ANNAMALAI UNIVERSITY

Annamalainagar

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF CHEMICAL ENGINEERING

B.E. Chemical Engineering

Four Year Degree Programme

Choice Based Credit System

(Part - Time)

HAND BOOK

2016 - 2017

ANNAMALAI UNIVERSITY

FACULTY OF ENGINEERING AND TECHNOLOGY

B.E. (3½ year PART TIME) DEGREE PROGRAMME
Choice Based Credit System (CBCS)

REGULATIONS

1. Condition for Admission

Candidates for admission to First year of the 3½ year B.E. Degree Programme by part-time shall be required to have passed the Diploma examination in the appropriate branch conducted by state Board of Technical Education of Tamil Nadu or its equivalent Examination accepted by the Syndicate of this University. They shall satisfy the conditions regarding eligibility norms as may be prescribed by the Syndicate of the Annamalai University from time to time.

A Pass in anyone of the Diploma Programmes (listed in Annexure-I) conducted by the State Board of Technical Education of Tamil Nadu or its equivalent examination with 2 years professional experience in a recognized industry or organization after passing the Diploma Examination.

The admission is restricted to those working or residing within a radius of 90 km from Annamalainagar. The application should be sent through their employers.

However the advance copy with all documents complete in all respects should be received before the prescribed last date. The application through proper channel to be received before entrance test.

2. Courses of study and Scheme of Examinations

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

3. Choice Based Credit System (CBCS)

The curriculum includes six components namely Humanities/Social Sciences/Management, Basic Sciences, Engineering Sciences, Professional Core, Professional Electives and Open Electives in addition to Project work. Each semester curriculum shall normally have a blend of theory and practical courses. The total credits for the entire degree Programme is 101.

4. Eligibility for the Degree

A candidate shall be eligible for the degree of Bachelor of Engineering if the candidate has satisfactorily undergone the prescribed courses of study for a period of 3½ years and has passed the prescribed examinations of all the courses of study. For the award of the degree, a student has to earn a minimum of 101 credits.

5. Assignment of Credits for Courses

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

6. Duration of the programme

A student is normally expected to complete the B.E. programme in 3½ years but in any case not more than eight years from the time 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 enroll for the courses intended to be credited in the succeeding semester in the current semester itself by completing the registration form indicating the list of courses. This registration will be done a week before the last working day of the current semester.

A student is required to earn 101 credits in order to be eligible for obtaining the degree.

8. Project Work

The student typically registers for project at the end of sixth semester and completes it at the end of the seventh semester along with the courses prescribed for study in the seventh semester. After completing his / her project work, submit the project report and appear for viva-voce examination at the end of seventh semester.

9. Electives

The elective courses fall under two categories: Professional Electives and Open Electives. The Professional Elective courses are offered in the concerned

branch of specialization and a student can choose the Professional Elective courses with the approval of the Head of the Department concerned. Apart from the various Professional elective courses, a student can choose the open electives from any specialization offered in any Department in the Faculty of Engineering and Technology during the entire period of study, with the approval of the Head of the Department and the Head of the Department offering the course.

10. Assessment

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

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

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

First assessment (Test-I)	**: 15 marks**
Second assessment (Test-II)	**: 15 marks**
Maintenance of record book	**: 10 marks**
End Semester Examination	**: 60 marks**

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

11. Substitute Assessment

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

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

12. Student Counsellors (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 counsellor for those students throughout their period of study. Such student counsellors shall advise the students, give preliminary approval for the courses to be taken by the students during each semester and obtain the final approval of the Head of the Department.

13. Class Committee

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

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

The class committee shall meet two times during the semester. The first meeting will be held within a week after the completion of the first assessment to review the performance and for follow-up action like test, assignment etc. for the third assessment and the dates of completion of the assessments will also be decided.

The second meeting will be held after all the assessments but at least one week before the commencement of the University examinations. During this meeting the assessment for a maximum of 25 marks for theory / 40 marks for practical courses and project work 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.

14. 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.

15. Temporary break of study

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

The student applies for break of study, the student shall apply to the Dean in advance, in any case, not later than the last date of the first assessment period. The application duly filled by the student shall be submitted through the Head of the Department.

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

16. Procedure for withdrawing from the Examinations

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

17. Passing and Declaration of Examination Results

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

90 to 100 marks	**:**	**Grade 'S'**
80 to 89 marks	**:**	**Grade 'A'**
70 to 79 marks	**:**	**Grade 'B'**

60 to 69 marks	**:**	**Grade 'C'**
55 to 59 marks	**:**	**Grade 'D'**
50 to 54 marks	**:**	**Grade 'E'**
Less than 50 marks	**:**	**Grade 'RA'**
Withdrawn from the examination	**:**	**Grade 'W'**

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

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

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

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

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

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

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

A student can apply for re-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.

18. Awarding degree

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

- **For First Class with Distinction, the student must earn a minimum of 101-credits within 3½ years from the time of admission , pass all the courses in the first attempt and obtain a CGPA of 8.25 or above for all the courses from I Semester to VII Semester.**
- **For First Class, the student must earn a minimum of 101 credits within four and half years from the time of admission and obtain a CGPA of 6.75 or above for all the courses from I Semester to VII Semester .**
- **For Second Class, the student must earn a minimum of 101 credits within eight years from the time of admission.**

19. Ranking of Candidates

The candidates who are eligible to get the B.E. degree in the First Class with Distinction will be ranked together on the basis of CGPA for all the courses of study from I Semester to VII Semester .

The Candidates passing with First Class will be ranked next after those with distinction on the basis of CGPA for all the courses of study from I Semester to VII Semester.

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

20. Transitory Regulations

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

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

Annexure-I

Diploma Programmes Eligible for the B.E (Part Time)
Programmes offered in FEAT (from 2017-2018)

Sl.No.	Branches of Study	Eligible Diploma Programme (FT / PT / SW)
1	**Civil Engineering**	Civil Engineering
2	**Civil and Structural Engineering.**	Civil Engineering(Architecture)
		Environmental Engineering and Pollution Control(Full Time)
		Architectural Assistantship
		Civil Engineering (Rural Tech.)
		Civil and Rural Engineering
3	**Mechanical Engineering**	Mechanical Engineering
		Mechanical and Rural Engineering
4	**Mechanical Engineering (Manufacturing Engineering)**	Mechanical Design and Drafting
		Production Engineering
		Production Technology
		Automobile Engineering
		Automobile Technology
		Metallurgy
		Mechatronics Engineering
		Machine Tool Maintenance and Repairs
		Tool and Die making
		Tool Engineering
		Tool Design
		Foundry Technology
		Refrigeration and Air Conditioning
		Agricultural Engineering
		Agricultural Technology
		Marine Engineering
		Mechanical Engineering (Production)
		Mechanical Engineering (Tool &Die)
		Automobile Technology
		Mechanical Engineering (Foundry)
		Mechanical Engineering(R & A.C.)
		Electronics (Robotics)
		Mining Engineering
		Agricultural Engineering and Farm

