Faculty of Engineering and Technology
Department of Chemical Engineering

B.E., Chemical Engineering
(Choice Based Credit System)

HAND BOOK
REGULATIONS AND SYLLABUS

2018 - 2019
(onwards)
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.

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<td>BRANCH VII</td>
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<td>BRANCH VIII</td>
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<td>BRANCH IX</td>
<td>Mechanical Engineering</td>
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<td>BRANCH X</td>
<td>Mechanical Engineering (Manufacturing)</td>
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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, IICChE, IEEE, SAE, ASHRAE, CSI and IWS

5.3 B.E (Honours) Degree

A student shall be eligible to get Under Graduate degree with Honours, if he/she completes an additional 20 credits. Thus the total credits are 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.

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 three 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)

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<th>Branches of Study</th>
<th>Eligible Diploma Programme (FT / PT / SW)</th>
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<td>Chemical Engineering</td>
<td>i. Petrochemical Engineering</td>
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<td>ii. Chemical Engineering</td>
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<td>iii. Environmental Engineering and Pollution Control</td>
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<td>iv. Leather Technology (Footwear)</td>
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<td>vi. Plastic Technology</td>
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<td>vii. Polymer Technology</td>
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<td>viii. Sugar Technology</td>
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<td>ix. Textile Technology</td>
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<td>xii. Petro Chemical Technology</td>
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<td>xiii. Pulp &amp; Paper Technology</td>
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<td>xiv. Petroleum Engineering</td>
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<td>2.</td>
<td>Civil Engineering</td>
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<td>ii. Civil Engineering (Architecture)</td>
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<td>iii. Environmental Engineering and Pollution Control (Full Time)</td>
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<td>iv. Architectural Assistantship</td>
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<td>v. Civil Engineering (Rural Tech.)</td>
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<td>vi. Civil and Rural Engineering</td>
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<td>vii. Agricultural Engineering</td>
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<td>Civil and Structural Engineering</td>
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<td>Computer Science and Engineering</td>
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<td>vi. Computer Networking</td>
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<td>vii. Electronics(Robotics)</td>
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<td>viii. Mechatronics Engineering</td>
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xii. Petro Chemical Technology  
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<td>vi. Instrumentation and Control Engineering</td>
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<td>x. Electronics (Robotics)</td>
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<td>xi. Mechatronics Engineering</td>
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<td>8.</td>
<td><strong>Information Technology</strong></td>
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<td>ii. Computer Technology</td>
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<td>iii. Computer Science and Engineering</td>
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<td>vii. Electronics(Robotics)</td>
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<td>9.</td>
<td><strong>Mechanical Engineering</strong></td>
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<td>iii. Mechanical Design and Drafting</td>
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<td>iv. Production Engineering</td>
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<td>xv. Refrigeration and Air Conditioning</td>
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<td>Honours Elective Courses from Same and Allied Departments of</td>
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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 |
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3. Electronics and Communication Engineering | 1. Civil Engineering  
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8. Chemical Engineering |
| 5.    | Electrical and Electronics Engineering | 1. Electrical Engineering  
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7. Information Technology |
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3. Mechanical Engineering  
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8. Chemical Engineering |
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# SEMESTER I

<table>
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<th>Category</th>
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Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming III Semester.

# SEMESTER II

<table>
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<tr>
<th>Course Code</th>
<th>Category</th>
<th>Course</th>
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<td><strong>Total Credits 20.5</strong></td>
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</table>

Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming III Semester.

<table>
<thead>
<tr>
<th>HS</th>
<th>Humanities and Social Sciences including Management courses</th>
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<tbody>
<tr>
<td>BS</td>
<td>Basic Science courses</td>
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<tr>
<td>ES</td>
<td>Engineering Science Courses</td>
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<td>CA</td>
<td>Continuous Assessment Marks</td>
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<td>FE</td>
<td>Final Exam Marks</td>
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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 eigenfrequencies, 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, CO₂), 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
(iii) E. Hecht, Optics
(iv) A. Ghatak, Optics
(v) O. Svelto, Principles of Lasers

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<tr>
<th>Course code</th>
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<tr>
<td>Category</td>
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<td>Scheme and Credits</td>
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**Unit 1: Calculus: (6 lectures)**
Evolutest 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**


Course Outcomes
The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate analysis and linear algebra. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

The students will learn:
- To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
- The fallouts of Rolle’s Theorem that is fundamental to application of analysis to Engineering problems.
- The tool of power series and Fourier series for learning advanced Engineering Mathematics.
- To deal with functions of several variables that are essential in most branches of engineering.
- The essential tool of matrices and linear algebra in a comprehensive manner.

