ANNAMALAI UNIVERSITY

FACULTY OF ENGINEERING AND TECHNOLOGY

M.E. / M. Tech (Two-Year Full Time & Three-year Part Time) DEGREE

PROGRAMME (CBCS)

REGULATIONS -2019

1. Conditions for Admission
Candidates for admission to the first year of the four-semester M.E / M.Tech Degree programme in Engineering shall be required to have passed B.E / B.Tech degree of Annamalai University or any other authority accepted by the syndicate of this University as equivalent thereto. They shall satisfy the conditions regarding qualifying marks and physical fitness as may be prescribed by the Syndicate of the Annamalai University from time to time. The admission for M.E Part Time programme is restricted to those working or residing within a radius of 90 km from Annamalainagar. The application should be sent through their employers.

2. Branches of Study in M.E / M.Tech
The Branch and Eligibility criteria of programmes are given in Annexure I

3. Courses of study
The courses of study along with the respective syllabi and the scheme of Examinations for each of the M.E / M. Tech programmes offered by the different Departments of study in the Faculty of Engineering and Technology are given separately.

4. Choice Based Credit System (CBCS)
The curriculum includes three components namely Program Core, Program Electives and Open Electives, Mandatory Learning Courses and Audit Courses in addition to Thesis. Each semester curriculum shall normally have a blend of theory and practical courses.

5. Assignment of Credits for Courses
Each course is normally assigned one credit per hour of lecture / tutorial per week and 0.5 credit for one hour of laboratory or project or industrial training or seminar per week. The total credits for the programme will be 68.

6. Duration of the programme
A student of M.E / M.Tech programme is normally expected to complete in four semesters for full-time / six semesters for part-time but in any case not more than four years for full-time / six years for part-time from the date of admission.

7. Registration for courses
A newly admitted student will automatically be registered for all the courses prescribed for the first semester, without any option. Every other student shall submit a completed registration form indicating the list of courses intended to be credited during the next semester. This registration will be done a week before the last working day of the current semester. Late registration with the approval of the Dean on the recommendation of the Head of the Department along with a late fee will be done up to
the last working day. Registration for the Thesis Phase - I and Phase-II shall be done at the appropriate semesters.

8. Electives
8.1 Program Electives
The student has to select two electives in first semester, another two electives in the second semester and one more in the third semester from the list of Program Electives.

8.2 Open Electives
The student has to select two electives in third semester from the list of Open Electives offered by the Department and / or other departments in the Faculty of Engineering and Technology.

8.3 MOOC (SWAYAM) Courses
Further, the student can be permitted to earn 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 open elective courses. Thus the credit earned through MOOC courses can be transferred and considered for awarding Degree to the student concerned.

8.4 Value added courses (Inter Faculty Electives)
Of the two open elective courses, a student must study one value added course that is offered by other Faculties in our University either in second or third semester of the M.E programme.

9. Industrial Project
A student may be allowed to take up the one program elective and two open elective courses of third semester (Full Time program) in the first and second semester, to enable him/her to carry out Project Phase-I and Phase-II in an industry during the entire second year of study. The condition is that the student must register those courses in the first 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.

10. Assessment
10.1 Theory Courses
The break-up of continuous assessment and examination marks for theory courses is as follows:

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Marks</th>
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<tr>
<td>First assessment (Mid-Semester Test-I)</td>
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<tr>
<td>Second assessment (Mid-Semester Test-II)</td>
<td>10 marks</td>
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<td>Third Assessment</td>
<td>5 marks</td>
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<td>End Semester Examination</td>
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10.2 Practical Courses
The break-up of continuous assessment and examination marks for Practical courses is as follows:

<table>
<thead>
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<th>Assessment</th>
<th>Marks</th>
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</thead>
<tbody>
<tr>
<td>First assessment (Test-I)</td>
<td>15 marks</td>
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<tr>
<td>Second assessment (Test-II)</td>
<td>15 marks</td>
</tr>
<tr>
<td>Maintenance of record book</td>
<td>10 marks</td>
</tr>
<tr>
<td>End Semester Examination</td>
<td>60 marks</td>
</tr>
</tbody>
</table>
10.3 Thesis work
The thesis Phase I will be assessed for 40 marks by a committee consisting of the Head of the Department, the guide and a minimum of two members nominated by the Head of the Department. The Head of the Department will be the chairman. The number of reviews must be a minimum of three per semester. 60 marks are allotted for the thesis work and viva voce examination at the end of the third semester. The same procedure will be adopted for thesis Phase II in the fourth semester.

10.4 Seminar / Industrial Training
The continuous assessment marks for the seminar / industrial training will be 40 and to be assessed by a seminar committee consisting of the Seminar Coordinator and a minimum of two members nominated by the Head of the Department. The continuous assessment marks will be awarded at the end of the seminar session. 60 marks are allotted for the seminar / industrial training and viva voce examination conducted based on the seminar / industrial training report at the end of the semester.

11. Student Counselors (Mentors)
To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a member of the faculty who shall function as student counselor (mentor) for those students throughout their period of study. Such student counselors shall advise the students in selecting open elective courses from, give preliminary approval for the courses to be taken by the students during each semester, and obtain the final approval of the Head of the Department monitor their progress in SWAYAM courses / open elective courses.

12. Class Committee
For each of the semesters of M.E / M.Tech programmes, separate class committees will be constituted by the respective Head of the Departments. The composition of the class committees from first to fourth semesters for Full time and first to sixth semesters for Part-time will be as follows:

- Teachers of the individual courses.
- A Thesis coordinator (for Thesis Phase I and II) shall be appointed by the Head of the Department from among the Thesis supervisors.
- A thesis review committee chairman shall be appointed by the Head of the Department
- 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.
- All counselors of the class and the Head of the Department (if not already a member) or any staff member nominated by the Head of the Department may opt to be special invitees.

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 courses / 40 marks for practical courses, for Industrial Training and for Thesis work (Phase-I and Phase-II) will be finalized for every student and tabulated and submitted to the Head of the Department for approval and transmission to the Controller of Examinations.

13. Temporary Break Of Study
A student can take a one-time temporary break of study covering the current semester and / or the next semester with the approval of the Dean on the recommendation of the Head of the Department, not later than seven days after the completion of the mid-semester test. However, the student must complete the entire programme within the maximum period of four years for Full time / six years for Part time.

14. Substitute Assessments
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 end of semester 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 Head of the Department within a week from the date of the missed assessment.

15. 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.
A student who withdraws from or does not meet the minimum attendance requirement in a semester must re-register and repeat the same semester in the subsequent academic years.

16. 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.

<table>
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<tr>
<th>Marks Range</th>
<th>Grade</th>
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<tbody>
<tr>
<td>90 to 100 marks</td>
<td>‘S’</td>
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<tr>
<td>80 to 89 marks</td>
<td>‘A’</td>
</tr>
<tr>
<td>70 to 79 marks</td>
<td>‘B’</td>
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<tr>
<td>60 to 69 marks</td>
<td>‘C’</td>
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<tr>
<td>55 to 59 marks</td>
<td>‘D’</td>
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<tr>
<td>50 to 54 marks</td>
<td>‘E’</td>
</tr>
<tr>
<td>Less than 50 marks</td>
<td>‘RA’</td>
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<tr>
<td>Withdrawn from the Examination</td>
<td>‘W’</td>
</tr>
</tbody>
</table>
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 and earned the credits for that course. Such a course cannot be repeated by the student.

A student who obtains letter grade RA / 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.

\[ \text{S} - 10; \quad \text{A} - 9; \quad \text{B} - 8; \quad \text{C} - 7; \quad \text{D} - 6; \quad \text{E} - 5; \quad \text{RA} - 0 \]

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-totaling 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.

17. **Awarding Degree**

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

For First Class with Distinction the student must earn a minimum of 68 credits within four semesters for full-time / six semesters for Part time from the time of admission, pass all the courses in the first attempt and obtain a CGPA of 8.25 or above.

For First Class, the student must earn a minimum of 68 credits within two years and six months for full-time / three years and six months for Part time from the time of admission and obtain a CGPA of 6.75 or above.

For Second class, the student must earn a minimum of 68 credits within four years for full-time / six years for Part time from the time of admission.
18. **Ranking of Candidates**

The candidates who are eligible to get the M.E / M.Tech degree in First Class with Distinction will be ranked on the basis of CGPA for all the courses of study from I to IV semester for M.E / M.Tech full-time / I to VI semester for M.E / M.Tech part-time.

The candidates passing with First Class and without failing in any subject from the time of admission will be ranked next to those with distinction on the basis of CGPA for all the courses of study from I to IV semester for full-time / I to VI semester for M.E / M.Tech part-time.