		Equipment Technology
5	**Electrical and Electronics Engineering**	Electrical and Electronics Engineering
6	**Electronics and Instrumentation Engineering**	Electronics and Communication Engg.
		Electronics and Instrumentation Engg
		Electronics Engineering (Instrumentation)
		Instrument Technology
		Instrumentation and Control Engineering
		Electrical Engineering (Instruments and Control)
		Electrical Engineering
		Instrumentation Technology
		Electronics (Robotics)
		Mechatronics Engineering
7	**Chemical Engineering**	Petrochemical Engineering
		Chemical Engineering
		Environmental Engineering and Pollution Control
		Leather Technology (Footwear)
		Leather Technology
		Plastic Technology
		Polymer Technology
		Sugar Technology
		Textile Technology
		Chemical Technology
		Ceramic Technology
		Petro Chemical Technology
		Pulp & Paper Technology
		Petroleum Engineering
8	**Computer Science and Engineering**	Electronics and Communication Engineering
9	**Information Technology**	Computer Technology
		Computer Science and Engineering
10	**Electronics and Communication Engineering**	Information Technology
		Computer Engineering
		Computer Networking
		Electronics (Robotics)
		Mechatronics Engineering

FT- Full Time; PT-Part Time; SW- Sandwich

DEPARTMENT OF CHEMICAL ENGINEERING

Vision

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

Mission

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

PROGRAMME SPECIFIC OUTCOMES (PSO's)

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

- **PSO 2:** Investigate and demonstrate innovative practices to develop processes and products and provide services with optimal utilization of resources with sustainability and ethics.
- **PSO 3:** Administer professional engineering competence to analyze and interpret data in engineering, economics and management to exhibit as an individual, leader and entrepreneur with ability to efficiently communicate, work effectively in diversified environments and pursue lifelong learning for careers in industry, academics and research

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PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

- **PEO1:** To master the basic principles with ability to apply mathematics, physics, chemistry and biology and to understand and apply the same in the practice of modern technologies.

- **PEO2:** To excel in designing and optimization of the processes and systems by analysis and evaluation with the knowledge of basic engineering sciences of mass and energy balances: Thermodynamics of physical & chemical equilibria: heat, mass & Momentum transfer with economic principles.

- **PEO3:** To develop the ability to express ideas with understanding of social and cultural context of work associated with environmental, safety and economic aspects and high standards of ethical practice.

- **PEO4:** To acquire the ability to solve problems in a broad range of career in multi-disciplinary professional team with effective management skills, moral responsibility applying critical thinking with leadership qualities at par with contemporary and global outlook.

- **PEO5:** The ability to cater the needs of Chemical industry, research organizations and academic institutes

PROGRAM OUTCOMES (POs)

- **PO 1 Engineering Knowledge**:
  Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **PO 2 Problem Analysis**:
  Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **PO 3 Design/Development of Solutions**:
  Designsolutionsforcomplexengineeringproblemsanddesignsystemcomponentsor processes
  thatmeetthespecifiedneedswithappropriateconsiderationforthepublichealthandsafety, and the cultural, societal, and environmental considerations.
- **PO 4 Conduct Investigations of Complex Problems**:
  Use research-based knowledge and research methods including design of experiments,analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **PO 5 Modern Tool Usage**:
  Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- **PO 6 The Engineer and Society**:
  Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- **PO 7 Environment and Sustainability:**
  Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- **PO 8 Ethics:**
  Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

- **PO 9 Individual and Team Work:**

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

- **PO10 Communication:**

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

- **PO 11 Project Management and Finance:**

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

- **PO 12 Life-Long Learning:**

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

Curriculum for B.E. (Part-Time) in Chemical Engineering
(For the Batch joining in 2017-2018)

Semester	No. of Courses		HS	BS	ES	PC	PE	OE	Proj.	Total Credit
	T+P	Total								
I	4+1	**5**	-	4	3	8	-	-	-	15
				1	1	2+1				
II	4+1	**5**	-	4	-	11	-	-	-	15
				1		3+1				
III	4+1	**5**	-	-	-	11	3	-	-	14
						3+1	1			
IV	4+1	**5**	-	-	-	11	3	-	-	14
						3+1	1			
V	4+1	**5**	3	-	-	5	6	-	-	14
			1			1+1	2			
VI	4+1	**5**	-	-	-	5	6	3	-	14
						1+1	2	1		
VII	3+1	**4**	3	-	-	-	3	3	6	15
			1				1	1	1	
Total Courses	27+7	**34**	**2**	**2**	**1**	**13+6**	**7**	**2**	**0+1**	**-**
Total credits →			**6**	**7**	**3**	**52**	**21**	**6**	**6**	**101**
			6 Practical Courses can be Professional Core or Professional Elective Labs.							

Legend:

HS - Humanities / Social Sciences / Management
BS - Basic Science
ES - Engineering Science
PC - Professional Core
PE - Professional Elective
OE - Open Elective
Proj. - Project
T - Theory
P - Practical / Proj

Code	Details	Code	Details
00	Common course for the faculty	06	Electronics and Instrumentation Engg. Course
01	Civil Engg. Course	07	Chemical Engg. Course
02	Civil and Structural Engg. course	08	Computer Science and Engg. course
03	Mechanical Engg. Course	09	Information Technology course
04	Mechanical(Manufacturing) Engg. Course	10	Electronics and Communication Engg. Course
05	Electrical and Electronics Engg. Course	XX	Code of the programme concerned (01 to 10)

Course Nos. **105,205, 305,405,505,605** are all Practical Courses that can be Professional Core Labs or Professional Elective Labs.

If a Practical Course is Professional Core Lab then the Course Code is **P06CP105**

If a Practical Course is Professional Elective Lab then the Course Code is **P06EP105**

Course Code in the 2nd Column represents the Part-Time course whereas the last column is the corresponding course code in the full time programme which can be from any semester

Code	Details	Code	Details
HS	Humanities Theory	PE	Professional Elective Theory
BS	Basic Science Theory	EP	Professional Elective Lab
ES	Engineering Science Theory	OE	Open Elective Theory
PC	Professional Core Theory	PV	Project and Viva-voce
CP	Professional Core Lab		

Sl. No.	Course Code	Category	Course	L	T	P	Exam	CA	Total	Credits	Equivalent Course Code in B.E. Full Time
Semester – I											
1	P00BS101	**BS**	Mathematics	4	-	-	75	25	100	4	—
2	P07ES102	**ES**	Engineering Mechanics	4	-	-	75	25	100	3	00ES303
3	P07PC103	**PC**	Chemical Process Industries	4	-	-	75	25	100	3	07PC406
4	P07PC104	**PC**	Process Calculation	4	-	-	75	25	100	3	07PC306
5	P07CP105	**CP**	Chemical Technology Lab	-	-	3	60	40	100	2	07CP408
Total →				**16**	**-**	**3**	**360**	**140**	**500**	**15**	**-**