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<th>Course Code</th>
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<tr>
<td>Category</td>
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<tr>
<td>Course Title</td>
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<td>Scheme and Credits</td>
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**Unit 1: DC Circuits (8 Hours)**

**Unit 2: AC Circuits (8 Hours)**
Representation of sinusoidal waveforms, peak and rms values, phasor representation, 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)**
Unit 4: Electrical Machines (8 Hours)

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

Course Outcomes
1. To understand and analyze basic electric and magnetic circuits.
2. To study and working principles of electrical machines and power convertors.
3. To introduce the components of low voltage electrical installations.
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<tr>
<td>Category</td>
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<td>Course title</td>
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<td>Scheme and Credits</td>
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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

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<td>Category</td>
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<td>Scheme and Credits</td>
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List of experiments/ demonstrations:
- 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.
- 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 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

• Get an exposure to common electrical components and their ratings.
• Make electrical connections by wires of appropriate ratings.
• Understand the usage of common electrical measuring instruments.
• Understand the basic characteristics of transformers and electrical machines.
• Get an exposure to the working of power electronic converters.

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<td>L T P Credits</td>
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**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];

**Customisation & 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:
5. (Corresponding set of) CAD Software Theory and User Manuals

Course Outcomes
All phases of manufacturing or construction require the conversion of new ideas and design concepts into the basic line language of graphics. Therefore, there are many areas (civil, mechanical, electrical, architectural and industrial) in which the skills of the CAD technicians play major roles in the design and development of new products or construction. Students prepare for actual work situations through practical training in a new state-of-the-art computer designed CAD laboratory using engineering software. This course is designed to address:

- to prepare you to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- to prepare you to communicate effectively
- to prepare you to use the techniques, skills, and modern engineering tools necessary for engineering practice

The student will learn:
- Introduction to engineering design and its place in society
- Exposure to the visual aspects of engineering design
- Exposure to engineering graphics standards
- Exposure to solid modelling
- Exposure to computer-aided geometric design
- Exposure to creating working drawings
- Exposure to engineering communication

II Semester

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23
### Course title
**English**

### Scheme and Credits

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#### 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:


### Course Outcomes
The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

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**Unit 1: Atomic and molecular structure (12 lectures)**
Schrodinger equation. Particle in a box solutions and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicentre orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomics. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

**Unit 2: Spectroscopic techniques and applications (8 lectures)**

**Unit 3: Intermolecular forces and potential energy surfaces & Periodic properties (8 Lectures)**
Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H₃, H₂F and HCN and trajectories on these surfaces. Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries

**Unit 4: Use of free energy in chemical equilibria (6 lectures)**

**Unit 5: Stereochemistry Organic reactions (8 lectures)**
Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical
activity, absolute configurations and conformational analysis. Isomerism in
transitional metal compounds.
Introduction to reactions involving substitution, addition, elimination, oxidation,
reduction, cyclization and ring openings. Synthesis of a commonly used drug
molecule.

Suggested Text Books
i. University chemistry, by B. H. Mahan
iii. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
iv. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S.
Krishnan
v. Physical Chemistry, by P. W. Atkins

Course Outcomes
The concepts developed in this course will aid in quantification of several concepts in
chemistry that have been introduced at the 10+2 levels in schools. Technology is being
increasingly based on the electronic, atomic and molecular level modifications.

Quantum theory is more than 100 years old and to understand phenomena at nanometer
levels, one has to base the description of all chemical processes at molecular levels. The
course will enable the student to:
• Analyse microscopic chemistry in terms of atomic and molecular orbitals
and intermolecular forces.
• Rationalise bulk properties and processes using thermodynamic considerations.
• Distinguish the ranges of the electromagnetic spectrum used for exciting
different molecular energy levels in various spectroscopic techniques
• Rationalise periodic properties such as ionization potential, electronegativity,
oxidation states and electronegativity.
• List major chemical reactions that are used in the synthesis of molecules.

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**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/Pseudocode with examples. From algorithms to programs; source code,
variables (with data types) variables and memorylocations, 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

Suggested Reference Books
Course Outcomes

The student will learn

- To formulate simple algorithms for arithmetic and logical problems.
- To translate the algorithms to programs (in C language).
- To test and execute the programs and correct syntax and logical errors.
- To implement conditional branching, iteration and recursion.
- To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
- To use arrays, pointers and structures to formulate algorithms and programs.
- To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
- To apply programming to solve simple numerical method problems, namely root finding of function, differentiation of function and simple integration.

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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**


**Course Outcomes**

The objective of this course is to familiarize the prospective engineers with techniques in multivariate integration, ordinary and partial differential equations and complex variables. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

The students will learn:

- The mathematical tools needed in evaluating multiple integrals and their usage.
- The effective mathematical tools for the solutions of differential equations that model physical processes.
- The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems.
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<td>Category</td>
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**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:**

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

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<tr>
<td>Category</td>
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<tr>
<td>Course title</td>
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**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

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<td>Category</td>
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[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:
**Lab 1:** 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

➢ To formulate the algorithms for simple problems
➢ To translate given algorithms to a working and correct program
➢ To be able to correct syntax errors as reported by the compilers
➢ To be able to identify and correct logical errors encountered at runtime
➢ To be able to write iterative as well as recursive programs
➢ To be able to represent data in arrays, strings and structures and manipulate them through a program
➢ To be able to declare pointers of different types and use them in defining self-referential structures.
➢ To be able to create, read and write to and from simple text files.