19. **Transitory Regulations**

If a candidate studying under the old regulations M.E. / M.Tech could not attend any of the courses in his/her courses, shall be permitted to attend equal number of courses, under the new regulation and will be examined on those subjects. The choice of courses will be decided by the concerned Head of the department. However he/she will be permitted to submit the thesis as per the old regulations. The results of such candidates will be passed as per old 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.
**ANNEXURE 1**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Department</th>
<th>Programme (Full Time &amp; Part time)</th>
<th>Eligible B.E./B.Tech Programme</th>
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<tbody>
<tr>
<td>1</td>
<td>Chemical Engineering</td>
<td>i. Chemical Engineering</td>
<td>B.E. / B.Tech – Chemical Engg, Petroleum Engg, Petrochemical Technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>iii. Industrial Bio Technology</td>
<td>B.E. / B.Tech - Chemical Engg, Food Technology, Biotechnology, Leather Technology</td>
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<tr>
<td></td>
<td></td>
<td>iv. Industrial Safety Engineering</td>
<td>B.E. / B.Tech – Any Branch of Engineering</td>
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<tr>
<td>3</td>
<td>Civil &amp; Structural Engineering</td>
<td>i. Structural Engineering</td>
<td>B.E. / B.Tech – Civil Engg, Civil &amp; Structural Engg.</td>
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<td>ii. Construction Engg. and Management</td>
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<td>iii. Geotechnical Engineering</td>
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<td>iv. Disaster Management &amp;Engg.</td>
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<td>ii. Smart Energy Systems</td>
<td>B.E. / B.Tech – Electrical and Electronics Engg, Control and Instrumentation Engg, Electronics and communication Engg,</td>
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<td>iii. Power System</td>
<td>Electronics and communication Engg,</td>
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<tr>
<td>S.No.</td>
<td>Department</td>
<td>Programme (Full Time &amp; Part time)</td>
<td>Eligible B.E./B.TechProgramme</td>
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<tr>
<td>8</td>
<td><strong>Information Technology</strong></td>
<td>i. Information Technology</td>
<td>B.E. / B.Tech - Computer Science and Engineering, Information Technology, Electronics and Communication Engg, Software Engineering</td>
</tr>
</tbody>
</table>
DEPARTMENT OF CHEMICAL ENGINEERING
M.E. 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 (PEO):
1. To prepare students for successful careers in Chemical Engineering and allied fields.
2. To make them professional to apply the principles of Chemical Engineering in solving practical problems
3. To develop the ability for designing chemical processes, equipments and plants with all constraints.
4. To develop the skills necessary for advanced research in Chemical Engineering through the project work.
5. To equip the students with state of art knowledge in Chemical Engineering including ethics, issues related to the global economy as well to as cultivate the skills of learning.
6. To know the latest technological advancements in computing and applied domains of engineering related to economic, environmental, social, political, ethical, and sustainability aspects.

PROGRAMME OUTCOMES (PO):
1. Work as an engineering professional as individual or as a team member/leader.
2. Ability to Identify the Chemical Engineering problem
3. Apply knowledge of mathematics, science, engineering fundamentals and core engineering subjects to define and apply them with proper improvisation to solve the chemical engineering problems.
4. Able to design and conduct experiments, as well as to analyze and interpret data
5. Able to survey appropriate literatures, identify, formulate, and analyze broadly-defined Chemical engineering and allied problems.
6. Ability to select and handle analytical instruments
7. Understand and commit to professional ethics and responsibilities and norms of engineering technology and practice.
8. Capability to handle research and design problems and engage in further research activities
9. Commitment towards environmentally benign design and engineering
10. To provide suitable environment and motivation for research activity
11. Recognize the need for, and an ability to engage in lifelong learning
12. Knowledge of contemporary issues

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<th>PO3</th>
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DEPARTMENT OF CHEMICAL ENGINEERING

Program : M.E
Specialization: Chemical Engineering

CURRICULUM – 2019

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LIST OF PROGRAMME ELECTIVES

1. Process Design and Synthesis
2. Chemical Reactor Analysis
3. Fluidization Engineering
4. Industrial Pollution Control
5. Application of Nanotechnology in Chemical Engineering
6. Chemoinformatics
7. Modern concepts in Catalysis and Surface Phenomenon
8. Advanced Downstream Processes
9. Computational Fluid Dynamics
10. Bioprocess Engineering
11. Process Intensification
12. Phase transitions in Process Equipment
13. Micro and Nano Fluidics
14. Process Integration
15. Transport in Porous Media
17. Process Plant Design & Flow sheeting
18. Design of Experiments and Parameter Estimation
19. Computer Aided Design
20. Cleaner Production

AUDIT COURSES

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills.

OPEN ELECTIVES

1. Business Analytics
2. Industrial Safety
3. Operations Research
5. Composite Materials
6. Waste to Energy
### M.E (PART TIME) - DEGREE PROGRAMME

Choice Based Credit System (CBCS)

REGULATION - 2019

Courses of Study and Scheme of Examination

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COURSE OBJECTIVES:

- To give students an insight in various Chemical Engineering Processes using advanced Numerical and Statistical Methods.
- To provide adequate background of Mathematics to deal with Chemical Engineering.
- To understand research papers on relevant topics involving advanced Mathematics.
- To study correlation and regression of multivariate data.
- To evaluate Experimental design methods and statistical quality control measures.

Equation Forms in Process Modeling, Introduction and Motivation, Linear and Nonlinear Algebraic Equation, Optimization based Formulations, ODE-IVPs and Differential Algebraic Equations, ODE-BVPs and PDEs, Abstract model forms. Fundamentals of Vector Spaces, Generalized concepts of vector space, sub-space, linear dependence, Concept of basis, dimension, norms defined on general vector spaces, Examples of norms defined on different vector spaces, Cauchy sequence and convergence, introduction to concept of completeness and Banach spaces, Inner product in a general vector space, Inner-product spaces and their examples, Cauchy-Schwartz inequality and orthogonal sets, Gram-Schmidt process and generation of orthogonal basis, well known orthogonal basis.


Solving Linear Algebraic Equations, System of linear algebraic equations, conditions for
existence of solution - geometric interpretations (row picture and column picture), review of concepts of rank and fundamental theorem of linear algebra, Classification of solution approaches as direct and iterative, review of Gaussian elimination, Introduction to methods for solving sparse linear systems: Thomas algorithm for tridiagonal and block tridiagonal matrices, Block-diagonal, triangular and block-triangular systems, solution by matrix decomposition, Iterative methods: Derivation of Jacobi, Gauss-Siedel and successive over-relaxation methods, Convergence of iterative solution schemes: analysis of asymptotic behavior of linear difference equations using Eigen values, Convergence of iterative solution schemes with examples, Convergence of iterative solution schemes, Optimization based solution of linear algebraic equations, Matrix conditioning, examples of well conditioned and ill-conditioned linear systems.


REFERENCES:
3. Gourdin, A. and M Boumhrat; Applied Numerical Methods, 2000,Prentice Hall India, New Delhi,
5. Linz, P.; Theoretical Numerical Analysis, 1979, Dover, New York,

COURSE OUTCOMES:
At the end of the course, the student will be able:
1. To solve system of linear algebraic equations
2. To do numerical integrations of functions.
3. To fit relationship between two data sets using linear, non-linear regression.
4. To calculate maxima/minima and functions.
5. To apply able to methods for solving chemical engineers problems

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COURSE OBJECTIVES:
- To familiarize students with various advanced aspects of separation processes and the selection of separation processes.
- To enable students to understand the principles and processes of adsorption, membrane separation and chromatography and to design an absorber or a membrane unit to achieve a specified separation.
- To introduce them to new trends used in the separation technologies.

Introduction: Conventional separation processes - Absorption, Adsorption, Conventional separation processes - Distillation, Drying, Conventional separation processes - Extraction, Diffusion, Conventional separation processes - Leaching, Crystalisation, Advances in separation techniques based on size, Advances in separation techniques based on surface properties, Advances in separation techniques based on ionic properties, Cross flow filtration, Electrofiltration, Dual functional filter, Surface based solid-liquid separations involving a second liquid, Sirofloc filter

Bubble and Foam Fractionation: Nature of bubbles and foams, stability of foams, foam fractionation techniques, batch, continuous, single stage and multistage columns. Types and choice of membranes, Plate and frame, spiral wound membranes, Tubular and hollow fibre membrane reactors, Membrane Permeates: Dialysis, Reverse osmosis, Nanofiltration, ultrafiltration, microfiltration, Donnan dialysis, Ceramic membranes

Membrane Separation: Characteristics of organic and inorganic membranes, basis of membrane selection, osmotic pressure, partition coefficient and permeability, concentration polarization,
electrolyte diffusion and facilitated transport, macro-filtration, ultra-filtration, reverse osmosis, electro-dialysis. Industrial applications.

Special Processes: Liquid membrane separation, super-critical extraction, adsorptive separation-pressure, vacuum and thermal swing, pervaporation and permeation, nano-separation.

Chromatographic Methods of Separation: Gel, solvent, ion and high performance liquid chromatography.