Sl. No.	Course Code	Category	Course	L	T	P	Exam	CA	Total	Credits	Equivalent Course Code in B.E. Full Time
Semester –II											
1	P00BS201	**BS**	Numerical Methods	4	-	-	75	25	100	4	07BS401
2	P07PC202	**PC**	Fluid Mechanics for Chemical Engineers	4	-	-	75	25	100	3	07PC403
3	P07PC203	**PC**	Particle mechanics & Mechanical Operation	4	-	-	75	25	100	3	07ES304
4	P07PC204	**PC**	Heat Transfer	4	-	-	75	25	100	3	07PC404
5	P07CP205	**CP**	FM & PM lab	-	-	3	60	40	100	2	07CP407 & 07SP307
Total →				**16**	**-**	**3**	**360**	**140**	**500**	**15**	**-**

Sl. No.	Course Code	Category	Course	L	T	P	Exam	CA	Total	Credits	Equivalent Course Code in B.E. Full Time
Semester –III											
1	P07PC301	**PC**	Chemical Engineering Thermodynamics I	4	-	-	75	25	100	3	07PC502
2	P07PC302	**PC**	Chemical Reaction Engineering I	4	-	-	75	25	100	3	07PC501
3	P07PC303	**PC**	Mass Transfer	4	-	-	75	25	100	3	07PC405
4	P07PE304	**PE**	Professional Elective -I	4	-	-	75	25	100	3	07PE505
5	P07CP305	**CP**	Heat & Mass Transfer Lab	-	-	3	60	40	100	2	07CP507 & 07CP508
Total→				**16**	**-**	**3**	**360**	**140**	**500**	**14**	**-**

Sl. No.	Course Code	Category	Course	L	T	P	Exam	CA	Total	Credits	Equivalent Course Code in B.E. Full Time
Semester –IV											
1	P07PC401	**PC**	Chemical Engineering Thermodynamics II	4	-	-	75	25	100	3	07PC602
2	P07PC402	**PC**	Momentum Transfer Operation	4	-	-	75	25	100	3	07PC503
3	P07PC403	**PC**	Chemical Reaction Engineering II	4	-	-	75	25	100	3	07PC601
4	P07PE404	**PE**	Professional Elective –II	4	-	-	75	25	100	3	07PE506
5	P07CP405	**CP**	CRE &Thermodynamics lab	-	-	3	60	40	100	2	07CP607& 07EP509
Total→				**16**	**-**	**3**	**360**	**140**	**500**	**14**	**-**

Sl. No.	Course Code	Category	Course	L	T	P	Exam	CA	Total	Credits	Equivalent Course Code in B.E. Full Time
Semester –V											
1	P00HS501	**HS**	Environmental Studies	4	-	-	75	25	100	3	00HS301
2	P07PC502	**PC**	Process Instrumentation Dynamics and Control	4	-	-	75	25	100	3	07PC504
3	P07PE503	**PE**	Professional Elective –III	4	-	-	75	25	100	3	07PE603
4	P07PE504	**PE**	Professional Elective –IV	4	-	-	75	25	100	3	07PE604
5	P07CP505	**CP**	Process Control Lab	-	-	3	60	40	100	2	07CP608
Total→				**16**	**-**	**3**	**360**	**140**	**500**	**14**	**-**

Sl. No.	Course Code	Category	Course	L	T	P	Exam	CA	Total	Credits	Equivalent Course Code in B.E. Full Time
Semester –VI											
1	P07PC601	**PC**	Process Engineering Economics	4	-	-	75	25	100	3	07PC702
2	P07PE602	**PE**	Professional Elective –V	4	-	-	75	25	100	3	07PE605
3	P07PE603	**PE**	Professional Elective -VI	4	-	-	75	25	100	3	07PE703
4	*PXXOE604	**OE**	Open Elective –I	4	-	-	75	25	100	3	XXOE606
5	P07CP605	**CP**	Chemical Plant Equipment Design& Drawing Laboratory	-	-	3	60	40	100	2	07CP706
Total→				**16**	**-**	**3**	**360**	**140**	**500**	**14**	**-**
*Second and third digits (**that is XX**) indicate thecode of the Department / branch offering the elective Course											

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Sl. No.	Course Code	Category	Course	L	T	P	Exam	CA	Total	Credits	Equivalent Course Code in B.E. Full Time
Semester –VII											
1	P00HS701	**HS**	Engineering Ethics	4	-	-	75	25	100	3	00HS701
2	P07PE702	**PE**	Professional Elective -VII	4	-	-	75	25	100	3	07PE704
3	*PXXOE703	**OE**	Open Elective-II	4	-	-	75	25	100	3	XXOE705
4	P07PV704	**PV**	Project Work and Viva-voce		-	8	60	40	100	6	07PV803
Total→				**12**	**-**	**8**	**285**	**115**	**400**	**15**	**-**
*Second and third digits (**that is XX**) indicate thecode of the Department / branch offering the elective Course.											

PROFESSIONAL ELECTIVES - THEORY

1. Process Modeling & Simulation
2. Polymer Engineering
3. Biochemical Engineering
4. Electrochemical Engineering
5. Nuclear Engineering
6. Nanotechnology
7. Chemical Works Organization and Management
8. Air Pollution &Control
9. Wastewater Treatment Technology
10. Environmental Engineering
11. Fluidization Engineering
12. Mixing Theory and Practice
13. Petroleum Refining and Petrochemicals
14. Hydrocarbon Processing and Engineering
15. Distillation
16. Membrane Science and Engineering
17. Analytical Techniques
18. Food Processing Technology
19. Industrial Biotechnology
20. Modern Separation Processes

OPEN ELECTIVES - THEORY

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

FIRST SEMESTER

P00BS101	MATHEMATICS	L	T	P
		4	0	0

COURSE OBJECTIVES

To acquaint the student with the concepts in matrices, ordinary differential equations, partial differential equations, Laplace transforms and Fourier series, which are most important in connection with practical engineering problems.

UNIT I: Matrices

Characteristic equation – Eigen values and eigen vectors of a real matrix – Properties – Cayley-Hamilton theorem – Orthogonal transformation of a real symmetric matrix to diagonal form – Quadratic form – Reduction of quadratic form to canonical form by orthogonal transformation.

UNIT II: Ordinary Differential Equations

Second order linear differential equations with constant coefficients, Second order linear differential equations with variable coefficients (Euler and Legendre's linear equations), Variation of parameters.

UNIT-III: Partial Differential Equations

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

UNIT IV: Laplace Transform

Definition, Transform of elementary functions, Properties, Derivatives and integrals of transforms, Transforms of derivatives, Inverse Laplace transform, Application to solution of linear ordinary differential equations of second order with constant coefficients.

