Suggested Software package: Globarena Package for communicative English

The Globarena Package consists of the following exercises

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

Suggested Readings:

(i) English Pronouncing Dictionary Daniel Jones Current Edition with CD.

(ii) Spoken English- R. K. Bansal and J. B. Harrison, Orient Longman 2006 Edn.

(iii) A Practical course in English Pronunciation, (with two Audio cassettes) by J. Sethi, Kamlesh Sadanand & D.V. Jindal, Prentice-Hall of India Pvt. Ltd., New Delhi.

(iv) A text book of English Phonetics for Indian Students by T.Balasubramanian (Macmillan)

(v) English Skills for Technical Students, WBSCTE with British Council, OL.

Course Outcomes:

1. Student will heighten their awareness of correct usage of English Grammar in writing and speaking.

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

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

ETBP206	PHYSICS LABORATORY	L	T	P	C
		0	0	3	1.5

List of Experiments:

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

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

1. Acquired the knowledge of torsional properties of metals wire.
2. Generalized the dispersion of light through the prism.
3. Calculate the wavelength of monochromatic and polychromatic source of light.

4. Analyze diffraction patterns can be formed by light passing through a series of fine lines.
5. Estimate the size and shape of given unknown fine powder using laser gratings.

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

ETSP207	**COMPUTER PROGRAMMING LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

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

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment

Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value:
Lab 7: Simple functions

Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical integration):
Lab 8 and 9: Programming for solving Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions

Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures

Tutorial 12: File handling:
Lab 12: File operations

Laboratory Outcomes

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

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

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

ETES208	WORKSHOP / MANUFACTURING PRACTICES	L	T	P	C
		1	0	4	3

(i) Lectures & Videos: (10 hours)

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods (3 lectures)
2. CNC machining, Additive manufacturing (1 lecture)
3. Fitting operations & power tools (1 lecture)
4. Electrical & Electronics (1 lecture)
5. Carpentry (1 lecture)
6. Plastic moulding, glass cutting (1 lecture)
7. Metal casting (1 lecture)
8. Welding (arc welding & gas welding), brazing (1 lecture)

(ii) Workshop Practice: (60 hours)

1. Machine shop (10 hours)
2. Fitting shop (8 hours)

3. Carpentry (6 hours)
4. Electrical & Electronics(8 hours)
5. Welding shop (8 hours (Arc welding 4 hrs + gas welding 4 hrs)
6. Casting (8 hours)
7. Smithy (6 hours)
8. Plastic moulding & Glass Cutting (6 hours)
9. Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Suggested Text/Reference Books:

(i) Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.

(ii) Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.

(iii) Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I" Pearson Education, 2008.

(iv) Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.

(v) Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGrawHill House, 2017.

Course Outcomes:

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

1. Summarize the various conventional and latest manufacturing processes
2. Gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.
3. Acquire the ability to fabricate models of their own.
4. Develop skill to make simple fitting joints.
5. Get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.

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

THIRD SEMESTER

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

COURSE OBJECTIVES:

The students will be trained on the

- Basics of chosen topics of mathematics, namely, partial differential equations, Fourier series, Boundary value problems, Fourier transform and Z-transform
- Topics introduced in this course will serve as basic tools for specialized studies in engineering.

UNIT-I: Partial differential equations

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

UNIT-II: Fourier series

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

UNIT-III: Boundary value problems

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

UNIT-IV: Fourier transform

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

UNIT-V: Z – Transform and difference equations

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

TEXT BOOKS:

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

REFERENCES:

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

COURSE OUTCOMES:

1. Relate and acquire basic understanding of the most common partial differential equations.
2. Illustrate the solution based Fourier series and limitations.
3. Distinguished learning of methods of solving problems using Fourier transforms.

4. Describes the boundary value problems and able to solve.
5. Observe the solution based Z-transform

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

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

COURSE OBJECTIVES:

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

UNIT I

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

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

UNIT II

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

UNIT III

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

UNIT IV

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

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

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

UNIT V

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

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 ecosystems-pond, river, hill slopes, etc.

TEXT BOOKS:

1. Agarwal, K.C. Environmental Biology, 2001, Nidi Publ, Ltd. Bikaner.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)

REFERENCES:

1. Brunner R.C., Hazardous Waste Incineration, 1989, McGraw Hill Inc. 480p
2. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
3. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. Environmental Encyclopedia, 2001, Jaico Publ. House, Mumabai, 1196p
4. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
5. Down to Earth, Centre for Science and Environment (R)
6. Gleick, H.P. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. 1993, Stockholm Env. Institute Oxford Univ. Press. 473p
7. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)

8. Heywood, V.H & Waston, R.T. Global Biodiversity Assessment, 1995, Cambridge Univ. Press 1140p.
9. Jadhav, H & Bhosale, V.M. Environmental Protection and Laws, 1995, Himalaya Pub. House, Delhi 284 p.
10. Mckinney, M.L. & School, R.M. Environmental Science systems & Solutions, 1996, Web enhanced edition. 639p.
11. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB)
12. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
13. Odum, E.P.. Fundamentals of Ecology, 1971, W.B. Saunders Co. USA, 574p
14. Rao M N. & Datta, A.K. Waste Water treatment, 1987, Oxford & IBH Publ. Co. Pvt. Ltd. 345p.
15. Sharma B.K., Environmental Chemistry, 2001, Geol Publ. House, Meerut
16. Survey of the Environment, The Hindu (M)
17. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB)
18. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vol I and II, Enviro Media (R)
19. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)
20. Wanger K.D. Environmental Management, 1998, W.B. Saunders Co. Philadelphia, USA 499p

COURSE OUTCOMES:

At the end students can able to

1. Recognize and interpret the importance of the natural resources for the sustainable development.
2. Analyze the importance of ecosystem and to demonstrate its knowledge for the sustainable development.
3. Assess the value of biodiversity and develop methods to conserve biodiversity.
4. Devise suitable measures to control pollutions and to practice ethical principles.
5 Appraise the population explosion, as well as to analyze and select suitable Information Technology Tools.

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

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

COURSE OBJECTIVES:

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

- To understand and predict the forces and its related motions.

UNIT I: Statics of particles

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

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

UNIT II: Equilibrium of rigid bodies

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

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

UNIT III: Geometrical properties of surfaces and solids

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

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

UNIT IV: Dynamics of particles

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

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

UNIT V: Friction and elements of rigid body dynamics

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

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

TEXT BOOKS:

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

REFERENCES:

1. Natesan,S.C, Engineering Mechanics (Statics and Dynamics), 2002, first edition, Umesh Publications, New Delhi.

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

COURSE OUTCOMES:

Students can able to

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

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

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

COURSE OBJECTIVES:

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

UNIT - I

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

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

UNIT - II

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

UNIT - III

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

UNIT – IV

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

UNIT-V

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

TEXT BOOKS:

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

REFERENCES:

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

COURSE OUTCOMES:

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

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

CHPC305	TRANSPORT PHENOMENA	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT - I

Introduction to Transport Phenomena, Formulation of transport problems from nature. Vector and Tensor Analysis: Basic concepts

UNIT-II

Basics of momentum transport: Euler/Lagrangian viewpoint, laminar and turbulent flows, boundary layers, stress tensor. Shell momentum balances, equations of change, dimensional analysis, applications to isothermal flow of Newtonian & non-Newtonian fluids.

UNIT-III

Basics of energy transport, conductive, convective and viscous dissipation energy fluxes. Equations of change for non-isothermal systems, dimensional analysis, and applications to steady-state conduction and convection.

UNIT-IV

Basics of mass transport, mechanisms, and mass and molar fluxes
Derivation of equation of continuity for a binary mixture and its application to convection diffusion problems.

UNIT-V

Unsteady-state momentum, heat and mass transport, formulation of basic equations and similarity transform method.

TEXT BOOKS:

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

REFERENCES :

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

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Demonstrate the basic skills of vector and tensor analysis for cracking the transport problems.

2. Solve transport problems using shell momentum balances.
3. Predict and solve one-dimensional transport problems by using the energy conservation equations.
4. Estimate simple multi-dimensional mass transport problems
5. Evaluate unsteady state basic transport problems in momentum, heat and mass and to meet out the sustainable solution.

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

CHPC306	**CHEMICAL PROCESS CALCULATIONS**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

COURSE OBJECTIVES:

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

Unit-I

Introductory concepts of units, physical quantities in chemical engineering, dimensionless groups, "basis" of calculations. Concept of stoichiometry and mole balances, examples, Gases, Vapours and Liquids: Equations of state, Vapour pressure, Clausius-Clapeyron equation, Cox chart, Duhring's plot, Raoult's law.

UNIT-II

Material Balance: Introduction, solving material balance problems without chemical reaction Solubility, Crystallization, Dissolution and Distillation.

Unit-III

Material Balance: With chemical reaction, Material Balances with recycle, bypass and purge, combustion.

Unit-IV

Energy balance: open and closed system, heat capacity, calculation of enthalpy changes

UNIT-V

Energy balances with chemical reaction: Heat of reaction, Heat of combustion.
Humidity and Saturation, humid heat, humid volume, dew point, humidity chart and its use.

TEXT BOOKS:

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

REFERENCES:

1. Felder, R. M.; Rousseau, R. W., "Elementary Principles of Chemical Processes", Third Edition, 2000, John Wiley & Sons.
2. 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

1. Discuss the fundamentals of Stoichiometry and process calculations
2. Draw the material balance for unit operations of chemical engineering.
3. Draw the material balance with chemical reaction and combustion process.
4. Illustrate energy balance and solve problems involving, concepts of thermophysics.
5. Demonstrate energy balance for chemical engineering operations

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

CHSP307	**ORGANIC AND PHYSICAL CHEMISTRY LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

COURSE OBJECTIVES:

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

ORGANIC CHEMISTRY

Preparation Compounds involving in the following reaction are to be prepared: (a) Oxidation, (b) Reduction, (c) Bromination, (d) Nitration, (e) Sulfonation, (f) Acetylation, (g) Methylation, (h) Hydrolysis and (i) Diazotisation

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

PHYSICAL CHEMISTRY

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

REFERENCES:

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

COURSE OUTCOMES:

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

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

CHCP308	**TECHNICAL ANALYSIS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES:

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

LIST OF EXPERIMENTS

Proximate and Ultimate analysis of Coal
Analysis of Water
Analysis of Common Salt
Analysis of Bleaching Powder
Analysis of Copper
Analysis of Mixed Acid
Analysis of Tannin
Analysis of Soap
Analysis of Cement
Analysis of Sugar
Viscosity Estimation
Turbidity Meter

COURSE OUTCOMES:

1. Estimate and analysis of chemical compounds.
2. Will be able to demonstrate and improve the ability to write clear lab reports.
3. Demonstrate the ability to produce a working model through hands on experience in technical design and explain its operation in terms of what was learned in the course
4. Think critically and creatively, especially about the use of technology to address local and global problems and
5. Become a socially responsible engineer by involving with community and professional organizations

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

FOURTH SEMESTER

CHBS401	NUMERICAL METHODS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce students to numerical methods used to solve engineering problems, in particular chemical engineering problems, using numerical methods and computer programming.
- Fundamentals of numerical methods/algorithms to solve systems of different mathematical equations (e.g. linear/ non-linear algebraic equations, ordinary /partial differential equations), will be introduced.
- The course would enable students to write their own computer programs using programming languages like C and commercial software like MATLAB.
- Hands-on experience will be provided to apply these computer programs to solve problems in different areas of chemical engineering e.g. fluid flow, heat and mass transfer, chemical reaction engineering etc.
- Practicals to involved solving actual chemical engineering problems through computer programming and coding.

UNIT-I

Introduction, Approximation and Concept of Error & Error Analysis, Linear Algebraic Equations: Methods like Gauss elimination, LU decomposition and matrix inversion, 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, Newton-Raphson and Secant methods, Chemical engineering problems involving solution of non-linear equations

UNIT-III

Interpolation and Approximation, Newton's polynomials and Lagrange polynomials, spline interpolation, linear regression, polynomial regression, least square regression. Numerical integration: Trapezoidal rule, Simpson's rule, integration with unequal segments, quadrature methods, Chemical engineering problems involving numerical differentiation and integration

UNIT-IV

Ordinary Differential Equations: Euler method, Runge-Kutta method, Adaptive Runge-Kutta method, Initial and boundary value problems, Chemical engineering problems involving single, and a system of ODEs.

UNIT-V

Introduction to Partial Differential Equations: Characterization of PDEs, Laplace equation, Heat conduction/diffusion equations, explicit, implicit, Crank-Nicholson method.

Practical

Practical description

1. Introduction to use of computers for numerical calculations
2. Solution of linear algebraic equations using Gauss elimination, Gauss-Siedel etc.
3. Solution of a non-linear equations using bracketing and Newton-Raphson method
4. Interpolation and Approximation
5. Numerical integration
6. Euler method

7. Runge-Kutta methods for ODEs
8. Solution of system of ODEs using simple methods
9. Solution of simple PDEs

TEXT BOOK:

1. Gupta, S. K., "Numerical Methods for Engineers, 2012, New Academic Science.

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

1. Perform an error analysis and solve a linear system of equations and to apply the methods for chemical engineering problems
2. Solve non-linear algebraic or transcendental equation by numerical methods and to implement these methods for solving chemical engineering problems
3. Demonstrate a function using an appropriate numerical method and to solve chemical engineering problems and calculate a definite integral and evaluate a derivative at a value using an appropriate numerical method and able to write codes for these methods in MATLAB
4. Solve an Ordinary differential equation using an appropriate numerical method and to write codes in MATLAB for these methods and to solve chemical engineering problems
5. Solve partial differential equations using an appropriate numerical method and to write program in MATLAB for solving chemical engineering problems

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

CHES402	**MATERIAL SCIENCE**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

COURSE OBJECTIVES

- The students a basic introduction to the different classes of materials relevant to engineering in general, and Chemical Engineering in particular.

- The intent of the course will be to relate the underlying molecular structure of the materials to their physical and chemical properties, and their processing and performance characteristics.