REFERENCES:

COURSE OUTCOMES:
At the end of the course, the student will be able to:
1. List situations where liquid–liquid extraction might be preferred to distillation, make a preliminary selection of a solvent using group-interaction rules, Size simple extraction equipment.
2. Differentiate between chemisorption and physical adsorption, List steps involved in adsorption of a solute, and which steps may control the rate of adsorption, Explain the concept of breakthrough in fixed-bed adsorption.
3. Explain how crystals grow, Explain the importance of supersaturation in crystallization. Describe effects of mixing on supersaturation, mass transfer, growth, and scale-up of crystallization.
4. Explain membrane processes in terms of the membrane, feed, sweep, retentate, permeate, and solute membrane interactions.
5. Distinguish among microfiltration, ultrafiltration, nanofiltration, virus filtration, sterile filtration, filter-aid filtration, and reverse osmosis in terms of average pore size. Explain common idealized flow patterns in membrane modules.

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20
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee


New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

REFERENCES:
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”

COURSE OUTCOMES:
At the end of this course, students will be able to
1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today’s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

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<th>CHCECP16</th>
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COURSE OBJECTIVES:
- To learn Process Modeling and Simulation of Chemical operations and processes.
- To understand Dynamic Behavior of processes.
- To understand Close loop control of processes.
- To learn Dynamic simulation of chemical processes.
- To get acquainted with Controllability Analysis of chemical processes.

List of experiments: Simulation laboratory practical
2. Simulate Mixer, splitter, heat exchangers, and reactive distillation column.
3. Apply sensitivity, design specification and case study tools in Aspen.
4. Solve linear and non-linear programming problems.
7. Simulation of Ideal Binary Distillation Column.
8. Simulation of Heat/Mass Transfer coefficient in 3 phase fluidized bed column.
9. Simulation studies of various unit operations using CHEMCAD.
10. Modeling and Simulation of cyclone separator.

Note: Simulation can be done using C/C++ / MATLAB/ ASPEN PLUS/ CHEMCAD

COURSE OUTCOMES:
At the end of the course, the student will be able to:
2. Simulate Mixer, splitter, heat exchangers, reactors, distillation columns.
3. Apply sensitivity, design specification and case study tools in Aspen.
4. Solve linear and non-linear programming problems.
5. Able to design and simulate the chemical engineering equipment’s.

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COURSE OBJECTIVES:
- To familiarize students with various advanced aspects of separation processes and the selection of separation processes.
- To enable students to understand the principles and processes of adsorption, membrane separation and chromatography and to design an absorber or a membrane unit to achieve a specified separation.
- To introduce them to new trends used in the separation technologies.

List of experiments: advanced separation processes
1) Separation of fluoride and arsenic using cellulose acetate asymmetric membrane separation process
2) Adsorption of dyes from waste water using nano adsorbents.
3) Supercritical extraction of the fragrance.
4) Study the effect of pressure on permeate flux and solution rejection in RO system.
5) Mass transfer studies and study the effect of parameters in separation system using liquid emulsion membrane.
6) Laboratory experiments on ion exchange membranes: effect of process parameters on flux.
7) Study the reaction with mass transfer: e.g. Synthesis of calcium carbonate.
8) Study the reactive distillation system considering batch and continuous mode

COURSE OUTCOMES:
At the end of the course, the student will be able to:
1. Gain Knowledge on mass transfer operations
2. Students should be able to know the synthesis of materials
3. Students will be able to provide applicable solutions to separation processes.
4. Acquire Knowledge on mechanical operations.
5. Know the applications of materials in separation processes.

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**SEMESTER II**

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<th>ADVANCED TRANSPORT PHENOMENA</th>
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**COURSE OBJECTIVES:**

- To familiarize the student with basic concepts of transport phenomena and brief review of mathematics.
- To enable students to understand the equations of change for isothermal flow and for nonisothermal flow.
- To introduce them details of equations of change for multi component systems.
- To give them insight into properties of two-dimensional flows and aspects of dimensional analysis.


REFERENCES:

COURSE OUTCOMES:
At the end of the course, the student will be able to:
1. Understand the mechanism of momentum, heat and mass transport for steady and unsteady flow.
2. Perform momentum, energy and mass balances for a given system at macroscopic and microscopic scale.
3. Solve the governing equations to obtain velocity, temperature and concentration profiles.
4. Model the momentum, heat and mass transport under turbulent conditions.
5. Develop analogies among momentum, energy and mass transport.

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<th>CHCEPC22</th>
<th>ADVANCED REACTION ENGINEERING</th>
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**COURSE OBJECTIVES:**
- This Subject is essential for Design of Reactor especially heterogeneous reactors.
- Students will learn the energy balance, temperature and concentration profiles in different reactors, advance design aspects of multiple reactors, students will get insight of importance of population balance of particles.
- Role of Reaction Engineering in mitigation of Global warming will also addressed.

Non-elementary Kinetics Importance: Approximations for formulations of Rate laws, Formulations of Kinetic model.
Effect of flow on conversions in Reactors: Semibatch Reactors : Importance and examples of applications , Material Balance on Semibatch Reactor, Multiple reaction in Semibatch Reactors, Conversion Vs Rate in Reactors, Use of POLYMATHS to solve the equations and understanding the profiles
Non-Isothermal reaction modeling in CSTR & Semi-Batch reactor: Energy Balance equations for CSTR, PFR and Batch reactors, Adiabatic operations Temperature conversion profiles in PFR, CSTR, Steady state tubular reactor with heat exchange.
Need for Multi-staging CSTR with multiple stages: Exothermic and Endothermic Reaction with Examples, CSTR with heat effects, Multiple reactions in CSTR and PFR with heat effects, Semi batch Reactors with heat exchange.


Catalytic reactions: theory and modeling: Global rate of reaction, Types of Heterogeneous reactions Catalysis, Different steps in catalytic reactions, Theories of heterogeneous catalysis. Steady State approximation, formulations of rate law Rate laws derived from the PSSH, Rate controlling steps, Eiley-Rideal model, Reforming catalyst example : Finding mechanism consistent with experimental observations Evaluation of rate law parameters, packed beds : Transport and Reactions, Gradients in the reactors : temperature.


REFERENCES:
4. Foggler, H.S., Elements of Chemical Reaction Engineering, 2008. Prentice Hall of India,

COURSE OUTCOMES:
At the end of the course, the student will be able to:
1. Evaluate heterogeneous reactor performance considering mass transfer limitations
2. Perform the energy balance and obtain concentration profiles in multiphase reactors.
3. Estimate the performance of multiphase reactors under non-isothermal conditions.
4. Understand modern reactor technologies for mitigation of global warming
5. Understand the kinetic Modeling of reactors.

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COURSE OBJECTIVES:
- Analyze characteristics of a fluidized bed dryer
- Estimate efficiency of compact heat exchangers
- Evaluate the performance of a process intensification in catalytic reactions, ultrasound assisted reactions, reactive distillation column, micro reactor and advanced flow reactor
- Design controller for a given process
- Evaluate the performance of membrane separation process for water purification
- Characterize electrochemical phenomena such as corrosion

List of Experiments:
1. Characteristics of a Fluidized bed dryer
2. Helical Coil heat exchanger
3. Determination of Effective thermal conductivity (ETC) in granular material
4. Plate Type Heat Exchanger
5. Kinetics for solid catalyzed esterification reaction in a batch reactor
6. Reactive distillation in Packed Column
7. Ultrasonic cavitation based reactions
8. Micro-reactor
9. Advanced Flow Reactor
10. Membrane Separation for water purification
11. Corrosion characteristics of a metal in a given electrolyte
12. Control of liquid level in non-interacting systems.
13. Identification and control of a three tank system.
14. pH control in a process.

**COURSE OUTCOMES:**
At the end of this course, students are able to understand:
1. Performance of dryer and heat exchangers
2. Membrane separation techniques
3. Control of level, pH in a chemical reactor
4. Fluidized bed and packed bed reactors
5. Packed bed distillation columns

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**COURSE OBJECTIVES:**
- To train the students in the field work related to chemical engineering and to have a practical knowledge in carrying out work at chemical engineering
- To train and develop skills in solving problems during execution of certain works related to chemical engineering

The students individually undergo a training program in reputed concerns in the field of chemical engineering during the summer vacation (at the end of second semester for full-time/ IV semester for part time) for a minimum stipulated period of four weeks. At the end of the training, the student has to submit a detailed report on the training they had, within ten days from the commencement of third semester for full time/fifth semester for part time. The student will be evaluated by a team of staff members nominated by head of the department through a viva voce examination.
**COURSE OUTCOME:**
1. The student can face the challenges and practice with confidence
2. The student will be benefitted by the training with managing the situation arises during the execution of work related to chemical process industries.

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THIRD SEMESTER

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FOURTH SEMESTER

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Dissertation Phase – I and Phase – II
Teaching Scheme Lab work: 20 and 32 hrs/week for phase I and II respectively

COURSE OBJECTIVES:
At the end of this course, students will be able to
- Ability to synthesize knowledge and skills previously gained and applied to an in-depth study and execution of new technical problem.
- Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design, and justify their design.
- Ability to present the findings of their technical solution in a written report.
- Presenting the work in International/ National conference or reputed journals.