UNIT-V: Fourier Series

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

(In all units, proof of theorems are not included)

TEXT BOOKS:

1. Venkataraman M K, Engineering Mathematics, Volumes I (2008) and II (2009), The National Publishing Company, Chennai.
2. Veerarajan T, Engineering Mathematics, Second Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.

REFERENCE BOOKS:

1. Grewal B S, Higher Engineering Mathematics, Khanna Publishers, Delhi, 40th Edition, 2007.

2. Erwin Kreysig, Advenced Engineering Mathematics, John Wiley & Sons, 8th Edition, 2002.
3. Kandasamy.P , Tilagavathy.K and Gunavathy.K, Engineering Mathematics ,6th ed., (Vol-I & II) S.Chand& Co Ltd. 2006, New Delhi.

COURSE OUTCOMES:

At the end of this course, students will able to

1. Solve eigen values and eigen vectors of a real matrix and Orthogonal transformation of a matrix.
2. Analyze the curvesby finding its curvature and evolutes.
3. Understand the extreme values for functions of two variables.
4. Evaluate double and triple integrals.
5. Apply Laplace transform in solving differential equations.

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

P07ES102	Engineering Mechanics	L	T	P
		4	0	0

Course Objectives:

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

UNIT I: Statics Of Particles

Introduction-Units and Dimensions-Laws of Mechanics-Lami's Theorem-Parallelogram, Triangular and Polygon Law of Forces-Classification of Forces-Vectorial Representation of Forces-Coplanar Forces-Resolution of Forces.
Equilibrium of Particle-Vector representation of Space Force-Equilibrium of Particle in Space-Equivalent System of Forces-Principle of Transmissibility.

UNIT II: Equilibrium Of Rigid Bodies

Free Body Diagram-Types of Supports- Types of loads- Types of beams-Action and Reaction of Forces- -Moments and Couples-Moment of a Force-Vectorial Representation of Moments and Couples.
Varignon's Theorem- Stable Equilibrium-Single Equivalent Force-Equilibrium of Rigid Bodies in Two Dimensions and Three Dimensions.

UNIT III: Geometrical Properties Of Surfaces And Solids

Centroid and Centre of Gravity-Determination of Centroid of Sections of Different Geometry-Centre of Gravity of a Body-Area Moment of Inertia-Parallel Axis Theorem-Perpendicular Axis Theorem-Determination of Moment of Inertias of Rectangular, Triangular, Circular and Semi-circular- Moment of Inertias of structural Steel Sections of Standard and Composite Sections.Polar Moment of Inertia-Radius of Gyration-Principal Moment of Inertia-Mass Moment of Inertia- Determination of Mass Moment of Inertia of a Thin Rectangular Plate, Thin Circular Disc, Solid Cylinder, Prism, Sphere and Cone from first principles.

UNIT IV: Dynamics Of Particles

Introduction-Kinematics and Kinetics-Displacements, Velocity and Acceleration-Equations of Motion-Types of Motion-Rectilinear Motion-Relative Motion-Curvilinear Motion-Projectiles.Newton's Laws of Motion-Linear Momentum-Impulse and Momentum-D'Alembert's Principle-Dynamic Equilibrium- Work Energy Equations-Law of Conservation of Energy-Principle of Work and Energy.

UNIT V: Friction And Elements Of Rigid Body Dynamics

Friction Force-Laws of Sliding Friction-Equilibrium Analysis of simple systems with Sliding Friction-Wedge Friction.
Rolling Resistance-Translation and Rotation of Rigid Bodies-Velocity and Acceleration-General Plane Motion of Simple Rigid Bodies such as Cylinder, Disc/Wheel and Sphere.

Text Books:

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

Reference Books:

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

Course Outcomes:

At the end, students can able to

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

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

P07PC103	Chemical Process Industries	L	T	P
		4	0	0

Course Objectives:

- To study process technologies of various inorganic process industries
- The purpose of the subject is to improve knowledge of the chemical processes along with emphasis on recent technological development
- Unit operations involve the physical separation of the products obtained during various unit processes.
- To study process technologies of various organic and inorganic process industries

Unit- I

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

UNIT – II

Nitrogen Industry - Ammonia, Ammonium sulfate, Ammonium Phosphate, urea, Nitric acid, Nitro Phosphate. Phosphorous Industry- Phosphorus, phosphoric acid Calcium phosphate, Sodium phosphate, Mixed Fertilizers and compound super phosphates.

UNIT-III

Silicate industry Ceramics, Glass and Cement, paint, Varnish, Enamel, pigments - Lithophone, Titanium di oxide and Lacquer. Bromine and Bromides, Fluorine and Flurochemicals

Unit – IV

Sugar, starch, glucose, pulp, paper, leather, glue and gelatin. Petroleum refining Processes, Oils, fats, soaps, glycerin, synthetic detergents, absolute alcohol and antibiotics.

UNIT - V

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

Text Book

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

Reference Books

1. Shukla,S.D, Pandey,G.N., Text Book of Chemical Technology, Vol.I, Vikas Publishing Company - 1977.
2. Kirk and Othmer, Encyclopedia of Chemical Technology 3rd Edn. , John Wiley. 3. Faith, Keys, Clark and M.K.Moran., Industrial Chemicals, 4th Edn.,Wiley International.
3. Pandey,G.N., A Text Book of Chemical Technology, Vikas Publishing Company, Vol. II, 1997.

Course Outcomes:

At the end, students can able to

1. Classify various industrial gases and chemical compounds produced in chemical industry
2. Explain about manufacture of Nitrogen and Phosphorous compounds and its applications
3. Develop the knowledge of production of various inorganic chemical compounds
4. Illustrate the importance of organic compounds and petroleum refinery operations
5. Describe about the applications of polymerization involved in the process industries

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

07PC104	**Process Calculations**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- To enable the students understand the quantitative approach of chemical engineering operations
- To introduce the basics of Stoichiometry, mass balance and energy balances
- To throw light on various concepts in thermo chemistry and thermo physics

Unit - I

Introduction Stoichiometric and composition relations, Excess and limiting reactants, Degree of completion. Ideal Gas Ideal gas law and its applications. Dissociating gases, gas mixture &Vapour pressure - Effect of temperature Vapor pressure plots. Vapor pressure of immiscible Liquids. Raoult's law, relative vapor pressure.

Unit - II

Humidity and saturation: Humidity chart. Relative & percent saturation evaporation and condensation processes. Solubility and crystallization: Mass balance and yield calculations in dissolution and crystallization processes. Solubility of gases (Henry's law).

Unit - III

Material Balance: Calculation for Batch and Continuous Processes, Recycling Process, by pass and purging operation. Fuels and Combustion: Problems on combustion of solids. liquids and Gaseous fuels and pyrites. Two stage conversion of SO_2 to SO_3.