UNIT – I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

TEXT BOOKS:

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

REFERENCES:

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

COURSE OUTCOMES:

At the end of this course, students will have

1. Apply knowledge of mathematics, science, and engineering on materials.
2. A fair understanding of hard and soft materials, including polymers and composites,
3. A Understanding on their characterization, properties, and use in engineering applications

4. Able to select materials for design and construction.
5. Understanding on corrosion and biomaterials

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

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

COURSE OBJECTIVES:

- The objective of this course is to introduce the mechanics of fluids (fluid statics and fluid dynamics), relevant to Chemical Engineering operations.
- The course will introduce students to forces on fluids, hydrostatic forces on submerged bodies, Eulerian and Lagrangian descriptions of flow, flow visualization, integral analysis involving mass and momentum balances, Bernoulli equation, flow through pipes and ducts, flow measurement and instruments, flow transportation - pumps, blowers and compressors, conservation of mass, linear and angular momentum in differential form, Navier-Stokes equation, viscous flows, skin and form friction, lubrication approximation, potential flows and boundary layer theory.
- Turbulence and turbulent flows will be introduced.

UNIT-I

Introduction to fluids, Continuum hypothesis, Forces on fluids, Normal and shear stresses. Fluid statics - pressure distribution, Manometry, Forces on submerged bodies (planar and curved), Buoyancy, Rigid body motion (translation and rotation). Kinematics of fluid flow- Eulerian and Lagrangian descriptions, Flow visualization, Stream function, Vorticity and Circulation, Kinematic decomposition of flow motion.

UNIT-II

System and control volume approaches, Reynolds transport theorem, Integral balances - mass and momentum, Euler's equation of motion, Bernoulli equation and applications, Turbulent flow, Head loss in pipe flow, Moody diagram. Flow measurement, Transportation of fluids - pumps, selection and design of pumps.

UNIT-III

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

UNIT-IV

Boundary layer theory, Blasius solution, Boundary layer separation, Drag and lift force on immersed body. Similitude analysis, Lubrication approximation.

UNIT-V

Compressible flows, Blowers and compressors, Introduction to turbulence: Structure of turbulence, visualization of turbulence, Reynolds decomposition, Spectral nature of turbulence and Kolmogorov hypothesis.

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
3. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 4th Ed.,2007, Wiley
4. B. R. Munson, D. F. Young, T. H. Okiishi and W. W. Huebsch, 6th Edition, 2010, Wiley-India.
5. R. L. Panton, Incompressible Flow, 3rd Edition, 2005, Wiley-India.
6. R. B. Bird, W. E. Stewart and E. N. Lightfoot, Transport Phenomena, 2nd Edition, 2002, Wiley-India.
7. Fluid Mechanics, Sadhu Singh, Khanna Book Publishing
8. Introduction to Fluid Mechanics and Fluid Machines, Som & Biswas, TMH

COURSE OUTCOMES:

After the completion of this course, the students should be able to

1. Use pertinent terminologies in fluid statics and kinematics of fluid flow to communicate the concepts and technical aspects and exhibit skill sets fundamental to fluids flow behavior.

2. Analyze the fluid flow problems and provide solutions by applying momentum and energy equations incorporating relevant principles with comprehension of the basics of transportation of fluids to educate and work efficiently in a challenging environment.

3. Analyze simple potential flow fields and specific types of flows governed by equations like Navier - Stokes Equation and to be able to make decisions to enhance the performance of operations confined to fluid dynamics.

4. Design and develop systems by efficiently incorporating fluid dynamics concepts like Boundary layer concept, drag and lift forces on immersed body to draw analogies and frame prediction equations.

5. Exhibit knowledge on compressible flow and comprehend principles on working of blowers and compressors and appreciate the turbulence in fluid flow to troubleshoot, value add and technically enhance performance of the systems which will be sensitive to society and environment

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

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

COURSE OBJECTIVES:

- Principles and application of first and second law of thermodynamics, and phase equilibria.

UNIT-I

Introduction- scope of thermodynamics, Dimensions and Units, Temperature, Pressure, Work, Energy, Heat. Energy conservation & first law of thermodynamics; State functions; Equilibrium; Phase Rule; Reversible process; Constant P,V, T processes; Mass and energy balances for open systems.

UNIT-II

Phases, phase transitions, PVT behavior; description of materials - Ideal gas law, van der Waals, virial and cubic equations of state; Reduced conditions & corresponding states theories; correlations in description of material properties and behavior. Heat effects-latent heat, sensible heat, standard heats of formation, reaction and combustion.

UNIT-III

Statements of the second law; 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. Thermodynamic analysis of steam power plants; Rankine cycle.

UNIT-IV

Internal combustion engine, Otto engine; Diesel engine; Jet engine. Thermodynamic property of fluids, Maxwell relations, 2-phase systems, graphs and tables of thermodynamic properties.

UNIT-V

Application of thermodynamics to flow processes-pumps, compressors and turbines
The Carnot refrigerator; Vapor-c ompression cycle; Absorption refrigeration; Heat pump, Liquefaction processes.

TEXT BOOKS

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

REFERENCES

1. M J Moran, H N Shapiro, D D Boettner and M B Bailey, Principles of Engineering Thermodynamics, 8th Edition, Willey .

2. Chemical Engineering Thermodynamics, YVC Rao, University Press

COURSE OUTCOMES

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

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

CHPC405	**HEAT TRANSFER**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

COURSE OBJECTIVES:

- Basic Concepts of Heat Transfer
- Design and Rating of Heat exchangers with and Without Phase Change
- Design and Rating of Compact Heat Exchangers

UNIT - I

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

UNIT-II

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

UNIT - III

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

UNIT-IV

Design aspects of finned tube and other compact heat exchangers (6L + 2T).Basics of Heat transfer with phase change - Introduction to boiling, Introduction to condensation.

UNIT-V

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

TEXT BOOKS:

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

REFERENCES:

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

COURSE OUTCOMES

Students will be able to

CO 1: Construct a general differential equation for energy transfer, decide the relevant terms for application in one dimensional and multidimensional conduction problems and calculate heat duty/ outlet temperatures

CO 2: Discuss the concepts evolved in convection mode of heat transfer, analyze convection heat transfer process by dimensional analysis and analogy between momentum transfer and also explain the basics of radiation mode heat transfer

CO 3: Express film coefficients estimation in pipes, tubes and annuli and design of double pipe heat exchanger, shell and tube heat exchanger with sustainable development

CO 4: Design of finned tube and compact heat exchangers sustainable development, describe about heat transfer with phase change in boiling and condensation

CO 5: Design of heat transfer equipments which are pertaining with phase change sustainable development, infer the heat transfer concepts in agitated tanks and extend the same in unsteady state processes with ethical principals

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

CHPC406	MASS TRANSFER-I	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

- Basic Concepts of Mass Transfer, Staged and Continuous Contact equipment design, gas absorption and distillation

UNIT-I

Constitutive laws of diffusion; unsteady state diffusion, Convective mass transfer, interphase mass transfer and mass transfer coefficients, mass transfer correlations.

UNIT-II

Mass transfer theories/models, Effect of chemical reaction on mass transfer.

UNIT-III

Equilibrium stages and transfer units: number and height of transfer units; stage efficiency. Gas absorption plate and packed column design; reactive absorption.

UNIT-IV

Batch distillation; continuous binary fractionation.

UNIT-V

Azeotropic distillation; use of steam. Introduction to multicomponent distillation.

TEXT BOOKS

1. Binay K.Dutta, Principles of Mass Transfer and Separation Processes,2nd edition, Prentice Hall of India,2007
2. R.E.Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983.

REFERENCES:

1. E.D. Cussler, Diffusion - Mass Transfer in Fluid Systems, Cambridge University Press, Cambridge 1984.
2. S. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980.
3. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, Prentice Hall, India, 1993.

COURSE OUTCOMES

Students will be

1. Understand the fundamentals of various types of mass transfer operations
2. Able to design various mass transfer problems used in industries
3. Equip the problem solving capacity to tackle trouble shooting and shut-down of operations
4. Able to design staged and continuous contactors
5. Familiar with special distillation techniques such as steam distillation and azeotropic distillation

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

CHCP407	FLUID MECHANICS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

- To determine experimentally the flow characteristics of fluids and also to determine the efficiency of the flow measuring devices and fluid transport machineries
- To gain practical knowledge on the measurement of Fluid Flow and their characteristics at different operating conditions.

LIST OF EXPERIMENTS

1. Reynolds apparatus
2. Bernoulis theorem
3. Notch Apparatus
4. Orifice Meter test rig
5. Pitot tube
6. Venturi meter test rig
7. Friction in pipe lines
8. Pipe fittings, sudden enlargement and contraction losses
9. Centrifugal Pump
10. Variable Speed Centrifugal Pump

COURSE OUTCOMES:

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

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

CHCP408	HEAT TRANSFER LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVE:

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

LIST OF EXPERIMENTS

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

COURSE OUTCOMES:

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

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

FIFTH SEMESTER

CHPC501	CHEMICAL REACTION ENGINEERING – I	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

- Basic Concepts of Kinetics and Rate Laws
- Design and Rating of Ideal Reactors including heat effects
- Interpretation of Rate data
- Design and Rating of Reactors involving multiple reactions including heat effects
- Analysis of Non-ideal flow Behavior in Reactors

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

RTD theory and analysis of non-ideal reactors

TEXT BOOKS

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

REFERENCES:

1. Chemical Reaction Engineering by Octave Levenspiel, 3rd Edition, 2001, John Wiley & Sons.
2. Principles of Chemical Reaction Engineering, Dawande S.D, Central Techno Publications, Nagpur

COURSE OUTCOMES

Students will be able to

1. Develop the kinetic rate expression by applying reaction mechanism with Concentration and temperature dependency
2. Design of ideal flow reactors for single reactions
3. Analyze and interpret the reaction kinetics of the batch reactor data in variable and constant volume systems
4. Design for Multiple Reactions
5. Adapt the concept of Residence Time Distribution (RTD) in various reactors and design parameters to design Real Reactor.

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

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

COURSE OBJECTIVES

- To introduce the principles and applications of new separation techniques for difficult systems
- To develop a sound working knowledge and able to operate on different types of mass transfer equipment's.

UNIT-I

Perspective on unified approach to operations. Liquid-liquid Extraction

UNIT-II

Adsorption, Fixed bed absorbers, breakthrough.

UNIT-III

Leaching & Washing, Simultaneous Heat & Mass Transfer: Humidification and Dehumidification, Simultaneous Heat and Mass Transfer: Drying

UNIT-IV

Design of Cooling Towers, Membrane processes.

UNIT-V

Ion-Exchange; Ultrafiltration and Osmosis, Reverse Osmosis.

TEXT BOOKS

1. Binay K.Dutta, Principles of Mass Transfer and Separation Processes,2nd edition, 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

1. List situations where liquid–liquid extraction might be preferred to distillation
2. Explain the concept of breakthrough in fixed-bed adsorption
3. Understand the fundamentals of leaching, humidification and drying
4. Design cooling towers
5. Distinguish among micro-filtration, ultra-filtration, nano-filtration, and reverse osmosis

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

CHPC503	PARTICLE AND FLUID-PARTICLE PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

UNIT-I

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

UNIT-II

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

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

UNIT-III

Separation of solids from fluids: Introduction. Sedimentation: Free Settling, hindered settling,

Richardson-Zaki equation, design of settling tanks. Filtration: Concepts, design of bag filters, design of electrostatic filters.

UNIT-IV

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

UNIT-V

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

TEXT BOOKS

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

REFERENCES:

1. Rhodes, M. J., Introduction to Particle Technology, 2nd edition, 2008, John Wiley, Chichester ; New York.
2. Unit Operations-I, Fluid Flow & Mechanical Operation, Gavhane, Nirali Prakashan
3. Unit Operations Vol.-I, K. A. Gavhane, Nirali Prakashan
4. Chemical Process Simulation, Husain, Wiley Eastern India
5. Allen, T., Powder Sampling and Particle Size Determination, 2003, Elsevier.
6. Masuda, H., Higashitani, K., Yoshida, H., Powder Technology Handbook, 2006, CRC, Taylor and Francis.
7. Vollath, D. Nanomaterials: An Introduction to Synthesis, Properties and Applications, 2nd Ed., 2013, Wiley.

COURSE OUTCOMES:

1. Calculate drag force and terminal settling velocity for single particles
2. Calculate pressure drop in fixed and fluidized beds
3. Know the significance and usage of different particulate characterization parameters, and equipment to estimate them
4. Describe Size reduction energy requirements, estimate performance of equipment, selection and sizing of equipment.
5. Analyse filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage

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

CHPC504	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. Introduction to molecular thermodynamics.

UNIT-I

Review of first and second law of thermodynamics. Vapor-liquid equilibrium: phase rule, simple models for VLE;VLE by modified Raoult's law; VLE from K-value correlations; Flash calculations.

UNIT-II

Solution Thermodynamics: fundamental property relationships, free energy and chemical potential, partial properties, definition of fugacity and fugacity coefficient of pure species and species in solution, the ideal solution and excess properties.

UNIT-III

Liquid phase properties from VLE, Models for excess Gibbs energy, heat effects and property change on mixing. UNIFAC and UNIQUAC models.

UNIT-IV

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

UNIT-V

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

TEXT BOOKS

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

REFERENCES:

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

COURSE OUTCOME:

At the end of the course, the student should be able to

1. Familiar with properties of solutions available in nature
2. Familiar with various reactions occurring in nature
3. Solve problems involving equilibria of different phases such as VLE, LLE, VLLE, SLE, SVE.
4. Solve problems involving reaction equilibria
5. Apply on principles of molecular thermodynamics in various field of applications

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

CHCP507	**PARTICLE AND FLUID PARTICLE PROCESSING LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES:

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

LIST OF EXPERIMENTS

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

COURSE OUTCOMES:

1. ɔ develop a sound working knowledge on different types of crushing equipments
2. ɛparation characteristics of different mechanical separators
3. ɔlid solid separations equipments
4. uid solid separation equipments
5. ɛtter understanding of industrial operations by performing the experiments

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

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

COURSE OBJECTIVE:

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

LIST OF EXPERIMENTS

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
10. Surface Evaporation
11. Liquid-Liquid Extraction
12. Diffusivity Measurement

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:

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

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

CHCP509	CHEMICAL ENGINEERING THERMODYNAMICS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

- The enable the students to understand the behavior of fluids under PVT conditions and also apply them for practical purpose

LIST OF EXPERIMENTS

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

TEXT BOOK

1. Y. V. C. Rao, Introduction to Thermodynamics, 2004th Edition, Universities Press.
2. P.K.Nag Engineering Thermodynamics, 2013, 5th Edition, Tata McGraw Hill.