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<tr>
<td>Category</td>
<td>Engineering Science Courses</td>
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<tr>
<td>Course title</td>
<td>Workshop / Manufacturing Practices</td>
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Lectures & Videos: (hours)
1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing
2. methods (3 lectures)
3. CNC machining, Additive manufacturing (1 lecture)
4. Fitting operations & power tools (1 lecture)
5. Electrical & Electronics (1 lecture)
6. Carpentry (1 lecture)
7. Plastic moulding, glass cutting (1 lecture)
8. Metal casting (1 lecture)
9. Welding (arc welding & gas welding), brazing (1 lecture)

Suggested Text/Reference Books:


Course Outcomes
Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

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)
Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Laboratory Outcomes
- Upon completion of this laboratory course, students will be able to fabricate components with their own hands.
- They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
- By assembling different components, they will be able to produce small devices of their interest.

******
## FACULTY OF ENGINEERING AND TECHNOLOGY
### DEPARTMENT OF CHEMICAL ENGINEERING
#### Curriculum 2019

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

### SEMESTER I

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**Total Credits**: 17.5

**Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming III Semester.**

### SEMESTER II

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**Total Credits**: 20.5
### DEPARTMENT OF CHEMICAL ENGINEERING

#### THIRD SEMESTER

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*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.

#### FOURTH SEMESTER

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**Total Credits 21.5**

Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming V Semester.
## DEPARTMENT OF CHEMICAL ENGINEERING

### FIFTH SEMESTER

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Total Credits 26.5

### SIXTH SEMESTER

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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

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**Four weeks during the summer vacation at the end of VI Semester**

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**Total Credits** 19.5

## EIGHTH SEMESTER

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**Total Credits** 12

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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

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<td>CHHE801</td>
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## MINOR ENGINEERING COURSES

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<td>CHMI701</td>
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<td>Basics of Fluid Mechanics</td>
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<td>CHMI801</td>
<td>Basic Principles of Chemical Reaction Engineering</td>
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DEPARTMENT OF CHEMICAL ENGINEERING

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

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

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

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

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

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

5. The ability to cater the needs of Chemical industry, research organizations and academic institutes
B.E. (Chemical Engineering)

PROGRAMME OUTCOMES (POs)

With the successful completion of the program, the students are expected to demonstrate the following technical skillsets

PO 1: To apply the knowledge of basic mathematics and science in solving Engineering problems
PO 2: To apply the principles of Engineering and Technology
PO 3: To design and conduct experiments with skills to analyze and interpret data
PO 4: To design a system, component or process to cater the need of industry
PO 5: To identify and synthesis innovative sustainable solutions to real-time engineering problems, understanding the global, economy, environmental and societal context and ethical nature
PO 6: To use techniques, skills, and tools effectively for modern engineering practice.
PO 7: To set up their own ventures and generate employment
PO 8: To recognise the need of advanced degrees for career development
PO 9: To understand the professional, social and ethical responsibility
PO 10: To effectively function in a multi-disciplinary diverse field of engineering
PO 11: To display leadership qualities with respect to the global need
PO 12: To apply critical and lateral thinking in solving problems

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THIRD SEMESTER

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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

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

TEXT BOOKS:

REFERENCES:

COURSE OUTCOMES:
1. Students acquire basic understanding of the most common partial differential equations
2. Fourier series and Fourier transform
3. To learn some methods of solving them.
4. The students should be able to solve some boundary value problems  
5. Able to solve Z-transform

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**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.

UNIT V

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:
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)

REFERENCES:
2. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
5. Down to Earth, Centre for Science and Environment (R)
7. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
16. Survey of the Environment, The Hindu (M)

COURSE OUTCOMES:
At the end students can able to
1. Understand the importance of environment.
2. Analyze the importance of environment in engineering.
3. Apply their own ideas and demonstrate advanced technologies that will be useful to protect environment.
4. Employ awareness among the society about environmental problems and natural disasters.
5. Practice according to the present and future environmental issues.

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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
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

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.

UNIT V: Friction and elements of rigid body dynamics
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:

REFERENCES:

COURSE OUTCOMES:
Students can able to
1. Explain the forces and its related laws of mechanics in static
2. Explain the forces and its related laws of mechanics in dynamic conditions.
3. Analyse the forces and its motions on particles, rigid bodies and structures.
4. Solve the moment of inertia of any sections
5. Masses for the structural members.