Unit - IV

Thermo Physics and Thermo Chemistry: Mean specific heat. Heat of fusion & vaporization.Heat of formation, combustion and reaction. Degree of conversion based on inlet and outlet temperature. Enthalpy - Theoretical flame temperature.

Unit - V

Energy balance for the systems with and without chemical reactions. Unsteady state material balance. Unsteady state energy balance.

Text Books:

1. Hougen,O.A.,Watsen,K.M., and R.A.Ragartz, Chemical Process Principles, part - I, John Wiley and Asia Publishing Co.,II edition 1975.
2. Bhatt,B.I., and S.M.Vohra, Stoichiometry, Tata McGraw Hill. IIIrd ed. 2007.

Reference Books :

1. Himmelblau,D.M.,Basic Principles and Calculations in Chemical Engineering. VIII Ed. 2012.
2. Mayers and Seider, Introduction to Chemical Engineering and Computer Calculations, Prentice Hall. III ed. 1982
3. Asokan, K., Chemical Process Calculations, First Edn., Universities Press, Hyderabad.2007

Course Outcomes:

At the end, students can able to

1. Discuss the fundamentals of various engineering knowledge.
2. Illustrate various aspects of fundamentals of physics and chemistry.
3. Explain quantitative approach material balance basic chemical engineering operations.
4. Focus on problem analysis involving stoichiometry,concepts of thermophysics and thermo chemistry.
5. Generalize on problem analysis to energy balance of chemical engineering operations

Mapping with POs & PSOs															
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	3	-
CO2	2	3	2	2	-	-	-	-	-	-	-	-	3	2	-
CO3	2	2	2	3	-	-	-	-	-	-	-	-	3	0	-
CO4	2	2	3	2	-	-	-	-	-	-	-	-	3	1	-
CO5	3	3	3	2	-	-	-	-	-	-	-	-	3	1	-

07PC105	Chemical Technology Laboratory	L	T	P
		0	0	3

Course Objectives:

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

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

Course Outcomes:

At the end, students can able to

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

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

SECOND SEMESTER

P00BS201	Numerical Methods	L	T	P
		4	0	0

Course Objectives:

- Providing the necessary basic concepts of a few numerical methods
- To give procedures for solving numerically different kinds of problems occurring in engineering and technology.

UNIT I Solution Of Equations And Eigenvalue Problems

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Matrix Inversion by Gauss Jordan method - Eigenvalues of a matrix by Power method.

UNIT II Interpolation And Approximation

Interpolation with unequal intervals - Lagrange's interpolation – Newton's divided difference interpolation – Cubic Splines - Interpolation with equal intervals - Newton's forward and backward difference formulae.

UNIT III Numerical Differentiation And Integration

Approximation of derivatives using interpolation polynomials – Numerical integration using Trapezoidal, Simpson's 1/3 rule – Romberg's method – Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.

UNIT IV Initial Value Problems For Ordinary Differential Equations

Single Step methods - Taylor's series method - Euler's method – Modified Euler's method - Fourth order Runge-Kutta method for solving first order equations - Multi step methods - Milne's and Adams-Bashforth predictor corrector methods for solving first order equations.

UNIT V Boundary Value Problems In Ordinary And Partial Differential Equations

Finite difference methods for solving two-point linear boundary value problems - Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

Text books

1. Grewal. B.S., and Grewal. J.S., " Numerical methods in Engineering and Science", Khanna Publishers, New Delhi, 9th Edition, 2007.
2. Gerald. C. F., and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, New Delhi, 6th Edition, 2006.

References

1. Chapra. S.C., and Canale.R.P., "Numerical Methods for Engineers, Tata McGraw-Hill, New Delhi, 5th Edition, 2007.
2. Brian Bradie. "A friendly introduction to Numerical analysis", Pearson Education, Asia, New Delhi, 2007.

3. Sankara Rao. K., "Numerical methods for Scientists and Engineers", Prentice Hall of India Private Ltd., New Delhi, 3rd Edition, 2007.

Course Outcomes:

At the end, students can able to

1. Helps the students to have a clear perception of the power of numerical techniques and ideas and to solve alhebraic equations, transcendental and eigen value problems.
2. Demonstrate a function using an appropriate numerical method and to solve interpolation and approximation problems
3. Derive numerical methods for various mathematical operations and tasks, such as differentiation, integration
4. Solve an Ordinary differential equation using an appropriate numerical method
5. Solve partial differential equations using an appropriate numerical method and to demonstrate the applications of these techniques to problems drawn from industry, management and other engineering fields.

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

P07PC202	Fluid Mechanics for Chemical Engineers	L	T	P
		4	0	0

Course Objectives:

- To develop an understanding of fluid statics and dynamics in chemical engineering
- To understand and use differential equations to determine pressure and velocity variation in fluid flows.
- To understand the concept of viscosity
- To use dimensional analysis to design physical or numerical experiments

UNIT I: Fluid Statics and Its Applications:

Unit systems-conversion of units- Dimensional analysis-Basic concepts; fluid mechanics
Hydrostatic equilibrium-application of fluid statics-manometers, continuous gravity decanter and centrifugal decanter

UNIT II: Fluid Flow Phenomena:

Rheological properties of fluids-laminar and turbulent flow-boundary layers
Basic equations of flow- continuity equation, mechanical energy equation. Bernoulli equation and correction factors, pump work in Bernoulli equation.

UNIT III: Flow of Incompressible Fluids

Incompressible flow in pipes-shear stress and skin friction in pipes, friction factor, flow in noncircular channels, laminar and turbulent flow in pipes and channels, friction factor chart, friction loss from sudden contraction and expansion

UNIT IV: Flow of compressible Fluids and Flow Past Immersed Bodies

Compressible fluids: Definitions and basic equations, velocity of sound, Mach number, asterisk condition, process of compressible flow, adiabatic friction flow, property equations, isothermal friction flow.

Drag and drag coefficients, flow through beds of solids-Ergun's equation. Motion of particles through fluids-terminal velocity, Stoke's law and Newton's law.Hindered settling.

UNIT V:Transportation and metering of fluids

Pipes, fittings and valves. Pumps - power requirement, suction lift and cavitation. Classification of pumps - positive displacement and centrifugal pumps.Introduction to fans, blowers and compressors, selection criteria of pumps.
Measurement of flowing fluids-venturi meter, orifice meter, rotameter, pitot tube, magnetic flow meter.

Text Book

1. McCabe,W.L, Smith,J.C and P.Harriot., Unit Operations of Chemical Engineering, Seventh Edn., McGraw Hill, 2005.

Reference Books:

1. Noel De Nevers, Fluid Mechanics for Chemical Engineers, Third Edn.,McGraw Hill, 2005.
2. J.M.Coulson, J.F. Richardson's, Chemical Engineering, Vol.1., VI Edition, 1999.