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

Course Outcomes:

1. To conduct experiments and subject the experimental data for analysis and interpretation
2. To apply the principles of Chemical Engineering thermodynamics
3. To develop mathematical expressions of various phase and reaction equilibrium phenomena
4. To calculate phase equilibrium of binary/multi component systems using proper models
5. To identify the existence of azeotrope and make the relevant calculations

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

SIXTH SEMESTER

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

COURSE OBJECTIVES

- Basic Concepts of Catalysis
- Kinetics and Mechanistic aspects of Catalysts
- Design and Rating of Catalytic Reactors
- Design Aspects of Gas-Liquid Reactors

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

TEXT BOOKS:

1. Foggler H. S., Elements of Chemical Reaction Engineering, 2001, Prentice Hall.

REFERENCES:

1. Gilbert F. Froment, Kenneth B. Bischoff, Juray De Wilde, Chemical Reactor Analysis and Design, 2010, John Wiley & Sons.
2. Dawande S.D, Principles of Chemical Reaction Engineering, Central Techno Publications, Nagpur
3. K. A. Gavhane, Chemical Reaction Engineering Vol. - II, , Nirali Prakashan

COURSE OUTCOMES:

Students will be able to

1. Deepen the Engineering knowledge and problem solving skills in Chemical Reaction Engineering
2. Understand the Chemical kinetic concepts
3. Design catalytic reactors
4. Identify regions of mass transfer control and reaction rate control and calculate conversion
5. Develop skills to choose the right reactor among different types.

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

CHPC602	**PROCESS INSTRUMENTATION DYNAMICS & CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

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

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

Controller tuning: Ziegler-Nichols method, Cohen-Coon method. Introduction to advanced controllers: cascade control, feed forward control, ratio control, Smith-predictor, IMC, MPC, dead-time compensation. Introduction to digital control

TEXT BOOKS:

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

REFERENCES:

1. Seborg, D.E., Edgar, T.F., Mellichamp, D.A. Process Dynamics and Control, 2nd 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
4. Instrumentation, Measurement and Analysis, Nakra, TMH

COURSE OUTCOMES

Students will be able to

1. Understand the concepts of various forms of mathematical models to express them, including differential equations, Laplace transfer functions, and frequency response plots.
2. Understand the importance of process dynamics
3. Tune a controller to reject disturbances or manage operating point transitions
4. Design of controllers
5. Application of control systems in processes

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

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

COURSE OBJECTIVES:

- Chemical Engineering lab provides students the first hand experience of verifying various theoretical concepts learnt in theory courses.
- To determine experimentally the kinetics and rate constants of reactions in different types of reactors.

LIST OF EXPERIMENTS

1. Batch Reactor
2. Semibatch Reactor I
3. Semibatch Reactor II
4. Plug Flow Reactor
5. Laminar Flow Reactor
6. Continuous Stirred Tank Reactor
7. Heterogeneous Reactor

8. Adiabatic Reactor
9. Residence Time Distribution Studies in CSTR
10. Determination of Activation Energy.

COURSE OUTCOMES:

1. Describe the basics of chemical reaction system and its practical application and principles
2. Apply these principles for the design of reactors and application in process industries
3. Express working knowledge on different types of reactors and design of chemical reactors with associated with Physical Parameters.
4. Explain variations between Experimental and Theoretical results based on technical knowledge.
5. Develop skills to choose the right kind of reactor among single, multiple, flow reactor, etc. schemes.

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

CHCP608	**PROCESS 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, pressure, flow, pH, humidity, density, and viscosity 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:

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

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

SEVENTH SEMESTER

ETHS701	ENGINEERING ETHICS	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES:

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

UNIT – I

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

UNIT – II

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

UNIT – III

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

UNIT – IV

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

UNIT – V

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

TEXT BOOKS:

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

REFERENCES:

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

COURSE OUTCOMES:

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

1. Describe the theories of ethics and lead the career with an ethical sense.
2. Review the experimentation by engineers and its impact on the society.
3. Evaluate the safety and risk involved in the engineering and to reduce its risk as a responsible engineer.
4. Organize their nature of work and work place to have an amicable relationship with workers.
5. Categorise the need of an engineer to play the role as manger, consultant, advisor and decision maker with a good virtue and honesty.

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

CHPC702	**PROCESS TECHNOLOGY & ECONOMICS**	**L**	**T**	**P**
		3	**0**	**0**

COURSE OBJECTIVES

- To familiarize students with manufacturing aspects of industrially relevant chemicals

Unit - I

Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for manufacture of inorganic chemicals, such as: inorganic acids, chlor-alkali, ammonia, fertilizers, etc.

UNIT - II

Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for Petroleum refining and cracking operations, syngas and hydrogen.

UNIT - III

Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for manufacture of Petrochemicals: C1, C2, C3, C4, etc.,

UNIT - IV

Description, energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for manufacture of benzene, toluene, xylene and other petrochemicals from C1, C2, C3, C4 etc. basic building blocks. Industrially relevant fuels, coal, coal based chemicals and fuels Common utilities such as electricity, cooling water, steam, hot oil, refrigeration and chilled water

UNIT - V

Introduction to project cost and cost of production, Various components of cost of production and their estimation, Various components of project cost and their estimation. Estimation of working capital. Analysis of working results project: Balance sheets, Project financing, concept of interest, time value of money, depreciation. Profitability Analysis of Projects

TEXT BOOKS:

1. George T. Austin, Shreve's Chemical Process Industries, 1984, McGraw-Hill International Editions Series.
2. M. Gopala Rao, Marshall Sittig, Dryden's Outlines of Chemical Technology, 1997, East West Press.
3. Mahajani V. V. and Mokashi S M, Chemical Project Economics, 2005, MacMillan India Ltd.
4. Max Peters, Klaus Timmerhaus, Ronald West, Plant Design and Economics for Chemical Engineers, 2013, McGraw Hill International Edition.

REFERENCES:

1. Moulijn, M. and van Dippen , Chemical Process Technology, 2013, Wiley.
2. O.P. Gupta , Chemical Process Technology, Khanna Publishing House
3. Mahajani, Chemical Project Economics, McMillan

COURSE OUTCOMES

Students will be able to

1. Describe sources and processes of manufacture of various industrially important chemicals
2. Draw block diagrams/ process flow diagrams of the processes used for manufacture of industrially important chemicals
3. Explain the economic aspects of Projects involved in manufacturing of Chemicals
4. Solve the problems in economics
5. Describe the energy sources and consumptions in the manufacture of various chemicals

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

CHCP706	CHEMICAL PLANT EQUIPMENT DESIGN & DRAWING LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

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

LIST OF EXPERIMENTS

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

DESIGN - CASE STUDIES

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

COURSE OUTCOMES:

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

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

CHPV803	PROJECT WORK AND VIVA-VOCE	L	PR	S	C
		0	8	4	10

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

PROFESSIONAL ELECTIVES

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

COURSE OBJECTIVES:

- Simulation of chemical processes
- Applications of simulation in advanced Chemical Engineering processes
- Use of computer in simulation of simple chemical process

UNIT - I

Use of Mathematical models, Principles of formulation, Fundamental Laws, Continuity equations, Energy equations, Equation of motions, Transport equation, Equation of State, Equilibrium and Chemical Kinetics, Simple Examples.

UNIT - II

Basic Modeling, Simple hydraulic Tank, Variable flow, Hydraulic Tank, Enclosed Tank, Adiabatic compression in Gas space, Mixing Vessel, Mixing with reaction, Reversible reaction, Steam jacketed vessel, continuous flow boiling system.

UNIT - III

Gas flow system, Example, Three volume gas flow system, Hydraulic transient between two reservoirs, Pumping system, Reaction kinetics, General modeling scheme, liquid phase CSTR, Radical kinetics, Elementary radical of mechanics, Rate limits steps, Heterogeneous kinetics, Example Auto Clave.

UNIT - IV

Staged operations, Counter current extraction, Distillation Column, Binary distillation.
Distributed systems: Counter current heat exchanger, pipeline Gas flow, pipe line flash process, reaction.

UNIT - V

Analog simulation, Introduction, Basic components, Operational blocks, Simple examples, Three CSTRs in series, Gravity flow tank. Digital Simulation, Numerical Methods, Implicit function - Conveyance Numerical Integration, Euler, Range Kutta Fourth Order methods, simple examples, Three CSTRs in series Non-Isothermal CSTR, Binary distillation column.

TEXT BOOKS:

1. Luyben W.L., Process Modeling, Simulation and control Chemical Engineering 1989, McGraw Hill(ISE).
2. Franks RGE, Modeling and Simulation in Chemical Engineering, 1971, Wiley Inter - Science, New York.

REFERENCES:

1. Himmelblau,D.M., and K.B.Bischoff, Process Analysis and Simulation, 1968, Wiley.

COURSE OUTCOMES:

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

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

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

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

COURSE OBJECTIVES:

- To enable the students to understand the mechanism of polymerization, various techniques of polymerization, characterization of polymers by molecular weight, reactions and degradation of polymers. The structure of polymers and prediction of polymer properties
- To enable the students to understand the methods of preparation, properties and applications of thermoplastic materials covering commodity, engineering and high performance plastics.
- To enable the students to understand mechanical behaviour of polymeric materials under applied load for short term and long term properties. Flow behavior of polymer melts and the experimental techniques for measuring the rheological

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

Polymerization reactor design - Principles of reactor design, batch reactor, CSTR, plug flow reactor, design equations.

UNIT-IV

Rheology Definitions, Simple shear flow, measurement of viscosity with various flow geometries

like capillary viscometer, cone and plate viscometer, cup and bob viscometer. Viscoelasticity Mechanical models, Maxwell model, Voight model, response of models in creep, Stress, Stress relaxation dynamic experiments. Temperature dependency of viscosity. William Landel Ferry equation.

UNIT-V

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

TEXT BOOKS:

1. F.W.Billmeyer, Text Book of Polymer Science, 3rd Edn., 1985, Wiley - Inter Science.
2. Anil Kumar and S.K.Gupta, Fundamentals of polymer Science and Engineering, 2003, Tata McGraw Hill Publications.

REFERENCES:

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

COURSE OUTCOMES:

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

1. Estimate the number- and weight-average molecular masses of polymer samples given the degree of polymerization and mass fraction of chains present
2. Explain the role of reaction engineering in improving the chemical properties of polymers
3. Develop the key design features of a product which relate directly to the material(s) used in its construction
4. Discover the role of rheology properties in improving the strength of polymers
5. Examine how the process operations of various polymeric products developed

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

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

COURSE OBJECTIVES:

- To introduce the essential concepts of bioprocessing to the young chemical engineers.
- To learn basic knowledge of enzymes and its industrial applications.
- To familiarize the operating of large scale fermenters and its control.

UNIT I

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

UNIT II

Fermentation -Fermentation types of mechanisms - Kinetics of fermentation processes - Enzyme inhibition

UNIT III

Sterilization – Liquid/ air/surface - Media sterilization- Industrial fermentations -- scale up criteria.

UNIT - IV

Design and Analysis of Biological Reactors, Fermentors, aeration and agitation, cell separation. Downstream Product Recovery and Purification

UNIT - V

Equipments- operations, measurement and control of a typical fermentation unit equipments for mechanical separation. Unit equipments for mechanical separation and integration 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. Aiba,S., Bio Chemical Engineering, 1973, Academic Press.
2. Bailey,J.E., and D.F.Ollis, Bio Chemical Engineering Fundamentals, 2nd Edn., 1986, McGrawHill,

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 (2en Edition).

COURSE OUTCOMES:

After the completion of this course, the students able to

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

1. Classify microorganisms and explain its characteristics and applications in fermentation.
2. Determine the kinetic mechanisms of microbial growth and enzyme fermentation.
3. Illustrate the types of sterilization and criteria of scale up of fermentors.
4. Analyze the operations and types of bioreactors and methods of downstream processing
5. Explain the unit operations in fermentation process , control of process variables in Fermentor employing microbes and immobilized enzymes.

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

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

COURSE OBJECTIVES:

- Gain basic understanding of the fundamental concepts of electrochemical science and engineering such as electrolyte solution, electrochemical cell, electric conductivity, equilibrium electrochemistry, electrochemical kinetics, and current-potential relationship.
- Gain basic understanding of the fundamental concepts of electrochemical reactor systems

UNIT I

Current-voltage relationships & estimation of mass transfer co-efficient, a general view of electrolytic processes; current-voltage relationships in electrolytic reactors; the limiting current plateau; mass & energy balance, and efficiency in electrochemical reactors. the estimation of mass transport coefficients at commonly occurring electrodes. the estimation of mass transport coefficients under enhanced convection conditions

UNIT II

Plug flow & CSTR systems model, A general view of plug flow model of electrolytic reactors: plug flow model of electrochemical reactors employing parallel plate reactor; Plug flow model under constant mass flux conditions; PFM analysis with electrolyte recycling PFM and real electrochemical reactors. General view of simple CSTER systems; CSTER in cascades; CSTER analysis of batch electrochemical reactors, CSTER analysis of semi-continuous electrochemical reactors; CSTER analysis of electrolyte recycling; Batch reactor combined with electrolyte recycling

UNIT III

Thermal behavior of reactors, General aspects of thermal behavior in electrochemical reactor. Thermal behavior under CSTER conditions. The estimation of heat losses; the thermal behavior under PFR conditions; Thermal behavior of batch electrochemical reactors.

UNIT IV

Convective diffusion equation and migration effects –derivation of convective diffusion equation theory – scope and limitation – migration effects – Electroneutrality conditions – supporting electrolyte effect – fundamental of Nernst layer model – Estimation of true limiting current

UNIT V

General aspects of dispersion models-tracer input signal/output signal - axial dispersion in

electrochemical reactors - axial dispersion and reactor performance - axial dispersion analysis via tank-in-series model - general notions on optimization of electrochemical reactor – elementary process optimization – IBL formula – optimization of electro refining process – Jaskula formula – optimization of a general electrolytic process – The Beck formula.