Mapping with Programme Outcomes

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CHES304 CHEMISTRY FOR CHEMICAL ENGINEERS

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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.
UNIT - II

UNIT - III

UNIT – IV

UNIT-V

TEXT BOOKS:
1. Advance organic Chemistry – B.S. Bahl and Arun Bahl
3. Principles of Physical Chemistry - B. R. Puri, L.R. Sharma, M.S. Pathania

REFERENCES:

COURSE OUTCOMES:
1. Understand the basic principles of chemistry applicable to chemical engineering.
2. Understand the basics of organic compounds
3. Familiarize the basic reaction concepts.
4. Familiarize the basic terms of reaction engineering.
5. Understand electrochemistry
## 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:

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 familiar with
1. Basics of vector and tensor analysis
2. Be able to solve transport problems using shell balances
3. Formulate and solve one-dimensional transport problems by using the conservation equations
4. Formulate simple multi-dimensional transport problems
5. Formulate unsteady state heat and mass transfer basic problems

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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
TEXT BOOKS:

REFERENCES:

COURSE OUTCOMES:
After completing the course, the students will
1. Develop mastery over process calculation relevant to chemical engineering processes
2. Know the fundamentals of physics and chemistry
3. Be familiar with equation of state and properties of gases and liquids
4. Analyze the problem involving stoichiometry, energy and mass balances
5. Be able to solve thermo physics and thermo chemistry problem

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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, (i) 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.
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. Properties and characteristics of solvents and mixtures
2. Analyzes a list of compounds and determines their reactivity
3. Determine the physical properties of substances
4. Analysis of industrial chemicals
5. Quality check for the final product to meet customer demands

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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. At the end of this practical course, the student would have a thorough understanding on the estimation and analysis of chemical compounds.
2. Demonstrate 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

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Mapping with Programme Outcomes
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

UNIT-V
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:

REFERENCES:

COURSE OUTCOMES:
1. Helps the students to have a clear perception of the power of numerical techniques and ideas.
2. Demonstrate the applications of these techniques to problems drawn from industry, management and other engineering fields.
3. Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
4. Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
5. Implement numerical methods in Matlab, Write efficient, well-documented Matlab code and present numerical results in an informative way.

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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

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:
REFERENCES:
4. Materials Science and Engineering, Raghavan, V, PHI
5. Material Science & Engineering, Upadhyaya, Anshan Publications

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 Programme Outcomes

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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:

REFERENCES:
1. O. Wilkes, Fluid Mechanics for Chemical Engineers, 2005, Prentice Hall of India
7. Fluid Mechanics, Sadhu Singh, Khanna Book Publishing
8. Introduction to Fluid Mechanics and Fluid Machines, Som & Biswas, TMH

COURSE OUTCOMES:
Students should be able to
1. Understand the fundamentals of fluid mechanics, concepts of mass and momentum conservation
2. Find velocity profiles by simplification of equations of motion in simple 1-D flows
3. Calculate boundary layer thicknesses, friction factor, pressure drop, power requirements in single phase flow in pipes
4. Calculate two phase gas/liquid pressure drop
5. Calculate power requirements, NPSH requirements of pumps

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**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-compression cycle; Absorption refrigeration; Heat pump, Liquefaction processes.
TEXT BOOKS

REFERENCES
2. Chemical Engineering Thermodynamics, YVC Rao, University Press

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

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CHPC405 HEAT TRANSFER

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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 Radiative 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:

REFERENCES:

COURSE OUTCOMES
Students will be able to
1. Calculate heat duty/outlet temperatures/pressure drops/area required for various equipment
2. Ability to understand and solve conduction, convection and radiation problems
3. Calculate temperature profiles in a slab, flat and composite wall at steady state and the heat transfer coefficients in various equipments
4. Identify and select type of shell and tube exchanger based on TEMA classification
5. Design double pipe heat exchanger, Shell and tube heat exchanger, finned tube and other compact heat exchangers

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**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**

**REFERENCES:**

**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
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. Bernoullis 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.
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. Stefan-Boltzmann Apparatus
7. Parallel And Counter Flow Heat Exchanger
8. Natural Convection
9. Thermal Conductivity of Insulating Material
10. Emissivity Measurement
11. Drop Wise and Film Wise Condensation
12. Finned Tube Heat Exchanger

COURSE OUTCOMES:
1. Students will learn about fundamentals of heat transfer mechanisms in fluids and solids
2. Students will learn about the applications in various heat transfer equipment in process industries.
3. Student would be able to calculate heat transfer by conduction, different types of convection using classical models for these phenomena.
4. To develop a sound working knowledge on different types of heat transfer equipments.
5. Students would be able to determine important data for the design and operation of the process equipments.

Mapping with Programme Outcomes

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FIFTH SEMESTER

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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

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

REFERENCES:

COURSE OUTCOMES
Students will be able to
1. Deepen the Engineering knowledge
2. Design chemical reactors involving heat effects optimally using minimum amount of data
3. Fix some problems related to operability and productivity
4. Operate reactors in a safe manner for single and multiple reactions
5. Analyse the non-ideality in the reactors

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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

UNIT-IV
Design of Cooling Towers, Membrane processes.

UNIT-V
Ion-Exchange; Ultrafiltration and Osmosis, Reverse Osmosis.

TEXT BOOKS
REFERENCES:

COURSE OUTCOMES
Students will be able to
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

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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

UNIT-IV
Centrifugal separation, design of cyclones and hydrocyclones. Size reduction, milling, laws of comminution, classification of particles. Size enlargement; Nucleation and growth of particles.