Course Outcomes:

At the end, students can able to

1. Understand the fundamentals of fluid mechanics, concepts of mass and momentum conservation.
2. Able to apply the Bernoulli equation and potential flow theory to solve problems in fluid mechanics.
3. Understand and articulate the principles that are in operation in a range of fluid motive and flow measuring devices.
4. Use appropriate modelling tools to design pipelines and equipment and Undertake basic design calculations of fluid engineering systems
5. Knowledge of basic principles of transportation and metering of fluids

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

CO5	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-

P07PC203	Particle Mechanics and Mechanical Operations	L	T	P
		4	0	0

Course Objectives:

To understand basic principles of various mechanical operations, construction and working of the equipments.

Unit I

Introduction, Particle shape, different ways of particle size, shape factor, sphericity. Mixed particle size analysis, Screen- ideal and actual screens, Differential and cumulative screen analysis – Problems, Effectiveness of screen, Derivation and problems

Unit II

Size reduction - Types of forces used for communication, criteria for communication, characteristics of comminuted products

Laws of size reduction, Work Index, Energy Utilization, Problem related to size reduction

Methods of operating crushers-Free crushing, Choke feeding, Open circuit grinding, Closed circuit grinding, Wet and Dry grindings

Equipment for size reduction-classification of size reduction equipment, Blake jaw crusher, Gyratory crusher, smooth roll crusher, toothed roll crusher, Attrition mill

Ball mill, Critical speed of ball mill, Derivation and problem related to critical speed

Unit III

Gravity settling, sedimentation, thickening, Basket centrifuge. - Settling velocity, Terminal settling velocity, Free and Hindered settlings.

Industrial dust removing equipments: Cyclone separator, Electrostatic precipitator, Magnetic separator, Floatation and Jigging

Unit IV Filtration

Introduction, Classification of filtration, Cake filtration, Clarification, Batch and continuous filtration, Pressure filtration and Vacuum filtration, constant rate filtration and cake filtration, Characteristics of filter media, Industrial filters, Sand filters, Centrifugal filtration, Filter press, Leaf filter, Rotary drum filter, Filter aids, Application of filter aids, Principles of cake filtration

Unit V Mixing, Agitation and Storage of Solids

Mixing of solids, Types of mixers-Constructional features and working principles, Mixing Index, Ribbon blender, Internal screw mixer, Tumbling mixer

Agitation equipment, Flow pattern in agitated vessel Standard turbine design, Power correlations and calculations. Application of Agitation,

Storage of solids-Bunkers, silos, Bins and hoppers

Text Books:

1. McCabe,W.L, Smith,J.C and P.Harriot., Unit Operations of Chemical Engineering, 6th edn., McGraw Hill, 2006

2. Coulson,J.M., Richardson,J.F, Backhurst,J.R. and J.H.Harker Chemical Engineering, Vol.2, 4th Edn., Asian Books, 1998

Reference Books:

1. Foust, A.S, Wenzel, L.A, Clump, C.W., Maus, L. and Anderson, L.B., Principles of Unit Operations, John Wiley (2008) 2nd ed.
2. Narayanan, C.M. and Bhattacharya, B.C., Mechanical Operations for Chemical Engineers Incorporating Computer Aided Analysis, Khanna Publishers (2005).
3. Brown G. G., "Unit operations", CBS publishers.(2005)

Course Outcomes:

At the end, students can able to

1. Know the significance and usage of different particulate characterization parameter and equipment to estimate them.
2. Describe size reduction energy requirement, estimate performance of equipment, selection and sizing of equipment.
3. Calculate drag force and terminal settling velocity for a single particle and equipment used for the removal of dust particle.
4. Analyze filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage.
5. Analyze different process and equipment involved in mixing and agitation, different solid storage vessel used.

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

P07PC204	Heat Transfer	L	T	P
		4	0	0

Course Objective

- To enable the students to learn heat transfer by conduction, convection and radiation and heat transfer equipments like evaporator and heat exchanger

UNIT – I: Heat Transfer by conduction

Importance of heat transfer in Chemical Engineering operations – Modes of Heat Transfer - Fourier's law, Conduction in steady state, Heat flow analysis for various profiles viz. Flat wall, Composite wall, Cylinder, Composite Cylinder, Sphere, Composite sphere.Heat flow analysis for materials of non - uniform conductivity, Critical insulation thickness.

UNIT - II: Heat transfer by convection

Film concept, individual film coefficients, overall heat transfer co-efficient, controlling resistance, Logarithmic mean temperature difference, Critical insulation thickness. Heat transfer

in fluids without phase change: Forced convection and Natural convection- Heat transfer in laminar flow, turbulent flow, transition flow - film co-efficient and factors affecting film co-efficient, Natural convection, Effects of natural convection in Laminar flow heat transfer.
Heat transfer in fluids with phase change: condensation-types and mechanisms correlations for estimation of heat transfer coefficient; Boiling- types and mechanisms critical heat flux-applications.

UNIT – III: Analogy equations and Heat transfer by radiation
Analogy between momentum transport and heat transport, Relation between fluid friction and heat transmission. Analogy equations: Reynolds analogy, Colburn analogy and other analogy equations.
Laws of radiation, Emissivity, Absorptivity, Transmissivity, Black body, grey body, Emissive power. Angle of vision, Intensity of radiation, Radiation between black surfaces, non-black surfaces.Combined heat transfer by conduction, convection, radiation.

UNIT - IV: Evaporators
Classification, Types and fields of applications of evaporators.Performance of evaporators. Evaporator capacity, Boiling point elevation and Duhrings rule, Effect of liquid head and friction on temperature drop, Heat transfer co-efficient, Overall heat transfer co-efficient, Evaporator economy. Operation of single and multiple effect evaporators under different feed conditions - Design calculations.

UNIT - V: Heat exchangers and furnaces
Heat Exchangers: Classification - Double pipe heat exchangers, Shell and tube heat exchanger, plate heat exchangers and Extended surface heat exchangers. Design principle of heat exchangers, Codes and various standards in heat exchanger design. Introduction to heat transfer studies through packed and fluidized beds.
Furnaces-Classification, Constructional details; Refractories-Different types, physical and chemical properties, refractory materials used in different furnaces, Insulating materials.

Text Books:

1. McCabe,W.L., Smith,J.C., and P.Harriot, Unit Operations of Chemical Engineering, Seventh Edn., McGraw Hill, 2005.
2. Trinks, W., Mawhinney, M.H., Shannon, R.A, Reed,R.J., Garvey,J.R., Industrial furnaces, Sixth Edn., Wiley-Interscience, 2003.