Syllabus Contents:
The dissertation / project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The dissertation should have the following
- Relevance to social needs of society
- Relevance to value addition to existing facilities in the institute
- Relevance to industry need
- Problems of national importance
- Research and development in various domain

The student should complete the following:

- Literature survey
  Problem Definition
- Motivation for study and Objectives
- Preliminary design / feasibility / modular approaches
- Implementation and Verification
- Report and presentation
The dissertation stage II is based on a report prepared by the students on dissertation allotted to them. It may be based on:
- Experimental verification / Proof of concept.
- Design, fabrication, testing of Communication System.
- The viva-voce examination will be based on the above report and work.

**Guidelines for Dissertation Phase – I and II**

- As per the AICTE directives, the dissertation is a yearlong activity, to be carried out and evaluated in two phases i.e. Phase – I: July to December and Phase – II: January to June.
- The dissertation may be carried out preferably in-house i.e. department’s laboratories and centers OR in industry allotted through department’s T & P coordinator.
- After multiple interactions with guide and based on comprehensive literature survey, the student shall identify the domain and define dissertation objectives. The referred literature should preferably include Springer/Science Direct. In case of Industry sponsored projects, the relevant application notes, while papers, product catalogues should be referred and reported.
- Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and phase wise work distribution, and submit the proposal within a month from the date of registration.
- Phase – I deliverables: A document report comprising of summary of literature survey, detailed objectives, project specifications, paper and/or computer aided design, proof of concept/functionality, part results, A record of continuous progress.
- Phase – I evaluation: A committee comprising of guides of respective specialization shall assess the progress/performance of the student based on report, presentation and Q & A. In case of unsatisfactory performance, committee may recommend repeating the phase-I work.
- During phase – II, student is expected to exert on design, development and testing of the proposed work as per the schedule. Accomplished results/contributions/innovations should be published in terms of research papers in reputed journals and reviewed focused conferences OR IP/Patents.
- Phase – II deliverables: A dissertation report as per the specified format, developed system in the form of hardware and/or software, A record of continuous progress.
- Phase – II evaluation: Guide along with appointed external examiner shall assess the progress/performance of the student based on report, presentation and Q & A. In case of unsatisfactory performance, committee may recommend for extension or repeating the work

**COURSE OUTCOMES:**

Students will be able to

1. Study and execute new technical problems related to chemical engineering.
2. Know different methodologies, methods and forms of analysis to produce a suitable research design, and justify their design.
3. Present the findings of their technical solution in a written report.
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COURSE OBJECTIVES:
- To understand the systematic approaches for the development of conceptual chemical process designs
- To learn the advances in problem formulation and software capabilities which offer the promise of a new generation of practical process synthesis techniques based directly on structural optimization.
- Learning chemical process synthesis, analysis, and optimization principles
- Product design and development procedure and Process life cycle assessment.

Introduction
Introduction to fundamental concepts and principles of process synthesis and design and use of flow sheet simulators to assist process design. Process Flow sheet Models: An Introduction to design, Chemical process synthesis, analysis and optimization. Introduction to commercial process design software such as HYSYS, Aspen plus etc., Chemical Process (reactor, heat exchanger, distillation etc) analysis using commercial software

Product design and developments

Reactor Networks
Geometry of mixing and basic reactor types, The Attainable Region (AR) approach, AR in higher dimensions & for other processes, Reactive Separation processes, Fundamental behavior and problems, Separation through reactions. Reactive Residue Curve Maps

Synthesis of Separation Trains
Criteria for selection of separation methods, select ion of equipment: Absorption, Liquid-liquid extraction Membrane separation, adsorption, leaching, drying, crystallization, Ideal distillation - Column and sequence fundamentals, Sharp splits & sequencing Phase diagrams for 2, 3 and 4 components, Feasibility and vapor ow rates for single columns, Residue curve basics, Non-ideal Distillation - Azeotropic systems; detecting binary azeotropes, Residue curve maps for azeotropic systems, Topological analysis, Feasibility for single azeotropic columns, Binary VLLE and pressure swing separation, Non-ideal distillation synthesis. Equipment sequencing: VLE + VLLE, Detailed Residue Curve Maps, Residue curve maps: Interior structure
Heat Exchanger Network Synthesis
Minimum heating and cooling requirements, Minimum Energy Heat Exchanger Network, Loops and Paths, Reducing Number of Exchangers, HENS basics & graphics, The pinch point approach, Stream Splitting, Performance targets, trade-off & utilities, Heat & power integration, HENS as mathematical programming

REFERENCES:

COURSE OUTCOMES:
At the end of the course, the student will be able to understand:
1. Fundamental concepts and principles of process synthesis
2. Flow sheet models, design software, process analysis
3. Reactor network, separator trains
4. Heat exchanger, network design
5. Residue curve maps for distillation column

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COURSE OBJECTIVES:
- To learn the heterogeneous catalyzed reactions and the models involved in reactor design
- To study mass and heat transfer mechanisms in the different reactors

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• To appreciate the importance of both external and internal transport effects in gas-solid and liquid-solid systems
• To design isothermal and non-isothermal reactors for heterogeneous catalytic reactions

Chemical factor affecting the choice of the reactor, fundamental mass, energy and momentum balance, Model for a semi-batch reactor, optimum operation policies and control strategies, optimal batch operation time, optimal temperature policies, stability of operation and transient behavior for mixed flow reactor. Transient CSTR analysis, Hot spot equation; Optimization using Lagrange multiplier, Pointrgins maximum principle.

Fixed bed catalytic reactor: The importance and scale of fixed bed catalytic processes, factors in preliminary design, modeling of fixed bed reactor. Pseudo-homogeneous model, the multibed adiabatic reactor, auto-thermal operation, non-steady-state model with axial mixing, two dimensional pseudo-homogeneous models, heterogeneous models, global and intrinsic rates, Mechanism of catalytic reactions, Engineering properties of catalysts - BET surface area, pore volume, pore size, pore size distribution, one dimensional and two dimensional model equation.


Design model for multiphase flow reactors, gas and liquid phase in completely mixed and plug flow, gas phase in plug flow and liquid phase in completely mixed flow, effective diffusion model, two zone model, specific design aspects, packed absorber, two-phase fixed bed reactor, plate column, spray tower, bubble reactor, stirred vessel reactor. Computer - aided reactor design.

Temperature effects in reactor: Introduction, well mixed system with steady feed, the stability and start-up of CSTR, limit cycles and oscillatory reactions, the plug flow reactors, tubular reactor, diffusion control, prorogation of reaction zone.

REFERENCES:
4. Elements of Chemical Reaction Engineering by H. Scott Fogler
7. Chemical Reactor Analysis and Design by G. F. Froment and K. B. Bischoff

**COURSE OUTCOMES:** At the end of the course, the student will be able to:
1. Evaluate heterogeneous reactor performance considering mass transfer limitations
2. Perform the energy balance
3. Estimate the performance of multiphase reactors under non-isothermal conditions
4. Obtain concentration profiles in multiphase reactors.
5. Understand the effects temperature in the reactors.

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**COURSE OBJECTIVES:**
- To study the phenomenon of fluidization with industrial processing objective
- To study the various regimes of fluidization and their mapping.
- To study the design of equipments based on fluidization technique

**Introduction to fluidization and applications**
Phenomenon of fluidization, behavior of fluidized bed, contacting modes, advantages and disadvantages of fluidization, fluidization quality, selection of contacting mode, Beds for Industrial applications, coal gasification, synthesis reactions, physical operations, cracking of hydrocarbons

**Mapping of fluidization regimes**
Characterization of particles, mechanics of flow around single particles, minimum fluidization velocity, pressure drop versus velocity diagram, The Geldart classification of solids, fluidization with carryover of particles, terminal velocity of particles, distributor types, gas entry region of bed, pressure drop requirements, design of gas distributor, power consumption

**Bubbling fluidized beds**
Davidson model for bubble in a fluidized bed, and its implications, the wake region and movement of solids at bubbles, coalescence and splitting of bubbles, bubble formation above a distributor, slug flow, Turbulent and fast fluidization - mechanics, flow regimes and design equations, Emulsion movement, estimation of bed properties, bubble rise velocity, scale up aspects, flow models, two phase model, K-L model

**Solids movement and Gas dispersion**
Vertical and horizontal movement of solids, Dispersion model, large solids in beds of smaller particles, staging of fluidized beds Gas dispersion in beds, gas interchange between bubble and emulsion, estimation of gas interchange coefficient, Heat and mass transfer in fluidized systems, Mixing in fluidized systems – measurements and models.