UNIT-V

TEXT BOOKS

REFERENCES:
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

COURSE OUTCOMES:
Students will be able to
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
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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

REFERENCES:
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

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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. Fluidized bed

COURSE OUTCOMES:
1. To develop a sound working knowledge on different types of crushing equipments
2. Separation characteristics of different mechanical separators
3. Solid solid separations equipments
4. Fluid solid separation equipments
5. Better understanding of industrial operations by performing the experiments

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**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:**

**REFERENCES:**
COURSE OUTCOMES:
1. Students will learn about fundamentals of mass transfer operations.
2. To develop a sound working knowledge and able to operate on different types of mass transfer equipments.
3. Students would be able to determine important data for the design and operation of the process equipments.
4. Provide proper understanding of unit operations.
5. To choose the separation operation which will be economical for the process.

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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

REFERENCE

Course Outcomes:
1. To design and conduct experiments with skills to analyze and interpret data.
2. To apply the principles of Engineering and Technology
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 calculate the azeotropic conditions

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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

TEXT BOOKS:

REFERENCES:
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.

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CHPC602 | PROCESS INSTRUMENTATION DYNAMICS & CONTROL | L | T | P | C
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**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**
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:

REFERENCES:
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

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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

**COURSE OUTCOMES:**
1. Students would get a sound working knowledge on different types of reactors.
2. The students should be able to explain variations (if any) between observed and expected results based on technical knowledge.
3. Develop skills to choose the right reactor among single, multiple, recycle reactor, etc. schemes.
4. To design chemical reactors with associated cooling/heating equipment.
5. Understanding the critical thinking in solving problems in various types of reactors.

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**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 1 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

REFERENCES:

COURSE OUTCOMES:
1. Students would have knowledge on the development and use of right type of control dynamics for process control under different operative conditions.
2. The student will be able to calculate the output of various measuring schemes
3. The student will be able to select the appropriate type of instrument for any application
4. The student will be able to prepare a basic control scheme for process units
5. The student will be able to write programs for a PLC

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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

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

UNIT – IV

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:

REFERENCES:

COURSE OUTCOMES:
Upon completion of the course, the student should be able to
1. Apply ethics in society
2. Discuss the ethical issues related to engineering
3. Realize the responsibilities and rights in the society.
4. Know the global issues
5. Gain knowledge on safety

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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:

REFERENCES:
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

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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. Knowledge of basics of process equipment design and parameters of equipment design
2. Ability to design internal pressure vessels and external pressure vessels
3. Ability to design special vessels and various parts of vessels
4. Knowledge of equipment fabrication and testing methods
5. Able to design various heat and mass transfer equipments

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COURSE OBJECTIVES
- To work on a technical topic related to chemical engineering and acquire the ability of written and oral presentation
- To prepare and present technical reports using power point presentation
- To acquire the ability of writing technical papers for conferences and journals

METHOD OF EVALUATION
- The student will work for two periods per week guided by student counsellor
- They will be asked to present a seminar of any technical topic of student choice related to chemical engineering and to engage in discussion with audience. They will defend their presentation
- A brief copy of their presentation also should be submitted. Evaluation will be done by the student counselor based on the technical presentation and the report and also on the interaction shown during the seminar.
- Students will as asked to go for a industrial training during their vacation for a period of one week

COURSE OUTCOMES:
1. The students will get trained to face the audience and to interact with them
2. The students will get exposed to real time operation of the processes in industry

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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. On completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.
2. Carrying out any experimental works on chosen topics.
3. Understand the modeling, analysis, design and control aspects.

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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

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

TEXT BOOKS:

REFERENCES:
COURSE OUTCOMES:
After the completion of this course, the students will be able to
1. Analyze the Problem
2. Design/development of models for chemical processes.
3. Apply the techniques for modern practices in process control
4. Gain knowledge for applying mathematics in process control
5. Understand the basic principles of simulation

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CHPESCN POLYMER ENGINEERING

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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

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:

REFERENCES:

COURSE OUTCOMES:
Upon completion of this course, the students will
1. Develop knowledge in polymerization techniques
2. Be aware about chemical reaction of polymers
3. Understand the influence of polymer structure in its properties
4. Acquire knowledge in handling rheological instruments
5. Attain the knowledge in flow behaviour of polymers

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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

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:

REFERENCES:
2. T.K.Ghose (Ed)., Process Computations in Biotechnology, 1994, Tata-McGraw Hill,

COURSE OUTCOMES:
After the completion of this course, the students able to
1. Understand the classification of microorganisms
2. Gain knowledge on industrial fermenters and its control
3. Design the bioreactors
4. Gain knowledge on enzyme engineering
5. To shine as a successful bioprocess engineer
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

TEXT BOOKS:

REFERENCES:

COURSE OUTCOMES:
At the end of the course, students are expected to have knowledge in
1. Basics of electrochemical science and reactor
2. Analysis of electrochemical device operation
3. Basic principles of electrochemical reactor
4. Quantitative characterization of kinetics of electrochemical reactor
5. Comparative evaluation of different electrochemical reactor configurations

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Mapping with Programme Outcomes

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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

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

TEXT BOOKS:

REFERENCES:

COURSE OUTCOMES:
1. Ability to understand nuclear reaction process
2. Able to gain knowledge on nuclear fuels.
3. Gaining knowledge in nuclear fuel reprocessing technology
4. Understanding of nuclear power plants
5. Acquiring knowledge in safety and disposal of nuclear fuels

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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

UNIT II
Methods of Synthesis of Nanomaterials. 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,

REFERENCES:

COURSE OUTCOMES:
On completion of course the students are expected to be
1. Familiar with the fundamentals of Nanotechnology
2. Familiar with the ability to manipulate matter at molecular scale, customizing it according to our specific needs
3. Familiar with its applications in medicine, environment and water purification
4. Familiar with its applications in energy, agriculture and material engineering
5. Familiar with the characterization of nano particles
### Mapping with Programme Outcomes

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### 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


### 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


### 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:

REFERENCES:
3. Industrial disputes act-1947
4. Chakraborty S K- Managerial Development & Appraisal –Macmillan India
5. Strauss & Sayles – Personnel Management

COURSE OUTCOMES:
1. To assess their own entrepreneurial and enterprising potential
2. To develop an understanding of the general role of Small Business Enterprises
3. To gain knowledge on material and scientific management
4. Know the difference between entrepreneurial and managerial type jobs
5. Understanding of individual personalities and interpersonal skills needed for effective communications

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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

UNIT – III: Meteorology and plume dispersion

UNIT – IV: Air pollution control methods

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:

REFERENCES:
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 completion of this course the student would be able to
1. Know the sources of air pollution
2. Understand the concepts in air quality monitoring
3. Understand the need to control air pollutants
4. Measure and analyze the air pollutants concentration in the atmosphere.
5. Apply different methods of pollution control and reduce the level of pollutant intensity in atmosphere.
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
Terminology, 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.

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COURSE OUTCOMES:
Upon completion of this course, the students would have knowledge on
1. Physical / chemical / biological characteristics of waste water
2. Various treatment methods of waste water
3. The evaluation technique for sewage
4. Reactors used in wastewater treatment
5. Advanced techniques employed in wastewater treatment

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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

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:

REFERENCES:

COURSE OUTCOMES:
After learning the course the students should be able to:
1. Understand various environmental laws and realize the importance of biosphere
2. Understand various types of pollution abatement techniques
3. Understand the quality and characteristics of wastewater
4. Determine various water/air quality parameters
5. Gain knowledge on various methods of solid waste management.

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Mapping with Programme Outcomes
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

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:

REFERENCES:

COURSE OUTCOMES:
Upon completion of this course, the students will have the
1. Knowledge on fluidization phenomenon,
2. Behavior of fluidized beds and
3. Industrial applications of fluidization
4. Understanding on heat and mass transfer in fluidized bed reactor
5. Idea of different types of fluidization
### 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

### UNIT IV
UNIT V

TEXT BOOKS:

REFERENCES:

COURSE OUTCOMES:
After completion of this course the student should be:
1. Familiar with the differential equations for flow phenomena
2. Able to apply numerical methods for the solution
3. Able to use and develop flow simulation software for the most important classes of flows in engineering and science.
4. Able to critically analyze different mathematical models and computational methods for flow simulations

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Mapping with Programme Outcomes

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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:**

**REFERENCES:**

**COURSE OUTCOMES:**
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

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**COURSE OBJECTIVES:**
- To teach the students about the theories of origin, formation of crude oil.
- To teach the students about the various petroleum products, evaluation procedures and its properties.
- To provide basic knowledge about the crude distillation techniques.
- To illustrate the concepts of various cracking and reforming Techniques.
- To illustrate the various petroleum products purification processes.

**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 Terephthalate (DMT), Ethylene Glycol, Synthetic Glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol and Acetone, Methanol, Pentaeerythritol and Production of Carbon Black. Acrylic Acid, Oxo Alcohols, Acrylates, Polyols, Propylene Glycol, Ethylene Oxide/Mono Ethylene Glycol.

TEXT BOOKS:

REFERENCES:

COURSE OUTCOMES:
1. Understand the basics of petroleum chemistry
2. Gain knowledge on crude distillation processes.
3. Develop suitable techniques to convert heavy distillates to lighter distillates of higher utility.
4. Understand the production methods for petroleum products
5. Understand the production methods for specialty petroleum products

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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 Heterogeneous 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 catalytic 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

TEXT BOOKS:
1. Dawe R.A.,”Modern Petroleum Technology part-I”, by Institute of petroleum(IP), John wiley

REFERENCES:
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 various refining operations

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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

UNIT IV
Azeotropic distillation and extractive distillation: separation of homogeneous azeotropes, separation of heterogeneous azeotropes, selection of addition agents-design of azeotropic
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:

REFERENCES:

COURSE OUTCOMES:
1. Understanding of the Basic Principles of Distillation Process
2. Distinguish between Different types of Distillation Processes.
4. Understanding the different types of Distillation Processes
5. And the concepts of various types of Distillation Processes and Design

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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 technics.
- 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:

REFERENCES:

COURSE OUTCOMES:
At the conclusion of this subject students will be able to:
1. Familiarize main membrane processes, principles, separation mechanisms, and applications
2. Appreciate the selection criteria for different membrane processes
3. Describe the principle of the most common membrane applications
4. Gain knowledge on different modules
5. Understand the application of membrane in various fields

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COURSE OBJECTIVES:

- To familiarize the students with 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 behaviour in food.