TEXT BOOKS:

1. T.Z.Fahidy, "Principles of Electrochemical Reactor Analysis", 1985, Elsevier.
2. K.Scott, "Electrochemical Reaction Engineering", 1991, Academic Press.

REFERENCES:

1. J.O.M Bockris & A.K.N. Reddy, "Modern Electrochemistry", Vol.1 & 2, Plenum Press
2. A.J.Bard & L.R. Faulkner, "Electrochemical Methods Fundamentals and Applications", 3nd Edition, 2001, John Wiley & Sons.
3. Octave Levenspiel, "Chemical Reaction Engineering", 3rd Edition, 2007, Wiley Eastern Publications Ltd.
4. 4 H.S.Fogler, "Elements of Chemical Reaction Engineering", III Edition, 2001. Prentice Hall of India Ltd.,

COURSE OUTCOMES:

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

1. Describe the in-depth analysis of electrochemical device operation
2. Analyze the quantitative characterization of kinetic, as well as comparative evaluation of different electrochemical reactor configurations
3. Describe the thermodynamic assessment of efficiencies
4. Explain the convective diffusion equation and migration effects
5. Describe the aspects of dispersion models and optimize the general electrolytic processes

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

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

COURSE OBJECTIVES:

- To gain some fundamental knowledge about nuclear physics, nuclear reactor, nuclear fuels, reactors and safe disposal of nuclear wastes.
- Knowledge about nuclear physics, nuclear reactor, nuclear fuels, reactors and safe disposal of nuclear wastes.

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

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

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

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

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

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

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

COURSE OUTCOMES:
After the completion of the course, the student should be able to
1. Explain the fundamentals of nuclear science.
2. List out nuclear reaction process and nuclear reactors.
3. Discover knowledge in nuclear fuel cycles and its characteristics.
4. Classification of nuclear reactor products.
5. Extend knowledge in safety and disposal of nuclear fuels.

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

CHPESCN	NANOTECHOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- The course is aimed at making the student to understand the basic principles of Nanotechnology which is a new and emerging area in Engineering.

UNIT I

Nanotechnology Basics- Optical or Particle Wave Based Nanotechnology - Crystals and Nanotechnology- Quantum Nanotechnology. Benefits of nanotechnology - Manufacturing technologies -Molecular Electronics. Medicine - Space Development.

UNIT II

Methods of Synthesis of Nanometerials. Equipment and processes needed to fabricate nanodevices and structures such as bio-chips, power devices, and opto-electronic structures. Bottom-up (building from molecular level) and top-down (breakdown of microcrystalline materials) approaches.

.

UNIT III

Applications of nanotechnology in biotechnology: A sample list of areas covered: Biotechnology, Genomics, Genetic Engineering, Cell Biology, Stem Cells, Cloning, Prosthetics, Cybernetics.

UNIT IV

Instrumentation for Nanoscale Characterization- Instrumentation SEM, TEM, XRD, FTIR for characterization of properties. Limits of each technique.

UNIT V

Molecular motors, biological motors, artificial photosynthesis, solar energy transduction. Impact of nanotechnology on the environment.

TEXT BOOKS:

1. G. Whitesides¸ P. Alivisatos, U. California, Fundamental scientific issues for nanotechnology, 2000,
2. Novailhat, Alain, Introduction to Nano technology, 2nd Edition, 2007, Wiley Publications.

REFERENCES:

1. Jean-Marie Lehn. Supramolecular Chemistry, 1st Edition, 1995, Wiley Publications.
2. Hovnyax G., Moore J., Tibbals J., Fundamental of Nanotechnology, 1st Edition, 1997 CRC Press.

COURSE OUTCOMES:

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

1. Describe the basic concepts and principles revolving around nanotechnology.
2. Explain the ability to manipulate matter at molecular scale, customizing it according to our specific needs
3. Apply the fundamentals of nanotechnology in biomedical and biological research.
4. State various synthesis and characterization techniques of Nano-materials and familiarizes about various equipment.
5. Justify the impact of nanotechnology for biology and environment.

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

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

COURSE OBJECTIVES

- To Introduce the labour welfare act, plant location and layout
- To introduce the multi dimensional facts of organizational behaviour.
- Effectiveness of the individual dimensions, the group dimensions and its dynamics

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 layout - guarding of machineries - illumination, heating and ventilation.

UNIT - III

Material management - Organization - Production Planning, purchase, store - inventory control, sales and marketing. Scientific management - Rationalization - time and motion study analysis. Time management.

UNIT IV

Personality predispositions – personality and personality types, Maddi's models of personality. Perpectual process – development of perpectual skills. Motivation and work performance. Reinforcement theory – Relationship between motivation and performance.

UNIT V

Dynamics of communication – The communication process, structure of communication, Transactional Analysis, The five common communication networks in an organization. Group

Dynamics – Synergy through groups, Group behaviour, group effectiveness, stages of 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.
3. Industrial disputes act-1947
4. Chakraborty S K- Managerial Development & Appraisal –Macmillan India
5. Strauss & Sayles – Personnel Management

COURSE OUTCOMES:

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

1. Assess their own entrepreneurial and enterprising potential
2. Develop an understanding of the general role of Small Business Enterprises
3. Know the differences between entrepreneurial and managerial type jobs.
4. Understanding of individual personalities and interpersonal skills needed for effective communications
5. Analyze and apply the Dynamics of communication

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

CHPESCN	**AIR POLLUTION AND 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.

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:

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

1. Understand about Air pollution
2. Measure and analyze the air pollutants concentration in the atmosphere.

3. Explain the dispersion of Air pollutant in atmosphere
4. Describe and explain different methods of removal of fine particles suspended in atmosphere.
5. Explain different methods of pollution control in process industry and automobiles

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

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

COURSE OBJECTIVES:

- To focus on the wastewater transport system and the theory techniques for the wastewater treatment process.

UNIT – I

Overview of waste water Engineering

Terminolgy, Wastewater characteristics, Physical characteristics, Inorganic Constituents, Organic constituents, Biological characteristics.

UNIT – II

Physical unit operations

Screening, Coarse Solids reduction, Flow equalization, Mixing and flocculation, Gravity separation, Grit removal, Sedimentation, Clarification and flotation.

Chemical unit process

Chemical coagulation, Chemical precipitation, Chemical oxidation, Chemical neutralization, Scale control and Stabilization.

UNIT – III

Biological treatment

Overview, classification, Basics and Mechanism of Aerobic and anaerobic process. Activated sludge process, Aerated lagoons, Trickling filter, Rotary biological reactor, Oxidation ponds.

UNIT – IV

Reactors in wastewater treatment

Principle, working, advantages and limitations of- Packed bed reactor, fluidized bed reactor, Inverse fluidized bed reactor, Air lift reactor, Anaerobic digestor, Sequential batch reactor, UASB reactor, Membrane reactor.

UNIT –V

Advanced wastewater treatment

Need and Techniques used for Advanced treatment, Depth Filters, Surface filtration, Membrane filtration process, Adsorption, Gas stripping, Ion exchange, Advanced oxidation process, Distillation.

TEXT BOOKS:

1. Metcalf & Eddy, Wastewater Engineering Treatment & Reuse, Tata McGraw –Hill, IV Edn, 2003.
2. Arun Kr. Jain, Ashok Kumar Jain, and B.C. Punmia, Wastewater Engineering, Laxmi Publications, New Delhi, 1998

REFERENCES:

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

COURSE OUTCOMES:

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

1. Characterize the various industrial effluents.
2. Perform the treatment of wastewater by physical removal and chemical degradation.
3. Articulate various aerobic and anaerobic processes for the waste water treatment and to select suitable treatment process for given situation.
4. Select and Employ different types of reactors in the waste water treatment
5. Device the adaptable treatment technology to meet out pollution control norms.

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

CHPESCN	**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-pollution of air, water and soil, air pollution laws and standards - water pollution laws and standards - water quality standards - MINAS. 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, secondary and tertiary treatments – advanced wastewater treatments; recovery of metals 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.George Tchobanoglous, Franklin L. Burton , H. David Stensel, Wastewater Engineering: Treatment and Reuse, 2002, Metcalf & Eddy, Inc., McGraw-Hill Education, pp 1848.
2. Mahajan.S.P, Pollution control in process industries, 1995, Tata-McGraw Hill, pp 273.

REFERENCES:

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

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

1. State that various environmental laws and realize the importance of biosphere
2. Evaluate the various types of pollution abatement techniques
3. Indicate the quality and characteristics of wastewater

4. Determine various water/air quality parameters
5. Explain the solid wastes collection, handling, waste management and Disposal

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

CHPESCN	**FLUIDIZATION ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To enable the students to learn the design aspects of fluidized beds.

UNIT-I : Basics of fluidization

Packed bed – Velocity – Pressure drop relations – Correlations of Ergun, Kozneykarman – On set of fluidization – Properties of fluidized beds –Development of fluidization from fixed bed.

UNIT-II: Fluidized bed types

Minimum fluidization conditions – Expanded bed – Elutriation – Moving solids and dilute phase – spouted bed.

UNIT-III: Design aspects

Channeling – Bed expansion in liquid – Solid and gas – Solid fluidizations. Design aspects of fluidized bed systems.

UNIT-IV: Heat and mass transfer in fluidized beds

Heat and mass transfer in fluidized bed systems – Industrial applications and case studies of fluidized bed systems.

UNIT-V: Other types of fluidization

Single stage and multistage fluidization – Collection of fines – Use of cyclones.

TEXT BOOKS:

1. Daizo Kunii, Octave Levenspiel," Fluidization Engineering" 2nd Edition, 1991, Butterworth – Heinmann.
2. Leva, M., "Fluidization", 1959, McGraw Hill Book Co

REFERENCES:

1. Rowe and Davidson, "Fluidization", 1971, Academic Press
2. Wen-Ching Yang., "Handbook of Fluidization and Fluid-Particle Systems", 20013, Marcel Dekker Inc.

COURSE OUTCOMES:

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

1. Explain the fundamentals of fluidization phenomena, correlations of Ergan and Kozney-karman equations.
2. Identify the fluidization bed types and describe minimum fluidization condition, bed expansion, elutriation and spouted bed.
3. Compare solid-liquid and solid-gas fluidizations and analyze the design aspects of fluidized bed systems
4. Describe the heat and mass transfer in fluidized beds and the industrial applications of fluidized bed reactors
5. Analyze single and multistage and the use of cyclones for the collection of fines.

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

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

COURSE OBJECTIVES:

- Formulate problems that can be solved and Hands - on experience with a commercial CFD program
- Develop skills to use CFD in industrial settings and get a solid foundation in both fluid mechanics and numerical analysis.
- Able to critically analyze different mathematical models and computational methods for flow simulations

UNIT I

Basic Concepts of Fluid Flow: Philosophy of computational fluid dynamics, conservation principles of mass, energy, and momentum, simplified flow models such as incompressible, inviscid, potential and creeping flows, classification of flows.

UNIT II

Turbulence and its Modelling:Transition from laminar to turbulent flow, Effect of turbulence on time - averaged Navier - Stokes equations, Characteristics of simple turbulent flows, Free turbulent flows, Flat plate boundary layer and pipe flow, Turbulence models, Mixing length model, The k - e model, Reynolds stress equation models, Algebraic stress equation models.

UNIT III

Grid Generation: Structured and unstructured grids, choice of grid, general transformation of equations, some modern developments in grid generation in solving the engineering problems. Finite Difference Method: Discretization of ordinary and partial differential equations, approximation of first, second and mixed derivatives, implementation of boundary conditions, discretization errors, applications to the engineering problems.

UNIT IV

Finite Volume Method: Discretisation methods, approximations of surface integrals and volume integrals, interpolation and differentiation practices, implementation of boundary conditions, applications to the engineering problems. Introduction, one- dimensional steady state diffusion, two - dimensional diffusion problems, three-dimensional diffusion problems. The Finite Volume Method for Unsteady Flows and Implementation of Boundary Conditions: On e-dimensional unsteady heat conduction .

UNIT V

Reactor Engineering and Flow Modelling, Introduction to reactor engineering and flow modelling, Reactive flow processes, Multiphase Flow processes, Reactor Engineering Methodology, Introduction to various CFD softwares.

TEXT BOOKS:

1. Sengupta T. K., "Fundamentals of Computational Fluid Dynamics", 2013, University Press.
2. Anderson Jr J. D., "Computational Fluid Dynamics: The Basics with Applications", 1995, McGraw Hill.

REFERENCES:

1. H. K. Versteeg and W. Malalasekera, An introduction to computational fluid dynamics: the finite volume method, 2007, Longman scientific & technical publishers.
2. Muralidhar K. and Sundararajan T., "Computational Fluid Flow and Heat Transfer", 2003, Narosa Publishing House.
3. Vivek V. Ranade, Computational flow modeling for chemical reactor engineering 2002, Academic Press, San Diego.

COURSE OUTCOMES:

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

1. Identify and determine velocity
2. Develop model of turbulent transport and highly sophisticated techniques for specialized area for predicting the force
3. Analyze various classification of partial differential equation (PDE) depends on the type of governing equation and imposition of initial and/ or boundary conditions. Familiar with the PDE for flow phenomena
4. Develop the PDE for flow phenomena
5. Apply and analyze a flow field for various quantities of interest such as flow rate

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

CHPESCN	**MIXING THEORY AND 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 coefficient and its reaction.
- To provide basic knowledge about the Non Newtonian Liquids.

UNIT - I

Importance of mixing in chemical process industries

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

Mixing equipments and operations

Different agitator types - appearance, characteristic features viscosity ranges, advantages, flow patterns they create and mounting specialties if any of turbines, propellers, paddles, anchors, gates, helical screws, helical ribbons).

Power curves

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 - Efficiency of agitator system experimental. Definition of mixing times.

UNIT - II

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) - Average residence time from RTD - RTD from response measurements - Interpretation of response data by mixing models - Imperfect mixing in Stirred tanks - transient analysis of chemical reactors in series.

UNIT - III

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 - isothermal heating or cooling medium - non isothermal cooling medium -external heat exchanger -

isothermal/non isothermal heating/cooling medium - Design calculation for heat transfer in mixing vessels - Stirred tank scale-up heat transfer consideration - Scale up of batch and other reactors.