**Fluidized bed reactors**
Entrainment and elutriation, Freeboard behavior, gas outlet, entrainment from tall vessel, freeboard entrainment model, high velocity fluidization, pressure drop in turbulent and fast fluidization, Slugging, Spouted beds, Circulating Fluidized Beds.
Mathematical model of a homogeneous fluidized bed, Design of catalytic reactors, pilot plant reactors, information for design, bench scale reactors, design decisions, deactivating catalysts, Design of noncatalytic reactors, kinetic models for conversion of solids, models for shrinking particles, conversion of solids of unchanging size.

**REFERENCES:**
2. Liang-Shih Fan, “Gas-Liquid-Solid Fluidization Engineering”, 1989 Butter worth’s,

**COURSE OUTCOMES:** At the end of the course, the student will be able to:
1. Performing and understanding the behavior fluidization in fluidized bed
2. Evaluate the characterization of particles and power consumption in fluidization regimes
3. Understanding the applicability of the fluidized beds in chemical industries
4. Evaluate the power consumption in fluidization regimes
5. Design the fluidized bed reactor

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COURSE OBJECTIVES:
- To understand the importance of industrial pollution and its abatement
- To study the underlying principles of industrial pollution control
- To acquaint the students with case studies
- Student should be able to design complete treatment system

**Industries & Environment**
Industrial scenario in India - Industrial activity and Environment - Uses of Water by industry - Sources and types of industrial wastewater - Industrial wastewater and environmental impacts - Regulatory requirements for treatment of industrial wastewater - Industrial waste survey – Industrial wastewater generation rates, characterization and variables - Population equivalent - Toxicity of industrial effluents and Bioassay tests.

**Industrial Noise pollution**
Sources of noise pollution, characterization of noise pollution prevention & control of noise pollution, Factories Act 1948 for regulatory aspects of noise pollution.

**Air Pollutant Abatement**
Air pollutants scales of concentration, lapse rate and stability, plume behavior, dispersion of air pollutants, atmospheric dispersion equation and its solutions, Gaussian plume models. Air pollution control methods, Source correction methods, Design concepts for pollution abatement systems for particulates and gases. Such as gravity chambers, cyclone separators, filters, electrostatic precipitators, condensation, adsorption and absorption, thermal oxidation and biological processes.

**Waste water treatment processes**
Design concepts for primary treatment, grid chambers and primary sedimentation basins, selection of treatment process flow diagram, elements of conceptual process design, design of thickener, biological treatment Bacterial population dynamics, kinetics of biological growth and its applications to biological treatment, process design relationships and analysis, determination of kinetic coefficients, activated sludge process. Design, trickling filter design considerations, advanced treatment processes, Study of environment pollution from process industries and their abatement: Fertilizer, paper and pulp, inorganic acids, petroleum and petrochemicals, recovery of materials from process effluents.

**Solid waste and Hazardous waste management**
Sources and classification, properties, public health aspects, Sanitary land fill design, Hazardous waste classification and rules, management strategies, Nuclear waste disposal Treatment methods – component separation, chemical and biological treatment, incineration, solidification and stabilization, and disposal methods, Latest Trends in solid waste management.

**REFERENCES:**
2. Mahajan S.P., “Pollution Control in Process Industries”.

**COURSE OUTCOMES:**
At the end of the course, the student will be able to:
1. Know the principles of industrial pollution control
2. Recognize the causes and effects of environmental pollution
3. Analyze the mechanism of proliferation of pollution
4. Develop methods for pollution abatement and waste minimization
5. Design treatment methods for gas, liquid and solid wastes

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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

**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.

**Approaches to Synthesis of Nanoscale Materials and characterization**

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. Size, shape, crystallinity, topology, chemistry analysis using X-ray imaging, Transmission Electron Microscopy, HRTEM, Scanning Electron Microscopy, SPM, AFM, STM, PSD, Zeta potential, DSC and TGA.

**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

**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.

**Applications to Safety, Environment and Others**

Chemical and Biosensors- Classification and Main Parameters of Chemical and Biosensors, Nanostructured Materials for Sensing, Waste Water Treatment, Nanobiotechnology, Drug Delivery, Nanocoatings, Self cleaning Materials, Hydrophobic Nanoparticles, Photocatalysts, Biological nanomaterials, Nanoelectronics, Nanomachines & nanodevices, Societal, Health and Environmental Impacts.

**REFERENCES:**

COURSE OUTCOMES:
At the end of the course, the student will be able to:
1. Understanding the different top down and bottom up approaches for nanoparticles
2. Get to know the different applications of nanoparticles in chemical engineering field.
3. Learning the characterization techniques for nanoparticles.
4. Acquire knowledge on polymer based nano composites
5. Understand the applications of nanoparticles to safety and the environment.

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COURSE OBJECTIVES:
- To give students a concept of Chemo-informatics related to chemical structure databases and database search methods
- To understand the quantum methods and models involved in drug discovery and targeted drug delivery
- To study the application of Chemical Libraries, Virtual Screening, Prediction of Pharmacological Properties

Chemo-informatics

Introduction to quantum methods
Combinatorial chemistry (library design, synthesis and deconvolution), spectroscopic methods and analytical techniques, Representation of Molecules and Chemical Reactions: Different types
of Notations, SMILES Coding, Structure of Mol files and Sd files (Molecular converter, SMILES Translator).

**Analysis and use of chemical reaction information**

Chemical property information, spectroscopic information, analytical chemistry information, chemical safety information, Drug Designing: Prediction of Properties of Compounds, QSAR Data Analysis, Structure-Activity Relationships, Electronic properties, Lead Identification, Molecular Descriptor Analysis.

**Target Identification**

Molecular Modeling and Structure Elucidation: Homology Modelling (Modeller 9v7, PROCHECK), Visualization and validation of the Molecule (Rasmol, Pymol Discovery studio), Applications of Chemoinformatics in Drug Research - Chemical Libraries, Virtual Screening, Prediction of Pharmacological Properties.

**Drug Discovery**

Structure based drug designing, Docking Studies (Target Selection, Active site analysis, Ligand preparation and conformational analysis, Rigid and flexible docking, Structure based design of lead compounds, Library docking), Pharmacophore - Based Drug Design, Pharmacophore Modeling (Identification of pharmacophore features, Building 2D/3D pharmacophore hypothesis), Toxicity Analysis-Pharmacological Properties (Absorption, Distribution and Toxicity), Global Properties (Oral Bioavailability and Drug-Likeness) (ADME, OSIRIS, and MOLINSPIRATION)

**REFERENCES:**

3. Gasteiger J. Engel T. “A textbook of Chemoinformatics” Wiley- VCH GmbH & Co. KGaA
5. Lavine B. “Chemometrics and Chemoinformatics”, (2005), American Chemical Society

**COURSE OUTCOMES:**

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

1. Prepare for professional work in chemistry must learn how to retrieve specific information from the enormous and rapidly expanding chemical literature.
2. Provide a broad overview of the computer technology to chemistry in all of its manifestations.
3. Expose the student to current and relevant applications in QSAR
4. Expose the student to current and relevant applications in Drug Design.
5. Understand the concept of Chemoinformatics

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**COURSE OBJECTIVES:**
- To give the students insight into advances in catalytic reaction engineering
- To understand the mechanisms involved in catalytic reactions
- To study the catalyst characterization techniques
- To study the advanced industrial applications in catalysis
- To understand the principles behind catalyst deactivation and study their models

**Introduction to Catalysis**

**Adsorption in Catalysis**
Adsorption and its importance in Catalysis, Adsorption and potential energy curves, Surface Reconstruction, Adsorption Isotherms and Isobars, Dynamical Considerations, Types of Adsorption Isotherms and their Derivation from Kinetic Principles, Mobility at Surfaces, Kinetics of surface Reactions, Photochemistry on oxide and metallic surfaces, Characterization of the adsorbed molecules

**Catalyst Characterization**

**Significance of Pore Structure and Surface Area**

Industrial applications – Case Studies
Contribution of homogeneous catalytic process in chemical industry: Oxidations of Alkenes such as production of acetaldehyde, propylene oxide etc., Polymerization such as production of polyethylene, polypropylene or polyester production

REFERENCES:

COURSE OUTCOMES:
At the end of the course, the student will be able to:
1. Understand the concepts of homogenous and heterogeneous catalysis, with specific examples.
2. Study reaction mechanisms and kinetics of homogenous and heterogeneous catalytic reactions.
3. Familiarize with the characterization of catalysts
4. Understand the mechanisms of several types of catalysts in chemical industry.
5. Understand the application of several types of catalysts in chemical industry.

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Mapping PO with PEO

CHCEPECN ADVANCED DOWNSTREAM L T P C

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COURSE OBJECTIVES:
- To understand the unit processes involved in downstream processing.
- To study advanced treatment methods.
- To study the energy conservation in different separation processes.
- To understand the underlying design principles.

Introduction
Introduction to Downstream processes theory, applications in chemical separation for Gas-Liquid system, Gas-Solid system. Super critical fluids extraction in food, pharmaceutical, environmental and petroleum applications, water treatment, desalination, Bio separation, dialysis, industrial dialysis.