Reference Books:

1. Holman,J.P, Heat transfer, 7thEdn., McGraw Hill international, 2002.
2. Kern.D.Q, Process Heat transfer, McGraw Hill international, 7th ed. 2002.
3. William H McAdams, Heat transmission, Third Edn., McGraw Hill international, 1978

Course Outcomes:

At the end, students can able to

1. Construct a general differential equation for energy transfer, decide the relevant terms
2. for application in one dimensional and multidimensional conduction problems and
3. Calculate heat duty/ outlet temperatures
4. Discuss the concepts evolved in convection mode of heat transfer, analyze convection
5. heat transfer process by dimensional analysis and analogy between momentum

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

P07CP 205	Fluid Mechanics& Particle Mechanics Laboratory	L	T	P
		0	0	3

Course Objectives:

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

1. Reynolds apparatus
2. Bernoulis theorem
3. Notch Apparatus
4. Pressure drop through packed bed
5. Orifice Meter test rig
6. Pitot tube
7. Venturi meter test rig
8. Friction in pipe lines
9. Pipe fittings, sudden enlargement and contraction losses
10. Centrifugal Pump
11. Packed Bed
12. Sedimentation
13. Ball Mill
14. Cyclone Separator
15. Vibrating Screen
16. Double Roll Crusher

Course Outcomes:

At the end, students can able to

1. Identify, name, and characterize flow patterns and regimes.
2. Utilize basic measurement techniques of fluid mechanics.
3. Measure fluid pressure and relate it to flow velocity.
4. Identify the new surface area generated by grinding the same feed in the two ball mill using open and closed circuit grinding method
5. Formulate the Rittingers, Bonds and Kicks law constants applicable for crushing operation in Jaw crusher, Drop weight crusher an Double roll crusher

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

CO2	3	2	-	-	-	-	-	-	-	-	-	-	3	2	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	3	2	-
CO4	2	2	1	-	-	-	-	-	-	-	-	-	2	2	-
CO5	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-

SEMESTER III

P07PC301	Chemical Engineering Thermodynamics I	L	T	P
		4	0	0

Course Objectives:

- To familiarize the students the fundamentals and uses of Thermodynamics
- To provide basic knowledge about the use of various laws of Thermodynamics.
- To illustrate the concepts of various equations relating Thermodynamics parameters and evaluation of these parameters

Unit I

Units and dimensions , Internal energy and enthalpy –Zeroth law of Thermodynamics, First Law of thermodynamics for flow and non-flow processes - Determination of heat and work for various flow and non-flow processes. Reversible and irreversible processes - Second law of thermodynamics - Carnot cycle - Thermodynamic temperature and concept of entropy - - Third Law of Thermodynamics - Entropy changes in mixing of ideal gases

Unit II

Volumetric properties of Pure Liquids: Equation of states - Ideal gas law. Vander Walls equation, Redlich - Kwong equation, Virial form of equation - accentric factor - Law of corresponding state - generalized compressibility factor with chart - behavior of liquids.

Unit III

Heat effects - Heat capacities, equation and charts - Heat effect with and without phase changes - Standard heat of formation and combustion - Standard heat of reaction. Hess Law of summation - Heat effect of industrial reaction.

Unit IV

Thermodynamic properties of fluids - Maxwell relations - Thermodynamic relations - Potential for a single component - with and without phase change - Generalized correlations for thermodynamic properties of gases - Charts construction and application, enthalpy and entropy changes.

Unit V

Thermodynamics of flow processes: Fundamental equations; Flow of compressible fluids - Expansion and Throttling processes- Joule Thomson coefficient - Nozzles, convergent and divergent, critical pressure ratio and Mach number. Compressors - Single and multistage - volumetric efficiency with ideal and real gases.

Text Books:

1. Smith,J.M.,VanNess,H.C., and M.M. Abbott, Introduction to chemical Engineering Thermodynamics, McGraw Hill, 5th Edn., 1998.
2. K.V.Narayanan , A textbook of Chemical Engineering Thermodynamics ,PHI Learning Pvt Ltd , 2nd edn 2013

Reference Books

1. Hougen and Watson, Chemical Process Principle, Vol.II Thermodynamics, John Wiley, 1959.
2. Rao,Y.V.C., Chemical Engineering Thermodynamics , Unity Press (India), Hyderabad, 1997.
3. Sundaram,S., Chemical Engineering Thermodynamics , Ahuja Book Publishers and Distributors, New Delhi, 1998.
4. Kyle, Process and Engineering Thermodynamics, Prentice Hall (India), New Delhi.2007

Course Outcomes:

5. At the end, students can able to

1. apply fundamental concepts of thermodynamics to engineering application
2. estimate the thermodynamic properties of substance in gas and liquid states for engineering calculations
3. devise and develop various energy related processes with maximum efficiency
4. define the thermodynamic laws and describe thermodynamic properties, states and processes
5. predict PVT behaviour of liquids and gases and estimate thermodynamic efficiency of various flow and non-flow processes

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

P07PC302	**Chemical Reaction Engineering - I**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- To provide basic knowledge on the selection of right type of reactor for the required reaction.
- To familiarize the students' knowledge on reaction kinetic principles and different type of reactors.
- To gain knowledge on ideal and non-ideal flow conditions.

Unit I

Thermodynamic Restrictions, chemical Kinetics, types of complex reactions, rate equation-Temperature dependency of rate equation.

Unit II

Interpretation of rate data in variable and constant volume systems, concentration dependency.

Unit III

Ideal reactors: Concepts of Ideality, development of design expressions for Batch, Tubular, Stirred tank, Semi batch and Recycle reactors, Combined reactor system, comparison, advantages and limitations in application-Isothermal reactors design.

Unit IV

Thermal characteristics of reactors, adiabatic and non-adiabatic conditions, principles of reactor stability and optimization.

Unit V

Residence time distribution: Residence time functions and relation among them, Application to non ideal reactors-modeling of real systems. Non-ideality parameters, prediction of reactor performances, concept of macro mixing.

Text Books

1. Octave Levenspiel, Chemical Reaction Engineering, 3rd edition, Wiley Eastern, 2006.
2. K.A. Gavhane, Chemical Reaction Engineering -I, 10th edition, NiraliPrakashan, 2008.

Reference Books:

1. Fogler .S "Fundamental Chemical Reaction Engg", Prentice Hall of India, 2nd edition, 1992.
2. Smith,J.M., Chemical Engineering Kinetics, 3rd edition, McGraw Hill, 1981.

Course Outcomes:

At the end, students can able to

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

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

P07PC303	**Mass Transfer**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- To familiarize the students to understand the fundamental concepts, principles and applications of mass transfer processes.
- To provide knowledge about the use of various design procedures followed in the design of various separation problems used in process industries
- To introduce the principles and applications of new separation techniques for difficult systems

- To develop a sound working knowledge and able to operate on different types of mass transfer equipments.
- Students would be able to determine important data for the design and operation of the process equipments.