UNIT - IV

Mixing and mass transfer - introduction - Liquid liquid extraction - equipments - batch -continuous differential - Triangular representation of concentration - phase equilibrium diagram - Material balance for stage wise contact - counter current continuous and differential contact - problems - 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 - V

Non-Newtonian liquids mixing - introduction, pseudoplastic, dilatant, Bingham plastic liquid, - thixotropic and rheopectic liquids - shear rate - shear stress behaviour - apparent viscosity - Power curve for non-Newtonian liquids - Viscometry - shear in stirred tanks -Shear in stirred tanks related to shear in pipes, apparent viscosity in pipe-line flow and stirred tanks - discussion of experimental work literature - Reynolds number modification - Practical application of Non-Newtonian mixing.

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, New York and London.

REFERENCES:

1. Shinji Nagata, Mixing Principles and Applications, 1975, Holted Press , Tokyo

COURSE OUTCOMES:

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

1. Understand the Basics of Chemical Process Industries.
2. Able to select the equipment for mixing
3. Able to design the equipment for mixing
4. Understand heat and mass transfer aspects in mixing
5. Understand mixing in non Newtonian liquids

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

CHPESCN	PETROCHEMICAL TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To teach the students about the basics of petroleum chemistry.
- To teach the students about the various petrochemical products, production techniques and its properties& Applications.

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. B. K. Bhaskara Rao, "Modern Petroleum Refining Processes", 2nd Edn., 1990, Oxford and IBH Publishing Company, 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. Bhaskara Rao, B. K. "A Text on Petrochemicals", 1st Edn., 1987, Khanna Publishers, New Delhi
4. G.T.Austin, Shreves chemical process industries, 5th edn., 1986, Mcgraw Hill.

COURSE OUTCOMES:

At the end of this course, Students will

1. Understand the basics of petroleum chemistry

2. Gain knowledge on first generation petrochemicals.
3. .Know about the second generation petrochemicals
4. Know the production methods for plastics and polymers
5. Understand the production methods for specialty petroleum products

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

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

COURSE OBJECTIVES:

- To provide students with a strong foundation in separation process and its principles, cracking operations and catalyst used in petroleum refineries.

UNIT-I

Major challenges and future strategies in petroleum refining industry, petroleum and petrochemical integration for value addition, refinery economic introduction to separation processes-Distillation, Extraction, Absorption, Adsorption, and Membrane separation processes.

UNIT-II

Catalyst in Petroleum refining and petrochemicals processes- Introduction Homogeneous and Hetrogeneous catalysts, catalyst morphology and activity catalysts for petroleum refining- Cracking, Reforming, Hydrotreating; catalysts for petrochemicals industry- synthesis gas, hydrogenation, hydrocarbon oxidation and polymerization; recent advances in industrial catalysis.

UNIT-III

Fluid catalystic Cracking-Development in technology, equipment, FCC catalyst and additives, FCC reactor and regeneration, recent developments in FCC.

UNIT-IV

Catalyst reforming process, catalyst preparation, characterisation, development and optimization, catalyst deactivation and regeneration, recent trends global and Indian scenario.

UNIT-V

Hydorcracking Technology, hydrocracker catalyst development- Recent trends lube base stock refining – national fuel policy, fuel options, bio-augmentation of fuel stock, hydrogen production and management in refinery.

TEXT BOOKS:

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.

REFERENCES:

1. B.K. Bhaskara Rao "Modern Petroleum Refining Processes", 2008.
2. Warren L. Mccabe, Julian C. smith, Peter Harriott "Unit Operations of Chemical Engineering", Seventh edition, 2005, McGraw-Hill.
3. G.N. Sarkar, "Advanced petrochemicals" Khanna Publishers.
4. Sukumar Maiti," Introduction to Petrochemicals", Second edition , 2008, Oxford & IBH Publishing Co.Pvt. Ltd., New Delhi.

COURSE OUTCOMES:

At the end of this course, Students will

1. Have the knowledge on catalytic process in refinery operations
2. Understand the importance of refining operations
3. The role of cracking operations in petroleum refineries
4. Understand the importance of reforming process
5. Gain knowledge on hydrocracking technology

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

CHPESCN	**DISTILLATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To provide the basic knowledge on Principles of Distillation Process and Industrial Application.
- To familiarize the students the functioning of different types of Distillation Processes
- To illustrate the concepts of various types of Distillation Processes and Design

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. Complex system fractionation: Pseudo-component design method, fraction with sidestreams.

UNIT IV

Azeotropic distillation and extractive distillation: separation of homogeneous azeoptropes, 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, McGraw Hill
3 McCabe,W.L., Smith,J.C. and P.Harriot, Unit Operations in Chemical Engineering, VIIth Edn., 2005, McGraw Hill.
4 Sherwood,T.K.,Pigford,R.L and Cr.Wilke., Mass Transfer, McGraw Hill

COURSE OUTCOMES:

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

1. State the basic laws of distillation and predict the boiling point of the Components in the mixture.
2. Differentiate distillation processes and determine the number of equilibrium stages by analytical and graphical methods.
3. Evaluate number of stages for ternary and multi component distillation.
4. Select suitable addition agent for azeotropic and extractive distillation and its respective design.
5. Design and develop the distillation process.

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

CHPESCN	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 of various Membrane configuration Units.
- 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:

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

1. Explain principles of permeation and separation
2. Describe liquid membranes
3. Classify separation process
4. Differentiate spiral wound and hollow fiber units
5. Discuss waste water treatment

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

CHPESCN	**FOOD PROCESSING TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To familiarize the students the nutritive value of food, microorganisms associated with foods.
- To provide basic knowledge about the principles of different food preservation techniques and the simultaneous extension of shelf life of food materials.
- To demonstrate about various dairy products and beverages like carbonated and non carbonated beverages.
- To illustrate the concepts of the processing of fruits and vegetables, meat, poultry and fishery products and packaging of food materials.

UNIT I

Introduction to food processing – nutritive values of food; types of microorganisms associated with food, its sources and behavior in food.

UNIT II

Food deterioration and its control – shelf life and dating of food – principles of food preservation – heat preservation and processing sterilization, pasteurization and blanching –cold preservation and processing freezing, refrigeration and cold storage – food irradiation, microwave heating and ohmic heating.

UNIT III

Dairy chemistry – milk as a food and its composition – quantitative analysis of milk – milk processing – pasteurization of milk – milk products – manufacturing process of milk cream, butter, evaporated milk, condensed milk, concentrated milk, ice cream, skim milk, fermented milk, butter milk, whey, dried milk products – beverages– carbonated and non carbonated beverages.

UNIT IV

Canning process of fruits and vegetables, grading, washing, peeling, coring and pitting –blanching – can filling – processing of meat and poultry – Canning of fish – preparation of raw material, salting, blanching process – filling, exhausting, sealing, can washing, thermal processing, cooling, drying and packing.

UNIT V

Principles of food packaging – introduction, types of containers, food packaging materials and forms, package testing, package with special features, safety of food packaging – method of food packaging.

TEXT BOOKS:

1 Norman N. Potter and Joseph H. Hotchkins, Food Science, V Edition, 1998, CBS Publishers & Distributors, New Delhi.
2 W.C. Frazier & D.C. Westhoff, Food Microbiology, 1986, Tata McGraw Hill.

REFERENCES:

1. Arthur W. Farrall, Engineering for Dairy and Food Products, 1967.Wiley Eastern Private Ltd,
2. G.S.Siddappa, Preservation of Fruits and Vegetables, 1986, ICAR, New Delhi.

COURSE OUTCOMES:

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

1. Describe the Principles of food science
2. Explain Food safety and Food preservation techniques
3. Analyze the nutritive value of food and microorganism associated with food.
4. Understand the principles of various food preservation methods
5. Gain knowledge on food packaging and adapt the safety techniques

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

CHPESCN	**INDUSTRIAL BIO-TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To motivate students to excel in research and to practice the technologies in the field of Industrial biotechnology . .
- To provide students with a solid understanding of Biotechnology fundamentals and applications required to solve real life problems.
- To provide students with an academic environment that is aware of professional excellence and leadership through interaction with professional bodies

UNIT-I

Overview of the cell

Cell, structure and properties, prokaryotic and eukaryotic cells, structural organization and function of intracellular organelles; Cell wall, Nucleus, Mitochondria, Golgi bodies, Lysosomes,

Endoplasmic reticulum, Peroxisomes and Chloroplast.

UNIT-II

Microbial growth: pure culture techniques

Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms. The definition of growth, mathematical expression of growth, Growth curve, availability of oxygen, culture collection and maintenance of cultures.

Media formulation: principles of microbial nutrition, formulation of culture medium, selective media, factors influencing the choice of various carbon and nitrogen sources, vitamins, minerals, precursors and antifoam agents. Importance of pH.

UNIT-III

Management of waste

Management of Contaminated land**,** lake sediments and Solid Waste, Anaerobic digestion, Biostimulation, Bioaugmentation, Phytoremediation, Natural attenuation, Vermicomposting

UNIT-IV

Bioremediation

Definition, constraints and priorities of Bioremediation, Types of bioremediation, *In-situ* and *Ex-situ* bioremediation techniques, Factors affecting bioremediation. Bioremediation of Hydrocarbons. Lignocellulosic Compounds.

UNIT-V

Bioenergy & biomining

Bio energy: Energy and Biomass Production from wastes, biofuels, bio hydrogen and biomass.

Biomining: Bioleaching, monitoring of pollutants, microbially enhanced oil recovery, microbial fuel cells.

TEXT BOOKS:

1. Molecular Biology of cell, Alberts. B et al. Developmental Biology, SF Gilbert, Sinauer Associates Inc.
2. AVN Swamy, Industrial Pollution Control Engineering, 2006, Galgotia Publication,

REFERENCES:

1. Environmental Biotechnology - Allan Stagg.

COURSE OUTCOMES:

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

1. Graduates will be able design, perform experiments, analyze and interpret data for investigating complex problems in Biotechnology, Engineering and related fields.
2. Graduates will be able to decide and apply appropriate tools and techniques in biotechnological manipulation.
3. Graduates will be able to justify societal, health, safety and legal issues and understand his responsibilities in biotechnological engineering practices
4. Graduates will be able to understand the need and impact of biotechnological solutions on environment and societal context keeping in view need for sustainable solution.
5. Apply the knowledge of biotechnology fundamentals for the solution of complex

engineering problems

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

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

COURSE OBJECTIVES:

- The course is aimed at developing the skills of engineering students in novel separation processes. The learners will be enabled to appreciate the important role of modern separation processes concepts in engineering application as well as industries.

UNIT I

Thermal Diffusion: Basic Rate Law, Theory of Thermal Diffusion Phenomena for gas and liquid mixtures, Equipments design and Applications. Zone Melting: Equilibrium diagrams, Controlling factors, Apparatus and Applications.

UNIT II

Sorption Techniques - Types and choice of adsorbents, Normal Adsorption techniques, chromatographic techniques, Equipment and commercial processes, Recent advances and economics, Molecular Sieves.

.

UNIT III

Membrane Separation Processes - Types and choice of membranes, their merits, commercial, pilot plant and laboratory membrane permeators, Dialysis, Reverse Osmosis, Ultrafiltration, Membrane bioreactor, Membrane Distillation, Economics of Membrane operations.

UNIT IV

Ionic Separation - Controlling factors, Applications, Equipments for Electrophoresis, Dielectrophoresis, Electro Dialysis and Ion -Exchange, Commercial processes.

Other Techniques: Adductive Crystallization: Molecular addition compounds, Clathrate compounds and Adducts, Equipments, Applications, Economics and Commercial processes..

UNIT V

Foam Separation - Surface Adsorption, Nature of foams, Apparatus, Applications, and Controlling factors.

TEXT BOOKS:

1. Schoen H. M., "New Chemical Engineering Separation Techniques", 2nd Edition, 1972, Inter Science Publications, New York.
2. Loeb .C and Lacey R. E., "Industrial Processing with Membranes", 2nd Edition, 1972, Wiley Inter Science.

REFERENCES:

1. Perry R.H. and. Green D.W, "Perry's Chemical Engineers Hand book", 6th Edition., 1990, McGraw Hill, New York.
2. Coulson J. M. and Richardson J. F., "Chemical Engineering", Vol. II, 4th Edition, 1991, Butterworth, Heinemann, London.

COURSE OUTCOMES:

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

1. Describe the design principle and application of thermal diffusion.
2. Explain adsorption techniques and its commercial equipments.
3. Select suitable membrane separation processes and explain applications of membrane.
4. Articulate about ionic, crystallization and its applications
5. Illustrate surface adsorption , foam separation apparatus and its application

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

CHPESCN	**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:

At the end of this course, the students are able to

1. Describe about various Nitrogen fertilizer production and its characteristics
2. Explain about Phosphatic fertilizer with flow diagram
3. Develop the knowledge of Potassic fertilizer with their specifications
4. Explain about mixed fertilizer and NPK fertilizer in our country
5. Justify the different types of fertilizer applied to agriculture production of various crops

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

CHPESCN	PULP AND 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

Introduction to pulp and paper technology – Wood haves dry – Wood as a raw material.

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,.,ISBN-13: 978-0120973620
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:

At the end of this course, the students would

1. Describe the basic concepts of pulp and paper technology and the raw material for paper making.
2. Analyze various unit operations and reactions involved in pulp making process.
3. Explain about paper machine and its distinct operational sections.
4. Summarize various paper products and surface treatments.
5. Analyze the properties, testing of paper and the waste disposal techniques in pulp and paper industry

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

CHPESCN	**TOTAL QUALITY MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To provide comprehensive knowledge about the principles, practices, tools and techniques of Total quality management.
- To understand the various principles, practices of TQM to achieve quality.
- To learn the various statistical approaches for Quality control.
- To understand the TQM tools for continuous process improvement.
- To learn the importance of ISO and Quality systems

UNIT I : Introduction

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality - Basic concepts of TQM – TQM Framework - Contributions of Quality Gurus – Barriers to TQM – Cost of Quality.

UNIT II : TQM principles

Quality statements - Customer focus –Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Continuous process improvement – PDCA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating

UNIT III : TQM tools & techniques I

The seven traditional tools of quality – New management tools – Six-sigma: Concepts,

methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

UNIT IV : TQM tools & techniques II

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures - BPR.