Downstream Processes in Petrochemical Industry
Cryogenic distillation for refinery, petrochemical off gases, natural gases, gas recovery-Olefin, Helium, Nitrogen, Desulfurization - coal, flue gases.

Advanced Distillation Processes
Azeotropic & extractive distillation - residue curve maps, homogeneous azeotropic distillation, pressure swing distillation, Column sequences, heterogeneous azeotropic distillation.

Energy conservation in separation processes
Energy balance, molecular sieves - zeolights, adsorption, catalytic properties, manufacturing processes, hydrogel process, application, New trends.

Non-Ideal Mixtures and Ion Exchange
Separations process synthesis for nonazeotropic mixtures, non ideal liquid mixtures, separation synthesis algorithm, Ion exchange - manufacture of resins, physical & chemical properties, capacity, selectivity, application, regeneration, equipment, catalysis use.

REFERENCES:

COURSE OUTCOMES:
At the end of the course, the student will be able to:
1. Learn effective strategies of downstream processing in chemical industry.
2. Understand the role of downstream processing.
3. Analyze reactors, upstream and downstream processes in production
4. Gain knowledge on energy conservation in separation processes
5. Understand the design principles.

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**COURSE OBJECTIVES:**
- To make students understand the governing equations of fluid dynamics and their derivation from laws of conservation
- To develop a good understanding in computational skills, including discretisation, accuracy and stability.
- To acquaint the students with a process of developing a mathematical and geometrical model of flow, applying appropriate boundary conditions and solving system of equations.

**Introduction to Fluid Dynamics**

**Grid Generation**
Basic theory of structured grid generation, Surface grid generation, Mono block, multi block, hierarchical multi block, Moving and sliding multiblock, Grid clustering and grid enhancement. Basic theory of unstructured grid generation, advancing front, Delaunay triangulation and various point insertion methods, Unstructured quad and hex generation, grid based methods, various elements in unstructured grids, Surface mesh generation, Surface mesh repair, Volume grid generation, Volume mesh improvement, mesh smoothing algorithms, grid clustering and
quality checks for volume mesh. Adaptive, Moving and Hybrid Grids, Need for adaptive and, moving grids, Tet, pyramid, prism, and hex grids, using various elements in combination

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

Chemical Fluid Mixing Simulation
Stirred tank modeling using the actual impeller geometry, Rotating frame model, The MRF Model Sliding mesh model, Snapshot model, Evaluating Mixing from Flow Field Results, Industrial Examples

Post-Processing of CFD results
Contour plots, vector plots, and scatter plots, Shaded and transparent surfaces, Particle trajectories and path line trajectories, Animations and movies, Exploration and analysis of data.

REFERENCES:

COURSE OUTCOMES:
At the end of the course, the students will be able to:
1. Understand the basic principles of mathematics and numerical concepts of fluid dynamics.
2. Develop governing equations for a given fluid flow system.
3. Adapt finite difference techniques for fluid flow models.
4. Apply finite difference method for heat transfer problems.
5. Solve computational fluid flow problems using finite volume techniques.
COURSE OBJECTIVES:
- To learn the principles of bioprocessing for traditional chemical engineering in the design and development of processes involving biocatalyst.
- To study engineering principles in the development of products based on living cells or subcomponents of such cells.
- To learn and develop quantitative models and approaches related to bioprocesses
- To learn mechanistic models for enzyme catalyzed reactions for large scale production of bioproducts

Introduction

Advance Enzyme Kinetics
Models for complex enzyme kinetics, modeling of effect of pH and temperature, models for insoluble substrate, models for immobilized enzyme systems, diffusion limitations in immobilized enzyme system, electrostatic and steric effects.

Bioreactors
Selection, scale-up, operation and control of bioreactors: Scale-up and its difficulties, bioreactor instrumentation and control, sterilization of process fluids. Modifications of batch and continuous reactors, chemostat with recycle, multistage chemostat, fed-batch operation, perfusion system, active and passive immobilization of cells, diffusional limitations in the immobilized system, solid state fomenters.

Homogeneous and heterogeneous reactions in bioprocesses

Recovery and purification of products:
Strategies to recover and purify products, separation of insoluble products, cell disruption, separation of soluble products.
REFERENCES:

Course Outcomes:
At the end of the course, the students will be able to:
1. Understand the principles of biotechnology and bioprocess engineering.
2. Understand the different cells and their use in biochemical processes.
3. Understand the role of enzymes in kinetic analysis of biochemical reaction.
4. Analyze bioreactors, upstream and downstream processes in production of bio-products
5. Demonstrate the fermentation process and its products for the latest industrial revolution

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COURSE OBJECTIVES:
- Understand the concept of Process Intensification.
- Know the limitations of intensification of the chemical processes.
- Apply the techniques of intensification to a range of chemical processes.
- Develop various process equipment used for intensifying the processes.
- Infer alternative solutions keeping in view point, the environmental protection, economic viability and social acceptance.


Process Intensification through micro reaction technology: Effect of miniaturization on unit operations and reactions, Implementation of Microreaction Technology, From basic Properties
To Technical Design Rules, Inherent Process Restrictions in Miniaturized Devices and Their Potential Solutions, Microfabrication of Reaction and unit operation Devices - Wet and Dry Etching Processes.


REFERENCES:
4. Segovia-Hernández, Juan Gabriel, Bonilla-Petriciolet, Adrián (Eds.), Process Intensification in Chemical Engineering Design Optimization and Control, 2016. Springer,
5. Reay, Ramshaw, Harvey, Process Intensification, Engineering for Efficiency, Sustainability and Flexibility, 2013. Butterworth-Heinemann,

COURSE OUTCOMES:
At the end of this course, students are able to:
1. Assess the values and limitations of process intensification, cleaner technologies and waste minimization options.
2. Measure and monitor the usage of raw materials and wastes generating from production and frame the strategies for reduction, reuse and recycle.
3. Obtain alternative solutions ensuring a more sustainable future based on environmental protection, economic viability and social acceptance.
4. Analyze data, observe trends and relate this to other variables.
5. Plan for research in new energy systems, materials and process intensification.

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**COURSE OBJECTIVES:**

- Basic laws in thermodynamics.
- Basic statistical concepts and methods: heat, work, energy, temperature and the kinetic theory of matter; entropy, ensemble, partition function, etc
- Learning phase transition catalysis
- Have a good grasp of the basic thermodynamic interactions and process: adiabatic, isothermal, etc

Thermodynamic aspects of phase transitions: Concept of phase, First-order phase transition, conditions for phase coexistence lines, free energy barrier of nucleation, and crystal-melt interfacial free energy, Ehrenfest classification of phase transitions, Van der Waals equation of state, Critical point

Single phase and multiphase catalytic reactions, Acid--base catalysis, Transition metal catalysis, Phase transfer catalysis, Micellar catalysis, Microemulsion catalysis, Electron transfer catalysis, Heteropoly acid catalysis, Homogeneous polymer catalysis, Heterogenisation of homogeneous catalysts.

Applications to Multi-phase Systems Stability conditions for a homogeneous system, equilibrium between phases, phase transformations, general relations for a system with several components, general conditions for chemical equilibrium, chemical equilibrium between ideal gases, and the equilibrium constants in terms of partition functions.
Phase diagrams and transformations Phase rule- single and binary phase diagrams, lever rule, micro structural changes during cooling, Al2O3, Cr2O3, Pb-Sn, Ag-Pt and Fe-Fe3C Systems phase diagrams, phase transformations, corrosion- theories of corrosion, control and prevention of corrosion

Energy balance - heat capacity and calculation of enthalpy changes, Enthalpy changes for phase transitions, evaporation, clausius - clapeyron equation,

REFERENCES:
2. Raghavan V., Material Science and Engineering, 1996, Prentice Hall of India,

COURSE OUTCOMES:
At the end of this course, students are able to:
1. Obtain considerable insight into various types of phase transitions, and how these can be described theoretically in different ways
2. Predict relationships between physical quantities using the laws and methods of thermodynamics.
3. Find probabilities and thermal quantities (free energy, entropy, etc) given the energy eigenvalues of a system.
4. Understand phase diagrams and transformations.
5. Solve the problems based on energy balance

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COURSE OBJECTIVES:
• To introduce to the students, the various opportunities in the emerging field of micro and nano fluids.
• To make students familiar with the important concepts applicable to small micro and nano fluidic devices, their fabrication, characterization and application.
• To get familiarize with the new concepts of real-time nano manipulation & assembly.


microactuators and other components of a larger implanted device or external system (synthetic organs).