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

UNIT III

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

TEXT BOOKS:

REFERENCES:
COURSE OUTCOMES:
At the end of this course, the students would know about the
1. Principles of food science
2. Food safety and Food preservation techniques
3. 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

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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

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:
2. AVN Swamy, Industrial Pollution Control Engineering, 2006, Galgotia Publication,

REFERENCES:
1. Environmental Biotechnology - Allan Stagg.

COURSE OUTCOMES:
After the completion of this course, the students will be able to
1. Design, perform experiments, analyze and interpret data for investigating complex problems in Biotechnology, Engineering and related fields.
2. Decide and apply appropriate tools and techniques in biotechnological manipulation.
3. Justify societal, health, safety and legal issues
4. Understand his responsibilities in biotechnological engineering practices
5. Understand the need and impact of biotechnological solutions on environment and societal context keeping in view need for sustainable solution.

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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

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

TEXT BOOKS:

REFERENCES:

COURSE OUTCOMES:
At the end of this course, the students are expected to
1. Know the importance of separation process.
2. Identify basic principles of separation mechanism.
3. Apply principles of this course to new separation processes.
4. Identify the recent advances in separation techniques
5. Gain knowledge on various separation process and its application
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, 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:
REFERENCES:
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. Acquire knowledge about the manufacturing techniques of fertilizers and design the equipment in fertilizer industry.
2. Attain knowledge in the use of reactions and unit operations steps in manufacturing of various fertilizers
3. Identify engineering problems in fertilizer manufacturing
4. Select appropriate methods for the synthesis of fertilizer
5. Know the different types of fertilizer and their applications

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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

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

TEXTBOOKS:

REFERENCES:
5. Trivedi, R.K., Pollution Management in Industries, Environmental Publication, Karad, India

COURSE OUTCOMES:
At the end of this course, the students would
1. Understand the basic concepts of pulp and paper technology to produce paper.
2. Apply reactions and unit operations steps to manufacture pulp.
3. Understand the operation of equipments employed in pulp and paper industry
4. Apply waste disposal techniques in pulp and paper industry.
5. Perform various chemical tests to monitor quality of raw material, output quality and influent/effluent of pulp and paper industry

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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

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

UNIT IV : TQM tools & techniques II

UNIT V : Quality systems

TEXT BOOKS:

REFERENCES:
COURSE OUTCOMES:
The students would be able to
1. Evaluate the principles of quality management
2. Apply the tools and techniques of quality management to manufacturing and services processes
3. Select and apply appropriate techniques in identifying customer needs
4. Study the quality impact that will be used as inputs in TQM methodologies
5. Critically analyse the strategic issues in quality management, including current issues and developments, and to devise and evaluate quality implementation plans

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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:

REFERENCES:

COURSE OUTCOMES:
Upon completion of the subject, students will be able to
1. Understand the mathematical tools that are needed to solve optimisation problems.
2. Formulate a managerial decision problem into a mathematical model;
3. Understand Operations Research models and apply them to real-life problems;
4. Critically analyse and optimize Chemical Engineering Processes
5. Develop a report that describes the model and solving technique, analyse the results and propose recommendations understandable to the decision-making processes in Management Engineering.

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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

TEXT BOOKS:

REFERENCES:

COURSE OUTCOMES:
On completion of course the students are expected to
1. Critically analyze the optimization problem
2. Gain knowledge on basic concepts of optimization
3. Use principles of engineering to develop equality
4. Use principles of engineering to develop inequality constraints
5. Know about applications of optimization for optimizing important industrial processes

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OPEN ELECTIVES

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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

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

TEXT BOOKS:

REFERENCES:

COURSE OUTCOMES:
Student should understand
1. Various types of hazards,
2. Industrial safety and health
3. Engineering Knowledge

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<tr>
<th>CHOESCN</th>
<th>SOLID WASTE MANAGEMENT</th>
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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
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 biodegradation; Thermal processing options – case studies under Indian conditions.

UNIT-V

TEXT BOOKS:

REFERENCES:

COURSE OUTCOMES:
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
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
TEXT BOOKS:

REFERENCES:

COURSE OUTCOMES:
Upon completion of this course, the students would have to
1. Learn the basic concepts relating to the project engineering and industrial safety
2. Develop knowledge to design and operate various heat exchangers, pumps, compressors and turbines
3. Understand various industrial hazards, use of personal protective equipments, evaluate and analyze hazards.

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<th>CHEESC/N</th>
<th>MATERIALS OF CONSTRUCTION IN THE PROCESS INDUSTRIES</th>
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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

UNIT II

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:

REFERENCES:
1. V. Raghavan, Materials Science and Engineering, 2004, Prentice Hall of India..