UNIT V : Quality systems

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing QS 9000 – ISO 14000 – Concepts, Requirements and Benefits –Quality Council – Leadership, Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward.

TEXT BOOKS:

1. Dale H.Besterfiled, , Carol Besterfield-Michna, Glen Besterfield , Mary Besterfield-Sacre, "Total Quality Management", Third Edition , 2006, Pearson Education Asia, , Indian Reprint
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 6th Ed., 2005, South-Western (Thomson Learning).

REFERENCES:

1. Oakland, J.S. "TQM – Text with Cases", Third Edition , 2003, Butterworth – Heinemann Ltd., Oxford.
2. Suganthi,L and Anand Samuel, "Total Quality Management", 2006, Prentice Hall (India) Pvt. Ltd.

COURSE OUTCOMES:

At the end, students can able to

1. Know prerequisites of evolution of total quality management and significance contributions of quality gurus' to the management of modern organizations.
2. Evaluate the principles of quality management and to administer how these principles can be applied within quality management systems.
3. Identify the key aspects of the quality improvement cycle and to select and use appropriate tools and techniques for controlling, improving and measuring quality.
4. Identify and prioritize customers' expectations quickly and effectively and to enlist the factors for improving the "Overall Equipment Effectiveness"
5. Describe the various elements of quality systems and Critically appraise the teamwork requirements for effective quality management.

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

CHPESCN	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop the skills of engineering students in Operations Research
- The learners will be enabled to appreciate the important role of Operations Research concepts in engineering application.

UNIT-I

Basics of operations research - Linear programming- mathematical formulation- graphical methods, theory and applications of simplex method, duality theory, revised simplex methods.

UNIT-II

Transportation models- formulation as LP problem, methods of obtaining initial solution, setting up of transportation table- performing optimality test- test for optimality

UNIT-III

Dynamic programming; Non linear programming

UNIT-IV

Decision theory and games: decision making under conditions of certainty- decision making under conditions of uncertainty- optimistic criterion- pessimistic criterion; decision making under conditions of risk. The theory of games- maximin and minimax criteria-mixed strategies for games with saddle points

UNIT-V

Programming Evaluation and Review Technique (PERT) and Critical path method (CPM)

TEXT BOOKS:

1. Gupta P.K, Hira D.S, Problems in Operations Research – First Edition 1991, S.Chand & Company Ltd. new Delhi.
2. Rudd, F., C. Watson, Strategy of Process Engineering, 19686, John Wiley.

REFERENCES:

1. Taha H.A "Operation Research" IX Edn, 2010, Prentice Hall of India, New Delhi.
2. Sharma S.K."Mathematical models in Operation Research," Tata McGraw Hill Publishing Company Ltd ,New Delhi.

COURSE OUTCOMES:

At the end, students can able to

1. Infer the systematic and rational approach to the fundamental problems in the industries.
2. Express and optimize the operations research problems using transportation methods.
3. Apply mathematical techniques of optimization in the non-linear problems.
4. Interpret a suitable method for the decision-making of process data concerning the different outcomes.
5. Validate the performance of project activities based on the network techniques.

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

CHPESCN	**OPTIMIZATION OF CHEMICAL PROCESSES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- The course is aimed at developing the skills of engineering students in Optimization of chemical processes.
- The learners will be enabled to appreciate the important role of Optimization of chemical processes concepts in engineering application.

UNIT I : Objective and formulation of optimization

Objective and Introduction, Objective Function and Decision variables, Inequality and Equality Constrains in Models Formulation of the Objective Function, Lower and Upper Bounds, Selecting Functions to Fit Empirical Data, Factorial Experimental Designs, Degrees of Freedom, Economic Objective Functions, Measures of Profitability

UNIT II : Basic concepts of optimization

Continuity of Function, NLP Problem Statement, Convexity and Its Applications, Interpretation of the Objective Function in Terms of its Quadratic Approximation, Necessary and Sufficient Conditions for an Extremum of an Unconstrained Function.

UNIT III : Optimization of unconstrained functions

One-Dimensional Search Numerical Methods for Optimizing a Function of One Variable, Scanning and Bracketing Procedures, Newton and Quasi-Newton Methods of Unidimensional Search.

UNIT IV : Unconstrained multivariable optimization

Linear Programming (LP) and Applications Geometry of Linear Programs, Basic Linear Programming Definitions and Results, Simplex Algorithm, Barrier Methods, Sensitivity Analysis, Linear Mixed Integer Programs, Application of the EXCEL Solver Spreadsheet for Optimization, Formulation. Introduction to Non linear Programming with Constraints and Mixed-Integer Programming.

UNIT V: Application of optimization in chemical engineering

Examples of Optimization in Chemical Processes like optimizing recovery of waste heat, Optimal Shell and Tube Heat Exchanger Design, Optimal Design and Operation of binary Distillation Column, Optimal pipe diameter etc. Flow sheet Optimization - Case studies.

.

TEXT BOOKS:

1. Edger T.F., Himmelblau D.M. and Lasdon L.S., "Optimization of Chemical Processes", 2nd Edition, 2001, McGraw- Hill.
2. Seider W.D., Seader J.D. and Lewin D.R., "Product and Process Design Principles-Synthesis, Analysis, and Evaluation", 2nd Edition, 2008, John Wiley and Sons Inc

REFERENCES:

1. Kalyan Moy Deb "Optimization for Engineering Design", 2nd Edition, 2009, Prentice Hall of India.
2. Gupta P.K, Hira D.S, Problems in Operations Research – First Edition 1991, S.Chand & Company Ltd. New Delhi.

COURSE OUTCOMES:

At the end, students can able to

1. Label to Identify the types of optimization problems in chemical engineering
2. Compare the constrained and un constrained situations in the chemical reactions
3. Apply the optimization software tools in chemical engineering processes
4. Examine to solve the various multivariable optimization problems
5. Interface the optimization in chemical process equipment's.

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

OPEN ELECTIVES

CHOESCN	INDUSTRIAL SAFETY AND OCCUPATIONAL HEALTH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To give an idea about different hazards and other safety procedures to be followed in an industry
- A comprehensive knowledge of industrial safety and occupational health be immensely useful for the students from all fields

UNIT- I

Industrial Safety - 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 II

Hazards - Physical hazards- Noise, compensation aspects, noise exposure regulation, Properties of sound, occupational damage, risk factors, sound measuring instruments, octave band analyzer, noise networks, noise surveys, noise control program

Chemical hazards- Recognition of chemical hazards-dust, fumes, mist, vapour, fog, gases, types, concentration, Exposure vs. dose, TLV - Methods of Evaluation, process or operation description, Field Survey, Sampling methodology, Industrial Hygiene calculations, Comparison with OSHAS Standard.

Biological and ergonomical hazards- Classification of Biohazardous agents –bacterial agents, viral agents, fungal, parasitic agents, infectious diseases - Biohazard control program, employee health program-laboratory safety program-biological safety cabinets

UNIT III

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

UNIT IV

Occupational health - Concept and spectrum of health - functional units and activities of occupational health services, pre-employment and post-employment medical examinations – occupational related diseases, notifiable occupational diseases such as silicosis, asbestosis, pneumoconiosis, siderosis, anthracosis, aluminosis and anthrax, lead nickel, chromium and manganese toxicity, gas poisoning (such as CO, ammonia, coal and dust etc) their effects and prevention – cardio pulmonary resuscitation, audiometric tests, eye tests, vital function tests.

UNIT V

Occupational physiology - Man as a system component – allocation of functions– efficiency – occupational . work capacity aerobic and anaerobic work – evaluation of physiological requirements of jobs – parameters of measurements – categorization of job heaviness – work organization – stress – strain – fatigue – rest pauses – shift work – personal hygiene.

TEXT BOOKS:

1. McCornick, E.J. and Sanders, M.S., Human Factorsin Engineering and Design, 1992, Tata McGraw-Hill.
2. Dan Patterson, Techniques of Safety Management, IV edition, 2003, Mc Graw Hill, Kogakusha.

REFERENCES:

1. K.V.Ragavan and A.A.Khan, Methodologies in Hazard Identification and Risk Assessment, Manual by CLRI 1990
2. R.V.Betrabeta and TPS.Rajan,, Safety in Chemical Industry in Chemical Technology-I, Chemical Engg. Division center IIT, Chennai.
3. Handbook of Occupational Health and Safety, NSC Chicago, 1982
4. Encyclopedia of Occupational Health and Safety, Vol. I & II, International Labour Organisation, Geneva, 1985

COURSE OUTCOMES:

Students will be able to

1. Explain about fire hazards and types of PPE.
2. Identify physical, chemical and biological hazards.
3. Analyze hazards using operability studies and explain about ergonomics.
4. Describe about occupation health and related diseases.
5. Explain about occupational physiology and personal hygiene.

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

CHOESCN	**SOLID WASTE MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To develop the skills of engineering students in solid waste management
- To make the students conversant with different aspects of the types, sources, generation, storage, collection, transport, processing and disposal of solid waste.

UNIT-I

Sources and types of municipal solid wastes-waste generation rates-factors affecting generation, characteristics-methods of sampling and characterization; Effects of improper disposal of solid wastes-Public health and environmental effects. Elements of solid waste management –Social and Financial aspects – Municipal solid waste (M&H) rules – integrated management-Public awareness; Role of NGO"s.

UNIT-II

On-site storage methods – Effect of storage, materials used for containers – segregation of solid wastes – Public health and economic aspects of open storage – waste segregation and storage – case studies under Indian conditions – source reduction of waste – Reduction, Reuse and Recycling.

UNIT-III

Methods of Residential and commercial waste collection – Collection vehicles – Manpower– Collection routes – Analysis of collection systems; Transfer stations – Selection of location, operation & maintenance; options under Indian conditions – Field problems- solving.

UNIT-IV

Objectives of waste processing – Physical Processing techniques and Equipments; Resource recovery from solid waste composting and biomethanation; Thermal processing options – case studies under Indian conditions.

UNIT-V

Land disposal of solid waste; Sanitary landfills – site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas- Landfill bioreactor– Dumpsite Rehabilitation. Incineration, composting methods.

TEXT BOOKS:

1. Tchobanoglous, G., Theisen, H. M., and Eliassen, R. "Solid. Wastes: Engineering Principles and Management Issues". 1993, McGraw Hill, New York,
2. Vesilind, P.A. and Rimer, A.E., "Unit Operations in Resource Recovery Engineering", 198, Prentice Hall, Inc.

REFERENCES:

1. Government of India, "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of Urban Development, New Delhi, 2000.
2. Bhide A.D. and Sundaresan, B.B. "Solid Waste Management Collection", Processing and Disposal, 2001
3. Manser A.G.R. and Keeling A.A.," Practical Handbook of Processing and Recycling of Municipal solid Wastes", 1996, Lewis Publishers, CRC Press,
4. George Tchobanoglous and Frank Kreith"Handbook of Solid waste Management", 2002, McGraw Hill, New York.
5. Paul T Willams, "Waste Treatment and Disposal", 2000, John Wiley and Sons.

COURSE OUTCOMES:

An understanding of the nature and characteristics of municipal solid wastes

Understand the regulatory requirements regarding municipal solid waste management

Ability to plan waste minimization and design storage, collection, transport, processing and disposal of municipal solid waste

Students will be able to

1. An understanding of the nature and characteristics of municipal solid wastes
2. Understand the regulatory requirements regarding municipal solid waste management
3. Ability to plan waste minimization and design storage, collection, transport, processing and disposal of municipal solid waste
4. Describe about treatment of solid wastes.
5. Explain about landfill and management.

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

CHOESCN	**PROJECT ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To familiarize the students on project engineering, operations and contracts.
- To provide knowledge about the selection of heat exchangers, pumps, compressors turbines etc.
- To illustrate the concepts of pipe design and thermal insulation.
- To impart knowledge on fire, explosion and other industrial hazards and to provide basic knowledge on personal protective equipments and their applications.
- To gain knowledge on hazard analysis, its types, hazard evaluation, health, safety and ergonomics.

UNIT - I

Preliminary data for construction projects- process Engineering - process flow and PI diagrams, scheduling the project; procurement operations - contracts.

UNIT - II

Selection of heat exchangers, pumps, compressors, vacuum pumps, motors turbines and other process equipment.

UNIT - III

Piping design - pipes and fittings, pipe supports, selection of valves - piping layout and arrangement.

Thermal insulation: types and characteristics, Selection and erection of insulation.

UNIT - IV

Fire Types of fire- fire hazards-hazards of flammable liquids and gases-ignition hazards-fire

extinguishers-fire exits.

Explosion Fire and explosion index-dust explosion and prevention

Toxic releases

Toxicity and its measurements- release control- reduction and removal methods maintenance-emergency management plans.

Personal protective equipment

Types-helmets-respirators-air purification-chemical protective clothing-gloves-eye glasses- foot and knee protection-skin care.

UNIT - V

Hazard analysis

Types of hazard analysis-hazard identification-hazard survey-hazard and operability studies-fault tree analysis -event tree analysis-technique of operation review-safety audit-hazard evaluation. Health and safety-ergonomics.

TEXT BOOKS:

1. Rase,H.F.,and M.H.Barrow, Project Engineering of process plants, 1987, John Wiley & Sons.
2. Dan Patterson, Techniques of Safety Management, 2nd edition, 1996, Mc Graw Hill, Kogakusha,

REFERENCES:

1. Anilkumar, Chemical Process Synthesis and Engg. Design, 1997, Tata McGraw Hill Pub. Co. New Delhi.
2. R.V.Betrabeta and TPS.Rajan, Safety in Chemical Industry in Chemical Technology - I, Chemical Engg. Division center IIT, Chennai.
3. K.V.Ragavan and A.A.Khan, Methodologies in Hazard Identification and Risk Assessment, , Manual by CLRI - 1990.

COURSE OUTCOMES:

Students will be able to

1. Convince with project engineering and process equipment.
2. Select heat exchangers, pumps, compressors turbines based on process conditions.
3. Apply the concepts of pipe design and thermal insulation.
4. Express knowledge on fire, explosion, industrial hazards and Evaluation.
5. Recommend relevant personal protective equipment, safety and ergonomics. Conduct hazard analysis.

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

CHOESCN	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
- The learners will be enabled to appreciate the important role of materials concepts in engineering application.