REFERENCES:
1. Joshua Edel “Nanofluidics” 2009. RCS publishing,
3. K. Sarit “Nano Fluids; Science and Technology”, 2007RCS Publishing,
4. M. Madou, Fundamentals of Microfabrication, 1997 CRC Press,
5. G. Kovacs, Micromachined Transducers, 1998, McGraw-Hill,

COURSE OUTCOMES:
At the end of this course, students are able to:
1. Introduce students to the physical principles
3. Unifies the thermal sciences with electrostatics, electrokinetics, colloid science; electrochemistry; and molecular biology.
4. Know the fabrication techniques for nano fluidic channels.
5. Acquire knowledge on bioMEMS

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COURSE OBJECTIVES:
- To introduce to the students, the various opportunities in the process integration in chemical industries.
- To the make students familiar with the important concepts process integration for heat recovery/minimization.
- To get familiarize with the case studies.

Introduction to process Intensification and Process Integration (PI). Areas of application and techniques available for PI, onion diagram.
Pinch Technology—an overview: Introduction, Basic concepts, How it is different from energy auditing, Roles of thermodynamic laws, problems addressed by Pinch Technology, Key steps of Pinch Technology: Concept of _Tmin , Data Extraction, Targeting, Designing, OptimizationSuper targeting, Basic Elements of Pinch Technology: Grid Diagram, Composite curve, Problem Table Algorithm, Grand Composite Curve.

Heat exchanger networks analysis, Maximum Energy Recovery (MER) networks for multiple utilities and multiple, Chemical Engineering Pre-requisites: Knowledge of basic process design of process equipment. Pinches, design of heat exchanger network.

Heat integrated distillation columns, evaporators, dryers, and reactors.

Waste and waste water minimization, flue gas emission targeting, and heat and power integration. Case studies.

REFERENCES:

COURSE OUTCOMES:
At the end of this course, students are able to:
1. Understand the basics of process intensifications and integration
2. Maximum heat recovery for a given process (both new processes, and retrofit of existing processes) identify opportunities for integration of high-efficiency energy.
3. Energy-intensive thermal separation operations (distillation, evaporation) at an industrial process site.
4. Evaluate the process integration measures with respect to energy efficiency, greenhouse gas emissions and economic performance.
5. Acquire knowledge on heat exchanger analysis

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COURSE OBJECTIVES:

- Introduce the physics and governing mechanisms controlling flow and transport processes in porous media.
- Learning Liquid and solute transport in porous media.

Fundamentals: Mass, momentum and energy transport, Darcy and Non-Darcy equations, equilibrium and non-equilibrium conditions, species transport, radioactive decay.

Effective medium approximation: equivalent thermal conductivity, viscosity, dispersion.

Exact solutions: Flow over a flat plate, flow past a cylinder, boundary-layers, reservoir problems.

Special topics: Field scale and stochastic modeling, Turbulent flow, compressible flow, multiphase flow, numerical techniques, hierarchical porous media, nanoscale porous media, multiscale modeling.

Engineering applications: Groundwater, waste disposal, oil and gas recovery, regenerators, energy storage systems. Experimental techniques: Flow visualization, quantitative methods, inverse parameter estimation.

REFERENCES:

COURSE OUTCOMES: At the end of this course, students are able to:

1. Understand the mechanisms involved in transport processes in porous media
2. Work with the equations that govern the fate and transport of gas, water and solutes in porous media.
3. Find solutions for various problems
4. Gain knowledge on flow visualization, quantitative methods and inverse parameters estimation.
5. Gain knowledge on engineering applications

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COURSE OBJECTIVES:
- Introduce the students to micro flow chemistry and process technology.
- Learning Micromixers, Mixing Principles.
- Learning micro reactor based chemicals production

State of the Art of Microreaction Technology, Structural Hierarchy of Microreactors, Functional Classification of Microreactors, Fundamental Advantages of Microreactors, Advantages of Microreactors Due to Decrease of Physical Size, Advantages of Microreactors Due to Increase of Number of Units, Potential Benefits of Microreactors

Modern Microfabrication Techniques for Microreactors, Evaluation of Suitability of a Technique, Anisotropic Wet Etching of Silicon, Dry Etching of Silicon, LIGA Process, Injection Molding, Wet Chemical Etching of Glass, Advanced Mechanical Techniques

Micromixers, Mixing Principles and Classes of Macroscopic Mixing Equipment, mixing Principles and Classes of Miniaturized Mixers, Mixing Tee-Type Configuration


Microsystems for Energy Generation, Microdevices for Vaporization of Liquid Fuels, Microdevices for Conversion of Gaseous Fuels to Syngas by Means of Partial Oxidations, Hydrogen Generation by Partial Oxidations, Microdevices for Conversion of Gaseous Fuels to Syngas by Means of Steam Reforming
REFERENCES:
2. S.V. Luis and E. Garcia-Verdugo, Chemical Reactions and Processes under Flow Conditions, 2010 University Jaume I/CSIC, Castello´n, Spain, The Royal Society of Chemistry

COURSE OUTCOMES: At the end of this course, students are able to:
1. Understand the role of micro flow chemistry
2. Gain the knowledge on process technology in chemical engineering.
3. Obtain considerable insight into various types of micro reactors.
4. Gain knowledge on micro systems for gas phase reactions
5. Gain knowledge on micro systems for energy generations.

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COURSE OBJECTIVES:
- Understanding of the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the specific discipline.
- Application of established engineering methods to complex engineering problem solving.
- Application of systematic engineering synthesis and design processes.

Introduction: Basic concepts: General design considerations, Process design development, Layout of plant items, Flow sheets and PI diagrams, Economic aspects and Optimum design, Practical considerations in design and engineering ethics, Degrees of freedom analysis in interconnected systems, Network analysis, PERT/CPM, Direct and Indirect costs, Optimum scheduling and crashing of activities.
Hierarchy of chemical process design; Nature of process synthesis and analysis; Developing a conceptual design and flow sheet synthesis. Synthesis of reaction-separation systems; Distillation sequencing; Energy targets. Heat integration of reactors, distillation columns, evaporators and driers; Process change for improved heat integration. Heat and mass exchange networks and network design.


REFERENCES:

COURSE OUTCOMES: At the end of this course, students are able to:
1. Analyze, synthesize and design processes for manufacturing products commercially
2. Integrate and apply techniques and knowledge acquired in other courses such as thermodynamics, heat and mass transfer, fluid mechanics, instrumentation and control to design heat exchangers, plate and packed columns and engineering flow diagrams
3. Use commercial flow sheeting software to simulate processes and design process equipment
4. Recognize economic, construction, safety, operability and other design constraints
5. Estimate fixed and working capitals and operating costs for process plants

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**COURSE OBJECTIVES:**
This subject provides students with the knowledge to
- Use statistics in experimentation;
- Understand the important role of experimentation in new product design, manufacturing process development, and process improvement;
- Analyze the results from such investigations to obtain conclusions; become familiar methodologies that can be used in conjunction with experimental designs for robustness and optimization.

Design of experiments. Basic concepts, Bias and confounding, controlling bias, causation, Examples. Random Variables: Introduction to discrete and continuous random variables, quantify spread and central tendencies of discrete and continuous random variables.

Exploratory Data Analysis Variable types, Displaying the distribution, mean variance and typical spread, quartiles and unusual spread, multivariate data: finding relations. Probability Definition of a random variable, expectation, percentiles, common distributions such as the binomial, Poisson and normal distributions.

Point Estimation Estimators as random variables, sample mean and the central limit theorem, normal approximations, assessing normality. Interval Estimation Confidence intervals for the mean when the variance is known, confidence interval for the mean when the variance is unknown, confidence intervals for a single proportion, sample size, Student distribution. Hypothesis Testing Hypothesis testing for a mean or proportion, testing the equality of two means assuming equal variances, testing the equality of two means with unequal variances, comparison of two proportions.

Linear Regression analysis: The linear regression model, Parameter estimation, accuracy of the coefficient estimates, checking the model, multiple linear regression, confidence and prediction intervals, potential issues, high leverage points, outliers. Matrix approach to linear regression, Variance-Covariance matrix, ANOVA in regression analysis, quantifying regression fits of experimental data, Extra sum of squares approach, confidence intervals on regression coefficients, lack of fit analysis.

**Response Surface Methodology:** Method of steepest ascent, first and second order models, identification of optimal process conditions

**REFERENCES:**
1. Hanneman, Robert A., Kposowa, Augustine J., Riddle, Mark D. Research Methods

COURSE OUTCOMES:
At the end of this course, students are able to:
1. Plan experiments for a critical comparison of outputs
2. Include statistical approach to propose hypothesis from experimental data
3. Implement factorial and randomized sampling from experiments
4. Estimate parameters by multi-dimensional optimization
5. Identify optimal process conditions

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CHCEPECN | COMPUTER AIDED DESIGN | L | T | P | C
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COURSE OBJECTIVES:
- To understand importance and applications of CAD in the field of chemical engineering
- To understand the basic structure and components of CAD software
- To understand the underlying thermodynamic and physical principles
- To give insight into the approaches used in the simulation of flow sheets
- To understand flow charts, computer languages and numerical methods used for writing algorithms

Introduction
Introduction to CAD, Scope and applications in chemical Engineering, Mathematical methods used in flow sheeting and simulation, Introduction to solution methods for linear and non-linear algebraic equations, solving one equation one unknown, solution methods for linear and nonlinear equations, general approach for solving sets of differential equations, solving sets of sparse non-linear equations.