COURSE OUTCOMES:
On completion of course the students are expected to
1. Select the materials based on its properties for construction
2. Critically analyze the usage of metals in process industries
3. Apply the non metals in industries for construction

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<tr>
<th>CHOESCN</th>
<th>FUEL TECHNOLOGY</th>
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COURSE OBJECTIVES:
- To know about the history of Fuels and its Types
- 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
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:

REFERENCES:

COURSE OUTCOMES:
1. Provides an idea about the Fuels and its Types
2. Knowledge about Mechanism of corrosion
3. Knowledge on kinetics of Combustion

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<th>CHOESCN</th>
<th>BIOCONVERSION AND PROCESSING OF WASTE</th>
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COURSE OBJECTIVES:
- To give an idea about different biomass and other solid waste materials as energy source and their processing and utilization for recovery of energy and other valuable products.
- A comprehensive knowledge of how wastes are utilized for recovery of value would be immensely useful for the students from all fields.

UNIT-I
Biomass 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 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:

REFERENCE S

COURSE OUTCOMES:
1. Understand the various types of biomass
2. Understand about solid wastes and their recovery value
3. Environment and sustainability
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

UNIT II
Nuclear wastes and e-waste

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

TEXT BOOKS:

REFERENCES:
6. Anjaneyulu, Hazardous waste management

**COURSE OUTCOMES:**
1. Understand the characteristics of different types of hazardous wastes and its treatment technologies.
2. Define and explain important concepts in the field of waste management
3. Suggest suitable technical solutions for treatment of municipal and industrial waste
4. Understand the role legislation and policy drivers play in stakeholders' response to the waste
5. apply the basic scientific principles for solving practical waste management challenges

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**COURSE OBJECTIVES:**
- To explain concept of various forms of renewable energy
- To outline division aspects and utilization of renewable energy sources for both domestics and industrial applications
- To analysis the environmental and cost economics of using renewable energy sources compared to fossil fuels.

**UNIT I**
**Introduction to energy**

**UNIT II**
**Solar energy**
UNIT III
Wind energy

UNIT IV
Bio-energy

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:

REFERENCES:

COURSE OUTCOMES:
1. Understanding of commercial energy and renewable energy sources
2. Knowledge in working principle of various energy systems
3. Capability to do basic design of renewable energy systems
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:

REFERENCES:

COURSE OUTCOMES:
1. The ability to understand the information known about familiar living systems.
2. The ability to anticipate the properties of an unfamiliar group of living things from knowledge about a familiar group.
3. The ability to demonstrate the relevance of engineering to biological systems.
4. The knowledge about the biological responses and it is scaling with respect to scientific principles that cannot be related back.
5. The knowledge of biological principles and generalizations that can lead to useful products and processes

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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

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:

REFERENCES:

COURSE OUTCOMES:
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
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

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

TEXT BOOKS:
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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

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 multicomponent phase equilibrium, VLE/SLE/LLE/VLLE, Chemical Equilibrium and Combined phase and reaction equilibria.

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COURSE OBJECTIVES:
- To impart advanced knowledge on the concepts of chemical process control
- To give an idea on indepth 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

TEXT BOOK:

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<th>CHHE702</th>
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COURSE OBJECTIVES:
- To learn the fluidization phenomena, industrial applications of fluidized beds and
- To acquire knowledge on their operational and design aspects.

Unit - I

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

Unit - IV

Unit - V

TEXT BOOKS:

| CHHE801 | APPLICATION OF NANOTECHNOLOGY IN CHEMICAL ENGINEERING |  |
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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

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.

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**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**

**Unit - II**
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:


REFERENCES:

MINOR ENGINEERING ELECTIVE COURSES

CHMI601  BASIC PRINCIPLES OF CHEMICAL ENGINEERING  

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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


UNIT – II: Humidity and saturation


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 SO₂ to SO₃.

UNIT – V: Thermo Physics and Thermo Chemistry


TEXT BOOKS:

REFERENCES:
2. Himmelblau,D.M.,Basic Principles and Calculations in chemical Engineering. 2nd ed. 1967

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<tr>
<th>CHMI602</th>
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**COURSE OBJECTIVES:**
- To study process technologies of various inorganic and organic process industries
- The purpose of the subject is to improve knowledge of the chemical processes along with emphasis on recent technological development
- Unit operations involve the physical separation of the products obtained during various unit processes.
- To study process technologies of various organic and inorganic process industries

**UNIT - I**

**UNIT - II**

**UNIT - III**

**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 formaldehyde; polypropylene and silicone. Elastomers, Natural and Synthetic fibers, Cellulose acetate, viscose rayon, Nylon, polyester.

**TEXT BOOKS:**

**REFERENCES:**
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:

REFERENCES:
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:

REFERENCES:
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.

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:

REFERENCE BOOKS:
COURSE OBJECTIVES:
- To teach principles of cost estimation, feasibility, management, organization and quality control that will enable the students to perform as efficient managers.

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:

REFERENCES:
1. S.N.Maheshwari, Principles of management Accounting, 2000, sultan Chand and sons, New Delhi