UNIT I

Properties and Corrosion Of Material: Mechanical, Electrical and magnetic properties of materials- Deformation of materials- Heat Treatment techniques -corrosion, theories of corrosion - control and prevention of corrosion.

UNIT II

Metals: 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..

COURSE OUTCOMES:

Students will be able to

1. Define properties, corrosion and prevention of materials.
2. Describe the properties and applications of ferrous and non-ferrous metals and alloys.
3. Describe the properties and applications of base metals and alloys.
4. Describe the properties and applications of inorganic materials.
5. Describe the properties and applications of organic materials.

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

CHOESCN	**FUEL TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To know about the Fuels and its Types and properties.
- To know about & Distillation Techniques
- To know about 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:

Students will be able to

1. Illustrate about fuels, characteristics and classification.
2. Describe solid fuels; their combustion technologies, efficiency and applications.
3. Describe liquid fuels; their characterization, processing and equipment.
4. Describe gaseous fuels and applications.
5. Discuss thermo chemistry and combustion properties.

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

CHOESCN	**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.

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UNIT-I

Biomass resources and biomass properties – biomass – definition – 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,

REFERENCE S

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:

Students will be able to

1. Illustrate biomass, characteristics and classification.
2. Explain the process of pyrolysis, efficiency and applications.
3. Explain the process of gasification, efficiency and applications and types of gasifiers.
4. Explain the process of biomass combustion, efficiency and applications.
5. Discuss bioconversion of biomass through different technologies

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

CHOESCN	**HAZARDOUS WASTE MANAGEMENT**	**L**	**P**	**0**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To impart knowledge and skills in the collection, storage, transport, treatment, disposal and recycling options for hazardous wastes including the related engineering principles, design criteria, methods and equipment.

UNIT I

Introduction

Need for hazardous waste management – Sources of hazardous wastes – Effects on community – terminology and classification – Storage and collection of hazardous wastes – 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. E-waste – sources and management.

UNIT III

Biomedical and chemical wastes

Biomedical wastes – Types – Management and handling – control of biomedical wastes 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

Sources and characteristics: handling, collection, storage and transport, TSDF concept. Hazardous waste treatment technologies - Physical, chemical and thermal treatment of hazardous waste: solidification, chemical fixation, encapsulation, pyrolysis and incineration.

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

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:

Students will be able to

1. Know the need for hazardous waste management and sources of hazardous wastes and its effects on community
2. Understand the characteristics and effects of Nuclear wastes and e-waste
3. Explain the characteristics and effects of Biomedical and chemical wastes
4. Understand the characteristics and effects of Hazardous wastes management
5. Understand the Waste treatment technologies

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

CHOESCN	**RENEWABLE ENERGY TECHNOLOGY**	**L**	**P**	**T**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

The course will,

- Describe the various types of conventional & renewable energy resources and present scenario with energy conservation objectives and regulations.
- Illustrate the aspects in utilization of different renewable energy sources for domestic and industrial applications.

- Contribute knowledge for description, selection, sizing and performance of existing and new systems at basic level.
- Outline the basic design and economic analysis of the renewable energy systems.
- Serve as foundation course, who wish to opt a specialty of renewable energy in the continuing education.

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 - Thermo chemical conversion - direct combustion – biomass gasification - pyrolysis and liquefaction – biochemical conversion - anaerobic digestion - types of biogas Plants - applications - alcohol production from biomass – bio diesel production – Urban waste to energy conversion - Biomass energy programme in India.

UNIT V

Other types of energy

Ocean energy resources - principle of ocean thermal energy conversion (OTEC) - ocean thermal power plants - ocean wave energy conversion - tidal energy conversion – small hydro – geothermal energy - geothermal power plants – hydrogen production and storage - Fuel cell – principle of working - various types - construction and applications.– Energy scenario in India – Growth of energy sector and its planning in India.

TEXT BOOKS:

1. Sukhatme, S.P., J.K.Nayak, Solar Energy, III Edn. 2008,Tata McGraw Hill,.
2. Twidell, J.W. and Weir, A., Renewable Energy Sources,1986, EFN Spon Ltd..

REFERENCES:

1. Kishore VVN, Renewable Energy Engineering and Technology, 2012, Teri Press, New Delhi
2. Peter Gevorkian, Sustainable Energy Systems Engineering, 2007, McGraw Hill
3. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, 1996, Oxford University Press, U.K,
3. Yogi Goswami, Kreith, F and Kreider, J. F., Principles of Solar Engineering, 2000, McGraw-Hill, II Edn.
4. Veziroglu, T.N., Alternative Energy Sources, Vol 5 and 6, 1990, McGraw-Hill
5. Anthony San Pietro, Biochemical and Photosynthetic aspects of Energy Production, 2012, Academic Press

COURSE OUTCOMES:

Students will be able to

1. Explain the environmental aspects & impacts of non-renewable and renewable energy resources with their prospects and limitations.

2. Illustrate the different renewable energy systems and identify the appropriate technology for both stand alone and integrated systems about opportunities and barriers to their use.

3. Analyze the functionality of components of the different renewable energy systems and their behavior in operation.

4. Demonstrate the skills necessary for pre-feasibility study and perform an initial design with details.

5. Identify, define, present and communicate issues within the area and know the main line of research in the field of technologies to harness renewable energy.

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

CHOESCN	**BIOLOGY FOR ENGINEERS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- The course acts as a bridge between engineering and biology to provide basic understanding of biological mechanisms of living systems from engineering perspective.
- It will illustrate the many possible means to utilize living things' relevance to engineering principles.
- With substantial knowledge and continuing interest will make a student into a specialist in the technical diversity.

UNIT I

Requirements of biological systems

Biological Units Need Water; Biological Units Need the Right Amount of Oxygen; Biological Units Need Food and Nutrients; Biological Units Become Ill in the Presence of Wastes; Biological Units Need Heat Sources and Sinks.

UNIT II

Behavior of biological systems

Biological Units Adapt to Their Environments; Biological Units Modify Their Environments; Adaptations Require Extra Energy and Resources; Biological Units, If Possible, Move to Friendlier Environments; Biological Units Evolve under Environmental Pressures.

UNIT III

Response to stress by biological systems

Crowding of Biological Units Produces Stress; Biological Units Are Affected by Chemical Stresses; Biological Units Respond to Mechanical Stresses; Optimization Is Used to Save Energy and Nutrient Resources; Biological Units Alter Themselves to Protect against Harsh Environments.

UNIT IV

Existence of biological systems

Biological Units Cooperate with Other Biological Units; Biological Units Compete with Other Biological Units; Biological Units Reproduce; Biological Units Coordinate Activities through Communication; Biological Units Maintain Stability with Exquisite Control; Biological Units Go through Natural Cycles; Biological Units Need Emotional Satisfaction and Intellectual Stimulation; Biological Units Die.

UNIT V

Scaling factors and biological engineering solutions

Allometric Relationships from Evolutionary Pressure; Dimensional Analysis; Golden Ratio; Fractal Scaling within an Organism; Self-Similarity for Tissues and Organs; Self-Similarity in Populations; Systems Approach; Relationships between Engineering and Biology; The Completed Design.

TEXT BOOKS:

1. Arthur T. Johnson, " Biology for Engineers", 2000, CRC Press.
2. S. Thyaga Rajan, N. Selvamurugan, M. P. Rajesh, R. A. Nazeer, Richard W. Thilagaraj, S. Barathi, and M. K. Jaganathan, "Biology for Engineers," 2012, Tata McGraw-Hill, New Delhi.

REFERENCES:

1. Aydin Tözeren, Stephen W. Byers, New Biology for Engineers and Computer Scientists, 2004, Pearson/Prentice Hall.

COURSE OUTCOMES

Students will be able to

1. ıderstand the information known about familiar living systems.

2. ıticipate the properties of an unfamiliar group of living things from knowledge about a familiar group.

3. monstrate the relevance of engineering to biological systems.
4. hibit knowledge about biological responses and it is scaling with respect to scientific principles that cannot be related back.
5. monstrate biological principles and generalizations that can lead to useful products and processes.

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

CHOESCN	**DISASTER MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

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COURSE OBJECTIVES:

- To provide basic concepts of disasters and
- To give a thorough knowledge and experience to reduce disaster risks.

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. Landslides- Rock falls- 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 in India and Tamilnadu- Preparedness- Tropical cyclones and their warning systems- Tropical

cyclone warning strategy in India special nature of the problem in the region- Classification- Protection of buildings from cyclones of India- Precautions during and before cyclones.

UNIT V

Coastal floods- Intensification of hazards due to human interference- Management-River and coastal floods- Temperature extremes and wild fires- Physiological hazards- Flood forecasting-mitigation- planning- management- flood prone areas the Indian scenario- Flood experience in India and Tamilnadu.

Environmental hazards- Typology- Assessment and response- Strategies -The scale of disaster- Vulnerability- Disaster trends- Paradigms towards a balanced view- Chemical hazards and toxicology-Biological hazards- Risk analysis- Other technological disasters.

TEXT BOOKS:

1. David R. Godschalk (Editor), Timothy Beatiey, Philip Berke,.David J. Browt:r, Edward J. Kaiser Charles C. Boh, R. Matthew Goebel, Natural Hazard Mitigation: Recasting Disaster Policy and Planning Island Press; (January 1999), ISBN) 559636025
2. Sinha, P.C. Wind & Water Driven Disasters, 1998, 250pp, Anmol Publications

REFERENCES:

1. Davide Wikersheimer Windstorm Mitigation Manual for Light Frame Construction, 1997, DIANE Publishing Co:
2. Brown D Redevelopment After the Storm: Hazard Mitigation Opportunities in the Post Disater Setting, 1985,John Wiley & Sons.
3. Sinha, P.C. Technological Disasters , 1997, 516 pp Anmol Publications Trivedi,

COURSE OUTCOMES

Students will be able to

1. Develop an understanding of the key concepts, definitions key perspectives of all Hazards Emergency Management
2. Develop a basic under understanding of Prevention, Mitigation, Preparedness, Response and Recovery
3. Explain about Tsunami, landslides and effects.
4. Explain about earthquake forecasting and risk assessment.
5. Discuss the environmental effects of coastal floods.

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

HONOUR ELECTIVE COURSES

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

COURSE OBJECTIVES:

- Apply scientific and engineering principles to analyze thermofluid aspects of engineering systems
- 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.
- Recognize the broad technological context of heat transfer, especially related to energy technology

Unit - I

Transient heat conduction. Extended surfaces and fins. Numerical solutions for one-dimensional and two-dimensional steady state heat conduction problems. Unsteady state conduction: unidimensional and multidimensional systems-Use of transient heat conduction charts.

Unit - II

Convective heat transfer: theories and practice-energy equation for thermal boundary layer over a flat plate. Momentum and heat exchange in turbulent fluid flow- empirical equations for forced and free convection based on experimental results.

Unit - III

Heat transfer with change of phase: Phenomena of boiling and condensation- Regimes of pool boiling-heat transfer during boiling-dropwise and filmwise condensation-effects of turbulence and high vapour velocity on filmwise condensation.

Unit - IV

Compact heat exchangers: plate and spiral type heat exchangers-finned tube heat exchangers- heat pipes-regenerators and recuperators.

Unit - V

Special topics in heat transfer: Heat transfer in magneto fluidynamic systems-transpiration cooling-ablation-heat transfer in liquid metals-heat transfer in fluidized beds- heat transfer processes in nuclear reactors

TEXT BOOKS:

1. Knudsen.J.G., D.L.Katz, Fluid Dynamics and Heat Transfer, 1958, McGraw-Hill, New York.
2. Jacob.M., Heat Transfer, 1962, John Wiley, New York.

REFERENCES:

1. Mc Adams, Heat transmission, 1954, McGraw Hill, New York.
2. Holman.J.P., Heat Transfer, 8th edition , 1997, McGraw Hill, New York

COURSE OUTCOMES

Students will be able to

1. Apply scientific and engineering principles to analyze thermofluid aspects of engineering systems.
2. Use appropriate analytical and computational tools to investigate the steady state and unsteady state heat transfer phenomena.
3. Discuss the heat transfer mechanisms in fluids and their applications.
4. Design heat exchangers.

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

CHHE602	**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

Review of Basic Postulates, Maxwell's relations, Legendre Transformation, Pure Component properties, Theory of corresponding states, real fluids Equilibrium, Phase Rule, Single component phase diagrams.

Unit - II

Introduction to Multicomponent Multiphase equilibrium, introduction to Classical Mechanics, quantum Mechanics, Canonical Ensemble, Microcanonical Ensemble, Grand Canonical Ensemble, Boltzmann, Fermi-dirac and Bose Einstein Statistics, Fluctuations, Monoatomic and Diatomic Gases,

Unit - III

Introduction to Classical Statistical Mechanics, phase space, liouville equation, Crystals, Intermolecular forces and potential energy functions, imperfect Monoatomic Gases, Molecular theory of corresponding states,

Unit - IV

Introduction to Molecular Simulations, Mixtures, partial molar properties, Gibbs Duhems equations, fugacity and activity coefficients, Ideal and Non-ideal solutions, Molecular theories of activity coefficients, lattice models,

Unit - V

Multiphase multi component phase equilibrium, VLE/SLE/LLE/VLLE, Chemical Equilibrium and Combined phase and reaction equilibria.

TEXT BOOKS:

1. McQuarrie D.A, Statistical Mechanics, 2003, Viva Books Private Limited.
2. Hill Terrel, An Introduction to Statistical Thermodynamics, 1960, Dover.

REFERENCES:

1. Allen MP, Tildesley DJ, Computer simulation of liquids,1989, Oxford
2. Callen, HB. Thermodynamics and an Introduction to Thermodstatics, 2nd Edition, 1985, John Wiley and Sons.
3. Prausnitz, J.M., Lichtenthaler R.M. and Azevedo, E.G., Molecular thermodynamics of fluid-phase Equilibria (3rd edition), 1996, Prentice Hall Inc., New Jersey.
4. 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

Students will be able to

1. Formulate solutions to phase equilibrium problems for complex systems based on classical and molecular thermodynamics
2. Explain statistical mechanical principles and intermolecular forces
3. Discuss concepts of statistical thermodynamics along with classical thermodynamics.
4. Illustrate molecular simulations
5. Explain multiphase multicomponent phase equilibrium.