Properties Estimation

**Equipment Design**
Computer aided Design of Equipment: Design of Shell and Tube Heat exchangers; Design of Evaporators; Design of Distillation columns; Design of Reactors, Design of adsorption columns. Distillation columns (specific attention to multi components systems. Heat exchangers)

**Computer Aided Flow Sheet Synthesis**
Computerized physical property systems – physical property calculations, degrees of freedom in process design, degrees of freedom for a unit, degrees of freedom in a flow sheet, steady state flow sheeting and process design, approach to flow sheeting systems, introduction to sequential modular approach, simultaneous modular approach and equation solving approach, sequential modular approach to flow sheeting, examples. Tear streams, convergence of tear streams, partitioning and tearing of a flow sheet, partitioning and precedence ordering, tearing a group of units. Flow sheeting by equation solving methods based on tearing.

**Dynamic Simulation**
Numerical recipes in CLinear and nonlinear equations, Ordinary and partial differential equations, Dynamic simulation of stirred tanks system with heating Multi component system, Reactors, Absorption and distillation columns, Application of orthogonal collocation and weighted residuals techniques in heat and mass transfer systems, Introduction to special software for steady and dynamic simulation of Chemical engineering systems. Introduction to various commercial design software and optimizers used in field of chemical engineering.

**REFERENCES:**
2. Remirez, W.F. - " Computational methods for Process Simulations ", Butterworths, New York,

**COURSE OUTCOMES:**
At the end of the course, the student will be able to:
1. Get the knowledge about computer Aided Flow Sheet Synthesis
2. Computer aided equipment design of Evaporators; Distillation columns; Reactors, adsorption columns.
3. Understand the principles of Computer aided flow sheet synthesis
4. Understand the concept of dynamics simulation
5. Exposed to various design software.

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**COURSE OBJECTIVES:**
- To give student an understanding about the concept of cleaner production.
- To understand in detail, the methodologies involved
- Financial evaluation of cleaner production technologies
- To study the practical applications of cleaner production technologies

**Introduction**
Cleaner production definition: Evaluation of cleaner production, Cleaner production network, Area covered by cleaner production (what is not cleaner production?). Difference between cleaner production and other methods, End of the pipe treatment to curb pollution, prerequisites of cleaner production.

**Cleaner production technique**
Waste reduction at source, (a) Good housekeeping, (b) Process changes: change in raw material, batter process, control, equipment modification and technology changes, Recycling: on site recovery and reuse creation of useful byproducts, Product modification.

**Cleaner production methodology**
Methods of environmental protection -- preventive strategy, Methods of environmental protection -- preventive strategy, making team for cleaner production, Analyzing process steps, Generating C.P opportunities Selection of C.P solution, Implementing C.P solution

**Concept of cleaner production**
Overview of CP Assessment Steps and skills, Preparing for the site visit, Information Gathering, and process flow diagram, material balance, CP Option Generation Technical and Environmental feasibility analysis-Economic valuation of alternatives fuels, Total cost analysis-CP Financing-Establishing a program-Organizing a program preparing a program plan-Measuring progress
pollution prevention and cleaner production Awareness plan -Waste audit-Environmental Statement.

Energy audit related to cleaner production, Energy audit’s need and scope, Types of energy audit. Preliminary or walk through energy audit. Detailed energy audit, Methodology of energy audit, Energy balance and identifying the energy conservation opportunities.

Financial analysis of cleaner production
Gathering base line information, Determining the capital or investment cost, Establishing lifetime of equipment and annual depreciation, Determine revenue implication of the project. Estimating change in operating cost, Calculating incremental cash flow, Assessing project’s viability.

Case studies and Cleaner Production applications
Application (Industrial application of CP,LCA,EMS and Environmental Audits. C.P in chemical process industry, Practical ways & means to save material loss in loading/unloading and unit operations equipment like distillation column, drying and other equipments like heat exchanger, vacuum unit, conveying, etc. Practical ways & means for energy saving in industries. Case Studies of cleaner production.

REFERENCES:

COURSE OUTCOMES:
At the end of the course, the student will be able to:
1. Explain the concept and principles of cleaner production.
2. Suggest different unit operations in industrial production process to minimize pollutions.
3. Plan good housekeeping practices for Industry/other places with concern of safety, hygiene and waste reduction.
4. Suggest basic methods and techniques of pollution prevention during production.
5. Suggest cleaner production methods for a given situation which will also lead to cost reduction in long run

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## COURSE OBJECTIVE:
- Understand the role of business analytics within an organization.
- Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
- To become familiar with processes needed to develop, report, and analyze business data.
- Use decision-making tools/Operations research techniques.
- Mange business process using analytical and management tools.


Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.

Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.


REFERENCES:
2. Business Analytics by James Evans, persons Education.

COURSE OUTCOMES:
At the end of this course, Students will
1. Demonstrate knowledge of data analytics.
2. Able to think critically in making decisions based on data and deep analytics.
3. Able to use technical skills in predictive and prescriptive modeling to support business decision-making.
4. Demonstrate the ability to translate data into clear, actionable insights.
5. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

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COURSE OBJECTIVE:
- To know about Industrial safety programs and toxicology, Industrial laws, regulations and source models.
- To understand about fire and explosion, preventive methods, relief and its sizing methods

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment’s like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

REFERENCES:

COURSE OUTCOMES:
By the end of the course the students will be able to

1. Analyze the effect of release of toxic substances
2. Understand the industrial laws, regulations and source models.
3. Apply the methods of prevention of fire and explosions.
4. Understand the relief and its sizing methods.
5. Understand the methods of preventive maintenance

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<th>COURSE OBJECTIVE:</th>
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<td>• Identify and develop operational research models from the verbal description of the real system.</td>
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<td>• Understand the mathematical tools that are needed to solve optimisation problems.</td>
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<td>• Use mathematical software to solve the proposed models.</td>
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• Develop a report that describes the model and the solving technique, analyse the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models
Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

REFERENCES:
2. H.M. Wagner, Principles of Operations Research, 1982. PHI, Delhi,
3. J.C. Pant, Introduction to Optimisation: Operations Research, 2008 Jain Brothers, Delhi,

COURSE OUTCOMES:
At the end of the course, the student should be able to
1. Apply the dynamic programming to solve problems of discreet and continuous variables.
2. Apply the concept of non-linear programming
3. Carry out sensitivity analysis
4. Understand scheduling and sequencing
5. Model the real world problem and simulate it.

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<th>CHCEOECN</th>
<th>COST MANAGEMENT OF ENGINEERING PROJECTS</th>
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COURSE OBJECTIVE:
• Prepare engineering students to analyze cost/revenue data and carry out make economic analyses in the decision making process to justify or reject alternatives/projects on an economic basis.


Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis.


REFERENCES:
1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

COURSE OUTCOMES:
On completion of this course, the student will be able to:
1. Recognise the objectives of costing system and decision making
2. Understanding various stages of project execution and role of each member in project team
3. Analyse basic project cost and time information and produce simple estimates and plans
4. Identify and managing resources using PRT/CPM
5. Appraise project information and critique a project's likely success
COURSE OBJECTIVES:

- Students will be able to model, simulate and optimise the performance of composite structures as well as develop practical skills in one or more common manufacturing techniques.
- Students will be taught how to use and apply classical laminate theory to intelligently design laminates with tailored mechanical responses in commercial composite analysis software.
- The course will also include a design exercise for a composite component or structure.


Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

REFERENCES:


COURSE OUTCOMES:  
On successful completion of this course, students should have the skills and knowledge to:

1. Identify, describe and evaluate the properties of fibre reinforcements, polymer matrix materials and commercial composites.
2. Develop competency in one or more common composite manufacturing techniques, and be able to select the appropriate technique for manufacture of fibre-reinforced composite products.
3. Analyse the elastic properties and simulate the mechanical performance of composite laminates; and understand and predict the failure behaviour of fibre-reinforced composites.
4. Apply knowledge of composite mechanical performance and manufacturing methods to a composites design project.
5. Critique and synthesise literature and apply the knowledge gained from the course in the design and application of fibre-reinforced composites.

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<th>CHCEOECN</th>
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COURSE OBJECTIVES:  
- To enable students to understand the concept of Waste to Energy.
- To link legal, technical and management principles for production of energy form waste.
- To learn about the best available technologies for waste to energy.
- To analyze of case studies for understanding success and failures.
- To facilitate the students in developing skills in the decision making process.

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors


Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.
Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

REFERENCES:

COURSE OUTCOMES:
On successful completion of this course the students will be able to:
1. Apply the knowledge about the operations of Waste to Energy Plants
2. Analyse the various aspects of Waste to Energy Management Systems
3. Carry out Techno-economic feasibility for Waste to Energy Plants
4. Apply the knowledge in planning and operations of Waste to Energy plants