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

CHHE701	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 apply various computer architecture for the study of inputs to various complex systems and to get their output
- To study about multivariable processes, Z-transform and stability analysis and an indepth idea of identification of processes

Unit - I

Introduction: Some important Simulation Results, General Concepts and terminology, Laws, Languages and Levels of process control. Time Domain Dynamics: Classification and definition, linearization and perturbation variables, responses to simple linear systems, solutions using MATLAB.

Unit - II

Laplace - Domain Dynamics, Laplace - Domain Analysis of conventional feed back 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

COURSE OUTCOMES

Students will 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. Explain multivariable processes, Z-transform and stability analysis and an in depth idea of identification of processes.

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

CHHE702	**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.
- Know the mathematical models of Fluidized Bed

Unit - I

The phenomenon of Fluidization - Liquid like behavior of a Fluidized Bed – Comparison with Other contacting Methods – Advantages and Disadvantages of Fluidization - Types of Fluidization Operations. Applications of fluidized bed: Physical Operations – Synthesis Reactions – Cracking and Reforming of Hydrocarbons – Carbonization and Gasification – Calcining and Clinkering – Gas Solid Reactions

Unit - II

Minimum Fluidizing Velocity, Terminal Velocity and Pressure Drop in Fluidized Beds – Types of Fluidization, bubble formation and importance of the distributors – Voidage in Fluidized Beds – Transport Disengaging Height, TDH – Variation in Size Distribution with height – Viscosity and Fluidity of Fluidized Beds – Power Consumption

Unit - III

Single Rising Bubbles – Stream of Bubbles from a Single Source – Bubbles in Ordinary Bubbling Beds – The Bubbling Bed Model for the Bubble Phase Movement of Individual Particles – Turnover of Individual Particles – Residence Time Distribution of solids – The Diffusion Model for

Movement of Solids – The Bubbling model for the Emulsion Phase – Interpretation of Solids Mixing Data in terms of the Bubbling Bed Model

Unit - IV

The Bubbling Bed Model for Gas Interchange – Interpretation of Gas Mixing Data in Terms of the Bubbling Bed Model. Experimental Findings of Mass Transfer – Mass Transfer Rate from the Bubbling Bed model – Experimental Findings on Heat Transfer – Heat Transfer Rate from the Bubbling Bed Model - Two Region Models – Catalytic Conversion from the Bubbling Bed Model

Unit - V

Experimental Findings – Theories for Bed Wall Heat Transfer – Comparison of Theories – Evaluation – A Model for Entrainment from a Dense Fluidized Bed. Particles of Unchanging Size – Particles of Changing Size – Finding required Circulation Rates for Solids – Flow of High Bulk Density Mixtures – Flow of Low Bulk Density Mixtures – Assemble of a Circuit

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

Students will be able to

1. Understand the fluidization phenomena and operational regimes.
2. Analyze fluidized bed behavior with respect to the gas velocity
3. Develop and solve mathematical models of the fluidized bed.
4. Estimate pressure drop, bubble size, voidage, heat and mass transfer rates for the fluidized beds.
5. Design gas-solid fluidized bed reactors.

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

CHHE801	**APPLICATION OF NANOTECHNOLOGY IN CHEMICAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the fundamentals of the preparation and properties of nanomaterials from a chemical engineering perspective.
- To gain knowledge of structure, properties, manufacturing, and applications of various nanomaterials and characterization methods in nanotechnology

- To give a survey of the key processes, principles, and techniques used to build novel nanomaterials and assemblies of nanomaterials

Unit – I: Introduction

Introduction to nanotechnology, Feynman's Vision-There's Plenty of Room at the Bottom, Classification of nanostructures, Nanoscale architecture, Chemical interactions at nanoscale, Types of carbon based nanomaterials, Synthesis of fullerenes, Graphene, Carbon nanotubes, Functionalization of carbon nanotubes, One, two and multidimensional structures, Crystallography.

Unit – II: Approaches to Synthesis of Nanoscale Materials

Top down approach, Bottom up approach Bottom-up vs. top-down fabrication; Top-down: Atomization, Sol gel technique, Arc discharge, Laser ablation, RF sputtering; Bottom-up: Chemical Vapor Deposition (CVD), Metal Oxide Chemical Vapor Deposition (MOCVD), Atomic layer deposition (ALD), Molecular beam Molecular self-assembly; Ultrasound assisted, microwave assisted, Mini, micro and nanoemulsion. Wet grinding method, Spray pyrolysis, Ultrasound assisted pyrolysis, atomization techniques. Surfactant based synthesis procedures, Types of molecular modeling methods.

Unit – III: Characterization of Nanoscale Structures and Surfaces

Size, shape, crystallinity, topology, chemistry analysis using X-ray imaging, Transmission Electron Microscopy, HRTEM, Scanning Electron Microscopy, SPM, AFM, STM, PSD, Zeta potential, DSC and TGA.

Unit – IV: Semiconductors and Quantum dots

Intrinsic semiconductors, Extrinsic semiconductors, Review of classical mechanics, de Broglie's hypothesis, Heisenberg uncertainty principle Pauli exclusion principle Schrödinger's equation Properties of the wave function, Applications: quantum well, wire, dot, Quantum cryptography

Unit – V: Polymer-based and Polymer-filled Nanocomposites

Nanoscale Fillers, Nanofiber or Nanotube Fillers, Plate-like Nanofillers, Equi-axed Nanoparticle Fillers, Inorganic Filler Polymer Interfaces, Processing of Polymer Nanocomposites, Nanotube/Polymer Composites, Layered Filler Polymer Composite Processing, Nanoparticle/Polymer Composite Processing: Direct Mixing, Solution Mixing, In-Situ Polymerization, In-Situ Particle Processing, In-Situ Particle Processing Metal/Polymer Nanocomposites, Properties of nanocomposites.

TEXT BOOKS:

1. Louis Hornyak G., Dutta Joydeep, Tibbals Harry F. and Rao Anil K., "Introduction to Nanoscience", 2008, Taylor and Francis.
2. Ajayan P. M., Schadler L. S., Braun P. V., "Nanocomposite Science and Technology", 2003, Wiley.

REFERENCES:

1. Kelsall Robert W., Hamley Ian W., Geoghegan Mark, "Nanoscale Science and Technology", 2006, John Wiley & Sons, Ltd
2. Kal Ranganathan Sharma, "Nanostructuring Operations in Nanoscale Science and Engineering", 2010, McGraw-Hill Companies, Inc.

COURSE OUTCOMES

Students will be able to

1. Illustrate the basics of nano science.
2. Synthesize nano materials through various methods.
3. Characterize nano materials.
4. Explain about Semiconductors and Quantum dots.
5. Distinguish polymer based nano materials.

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

CHHE802	**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 analysis 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- Interpellet 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

Students will be able to

1. Discuss catalyst characters.
2. Explain kinetics of catalytic reactions.
3. Discuss transport of heat and mass around catalyst.
4. Illustrate fluid-fluid reaction kinetics.
5. Design and analyze heterogeneous reactors.

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

MINOR ENGINEERING ELECTIVE COURSES

CHMI601	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. 3rd ed
2. Himmelblau,D.M.,Basic Principles and Calculations in chemical Engineering. 2nd ed. 1967
3. Mayers and seider, Introduction to chemical Engineering and computer calculations, 3rd ed. 1982, Prentice Hall.
4. Asokan, K., Chemical Process Calculations, First Edn., 2007, Universities Press, Hyderabad.

COURSE OUTCOMES

Students will 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 thermo physics and chemistry.

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

CHMI602	ORGANIC & INORGANIC CHEMICAL TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Impart clear description of one latest process along with its Chemistry, Process parameters, Engineering Problems and Optimum Conditions.
- To improve knowledge of the chemical processes along with emphasis on recent technological development
- To understand unit operations involved in the physical separation of the products obtained during various unit processes.
- To study process technologies of various organic and inorganic process industries
- Appreciate the usage of other engineering principles such as Thermodynamics, Heat, mass and momentum transfer in operation and maintain the productivity.

UNIT -I

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

UNIT -II

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

UNIT-III

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

UNIT - IV

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

UNIT - V

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

TEXT BOOKS:

1. Austin.G.T., Shreve's Chemical Process Industries, Fifth Edn., 1984, McGraw Hill.

2. Gopal Rao,M., and M. Sittig., Dryden's Outlines of Chemical Technology, 2nd edition, 1979 Affiliated East West Press.

REFERENCES:

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

COURSE OUTCOMES

Students will be able to

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

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

CHMI701	**CHEMICAL ENGINEERING OPERATIONS**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

COURSE OBJECTIVES:

The principles learnt in this course are required in almost all the courses and throughout the professional career of Chemical Engineer

UNIT-I

Introduction to Unit Operations and Chemical Engineering Processes. Single Equilibrium Stage, Binary vapor–liquid systems, bubble-point, and dew-point calculations. Absorption and Stripping of dilute mixtures: Fundamentals of absorption, equilibrium curves, Operating lines from material balances, Number of equilibrium stages.

UNIT-II

Distillation of binary mixtures: Differential distillation, Flash or equilibrium distillation, Fractionating column and multistage column, design and analysis factors, degrees of freedom, specifications, reflux, reflux ratio, need for reflux,

UNIT-III

Particulate solids: Particle characterization Shape, size, particle size measurement, Particle size analysis in process equipment. Particle Size Reduction: Necessity for size reduction of solids, Mechanism for size reduction, Energy requirements for size reduction and scale-up considerations, Operational considerations, Crushing and grinding equipment: impact and roller mills, fluid energy mills, wet/dry media mills

UNIT-IV

Liquid Filtration: Filtration theory: constant pressure, constant rate, and variable pressure-variable rate filtration, Incompressible and compressible cake filtration, Continuous filtration, filter aids, Filtration equipment. Sedimentation, Classification and Centrifugal Separations: Design and scale up equations, Performance evaluation, Sedimentation equipment, classifiers, centrifugal equipment, Sieving operations, types of sieving (dry, wet, vibro), magnetic separators, and froth flotation.

UNIT-V

Drying of solids: Mechanism of drying, drying rate curves, Estimation of drying time , Drying Equipment, operation.

TEXT BOOKS:

1. Richardson, J.F., Coulson, J.M., Harker, J.H., Backhurst, J.R., Chemical engineering: Particle technology and separation processes. 2002, Butterworth-Heinemann, Woburn, MA.
2. McCabe, W., Smith, J., Harriott, P., Unit Operations of Chemical Engineering, 7 ed. 2004, McGraw- Hill Science/Engineering/Math, Boston.

REFERENCES:

1. Green, D., Perry, R., Perry's Chemical Engineers' Handbook, Eighth Edition, 8 ed. 2007, McGraw-Hill
2. Dutta, B.K., Principles of Mass Transfer and Separation Process.2007, Prentice-Hall of India Pvt. Ltd, New Delhi.

COURSE OUTCOMES

Students will be able to

1. Explain the fundamentals of absorption and operation
2. Describe distillation and design concepts.
3. State about particulates and classify size reduction equipment.
4. Describe the solid-liquid separation operations.
5. Describe drying, characteristics and operation.

Mapping with POs & PSOs

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

CHMI702	BASICS OF FLUID MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop an understanding of fluid statics and dynamics in chemical engineering
- To understand and use differential equations to determine pressure and velocity variation in fluid flows.
- To understand the concept of viscosity
- To use dimensional analysis to design physical or numerical experiments

UNIT I: Fluid statics and its applications

Unit systems-conversion of units- Dimensional analysis-Basic concepts; fluid mechanics
Hydrostatic equilibrium-application of fluid statics-manometers, continuous gravity decanter and centrifugal decanter

UNIT II: Fluid flow phenomena

Rheological properties of fluids-laminar and turbulent flow-boundary layers
Basic equations of flow- continuity equation, mechanical energy equation. Bernoulli equation and correction factors, pump work in Bernoulli equation.

UNIT III: Flow of incompressible fluids

Incompressible flow in pipes-shear stress and skin friction in pipes, friction factor, flow in noncircular channels, laminar and turbulent flow in pipes and channels, friction factor chart, friction loss from sudden contraction and expansion

UNIT IV: Flow past immersed bodies

Drag and drag coefficients, flow through beds of solids-Ergun's equation. Motion of particles through fluids-terminal velocity, Stoke's law and Newton's law. Hindered settling.

UNIT V:Transportation and metering of fluids

Pipes, fittings and valves. Pumps - power requirement, suction lift and cavitation. Classification of pumps - positive displacement and centrifugal pumps. Introduction to fans, blowers and compressors, selection criteria of pumps.
Measurement of flowing fluids-venturi meter, orifice meter, rotameter, pitot tube, magnetic flow meter.

TEXT BOOKS:

1. McCabe,W.L, Smith,J.C and P.Harriot., Unit Operations of Chemical Engineering, Seventh Edn., 2005, McGraw Hill
2. Noel De Nevers, Fluid Mechanics for Chemical Engineers, Third Edn.,2005, McGraw Hill.

REFERENCES:

1. J.M.Coulson, J.F. Richardson's, Chemical Engineering, Vol.1., VI Edition, 1999.

COURSE OUTCOMES

Students will be able to

1. Perform dimensional analysis and explain basic concepts of fluid flow.
2. Apply Bernouli principle and compute pressure drop in flow systems of different configurations
3. Explain flow characteristics of incompressible fluids.
4. Compute power requirement in fixed bed system and determine minimum fluidization velocity in fluidized bed
5. Determine and analyze the performance aspects of fluid machinery.

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

CHMI 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

Students will be able to

1. Select right type of reactor for specific type of process.
2. Interpret rate data.
3. Develop design expressions for different reactors.
4. Understand thermal characteristics of reactors.
5. Predict reactor performances and non-ideality.

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

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

COURSE OBJECTIVES:

The course will

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

UNIT - I

Value of money and equivalence - Amortization - Depreciation

UNIT - II

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

UNIT- III

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

UNIT - IV

Economics of selecting alternatives

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

UNIT - V

Economic balance

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

TEXT BOOKS:

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

REFERENCES:

1. S.N.Maheshwari, Principles of management Accounting, 2000, sultan Chand and sons , New Delhi

COURSE OUTCOMES

Students will be able to

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

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