Unit I

Molecular and Eddy diffusion, calculation of diffusivities; theories of mass transfer coefficient; mass, heat, and momentum transfer analogies.
Gas-liquid equlibria, packed towers-packing, flooding and loading, and pressure-drop calculations, choice of solvent. Design and calculation of absorption/stripping towers; Continuous contact equipment- HETP, HTU, NTU concepts; design calculations.

Unit II

Humidification – theories, humidity chart, adiabatic saturation curve, wet bulb temperature; humidification applications- cooling towers.
Drying-Equilibrium; Batch and continuous drying- Rate and estimation of time - mechanism of drying – design and performance of continuous and batch dryers.

UnitIII

Introduction to Distillation – vapour liquid equilibria - Relative volatility, Roults law; Methods of distillation - batch, continuous, flash, steam, vacuum ,molecular, extractive and azeotropic distillations. Design and control of distillation towers- McCabe – Thiele method.

Unit IV

Liquid – solid, liquid-liquid extraction- Equlibria, Design of extraction system - analytical solution of single and multistage operations in extraction and leaching.

Unit V

Adsorption -Theories of adsorption, Nature of adsorbents ; Stage wise operations- Single and multi stage operations calculations
Crystallization -factors governing nucleation and crystal growth, theory of crystallization. Incorporation of principles into design of equipments.Batch and continuous crystallizer.

Text Books

1. Treybal, R.E., Mass Transfer Operation, 3rd Edn., McGraw Hill, 1981.
2. McCabe,W.L., Smith,J.C. and P.Harriot, Unit Operations in Chemical Engineering, VII Edn., McGraw Hill, 2005.

Reference Books

1. Sherwood,T.K.,Pigford,R.L and Cr.Wilke., Mass Transfer, McGraw Hill.
2. Coulson and Richardson`s Chemical Engineering Volume –I, Fluid flow, Heat transfer and Mass Transfer – VI Edition, 1999.

Course Outcomes:

At the end, students can able to

1. Familiarize the fundamental concepts, principles and application of various downstream processes.
2. Design and Develop the transfer process widely used in process industries.
3. Articulate the conventional separation techniques based on the phase equilibrium.
4. Achieve the working knowledge for non-conventional separation process.
5. Perform the design calculation for process equipments

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

P07CP305	**Heat & Mass Transfer Laboratory**	**L**	**T**	**P**
		0	**0**	**3**

Heat Transfer Laboratory:

Course Objective:

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

1. Muffle Furnace
2. Forced convection
3. Stefen-Boltzmann Apparatus
4. Parallel And Counter Flow Heat Exchanger
5. Natural Convection
6. Thermal Conductivity Of Insulating Material
7. Air Drying
8. Steam Distillation
9. HETP Determination
10. Leaching Cross Current and Counter Current
11. Adsorption
12. Surface Evaporation
13. Liquid-Liquid Extraction
14. Diffusivity Measurement

Course Outcomes:

At the end, students can able to

1. Explain the fundamentals of heat transfer mechanisms in fluids and solids
2. Calculate heat transfer by conduction, different types of convection usingclassicalmodels for

these phenomena

3. illustrate applications invarious heat transfer equipment in process industries
4. Classify different types of downstream processing
5. Select the separation operations which will be economical for the process

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

SEMESTER IV

P07PC401	Chemical Engineering Thermodynamics II	L	T	P
		4	0	0

Course Objectives:

- To familiarize the students the fundamentals and uses of Thermodynamics
- To provide basic knowledge about the use of various parameters for the design of equipments for different operations.
- To illustrate the concepts of various equations relating Thermodynamics parameters and evaluation of these parameters for determining the operability of any reaction

Unit I

Thermodynamic properties of Heterogeneous mixtures, Partial molar properties, fugacity and fugacity coefficients - Lewis and Randall rule - Property changes of mixing, Activity and activity coefficients - Heat effects of mixing process - Enthalpy - Concentration charts - Excess properties.

Unit II

Phase equilibria - Miscible, partially miscible and immiscible systems - their phase behaviour at low, moderate and high pressures. Gibbs-Duhemequation.Analysis of multi-component system.Determination of phase equilibrium data, Margule, van Laar, Wilson and NRTL Equations, Introduction to UNIFAC method – Estimation of combinatorial and residual parts of activity coefficients.

Unit III

Chemical Equilibrium: Equilibrium constant and its determination - Standard state for gases, liquids and solids - Equilibrium conversion for single and multiple reactions, application to heterogeneous systems.

Unit IV

Refrigeration, choice of refrigerant, Carnot Refrigeration , air and vapor compression cycles - wet and dry compressions - C.O.P, heat pump, absorption refrigeration - Industrial liquification processes.

Unit V

Power cycles – Steam Power cycle, Internal combustion Engine , Otto Engine , Diesel Engine, Gas Turbine power plant , Jet Engine , Rocket Engine

Text Books:

1. Smith,J.M.,VanNess,H.C., and M.M. Abbott, Introduction to chemical Engineering Thermodynamics, McGraw Hill, 5th Edn., 1998.
2. K.V.Narayanan , A textbook of Chemical Engineering Thermodynamics ,PHI Learning PvtLtd , 2nd edn 2013

Reference Books

1. Hougen and Watson, Chemical Process Principle, Vol.II Thermodynamics, John Wiley, 1959.
2. Rao,Y.V.C., Chemical Engineering Thermodynamics , Unity Press (India), Hyderabad, 1997.
3. Sundaram,S., Chemical Engineering Thermodynamics , Ahuja Book Publishers and Distributors, New Delhi, 1998.
4. Kyle, Process and Engineering Thermodynamics, Prentice Hall (India), New Delhi.2007

Course Outcomes:

At the end, students can able to

1. Describe the terms and concepts involved in solution thermodynamics
2. Develop model equations for ideal and non ideal cases pertaining to equilibrium computations
3. Apply relevant models and validation with experimental data
4. Explain the concepts of refrigeration and power cycles in industries
5. Choose energy efficient systems using thermodynamic principles

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

P07PC402	**Momentum Transfer Operations**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- To understand the transport properties and mechanism of momentum transport.
- To study about the one dimensional transport, equation of change for isothermal systems.
- To demonstrate the interphase momentum transport and isothermal macroscopic balance.

Unit I

Transport properties and mechanism of momentum transport - Newton's law of viscosity, Generalization of Newton's law of viscosity, Pressure and temperature dependence of viscosity, Molecular theory of the viscosity of gases at low density, Molecular theory of the viscosity of liquids, Viscosity of suspensions and emulsions, Convective momentum transport

Unit II

Shell Momentum balances and velocity distributions in laminar flow - Shell momentum balances and boundary conditions, Flow of a falling film, Flow through a circular tube, Flow through an annulus, Flow of two adjacent immiscible fluids, Creeping flow around a sphere

Unit III

The Equation of Change for Isothermal systems – The equation of continuity, The equation of motion, The equation of mechanical energy, The equation of angular momentum, The equation of change in terms of substantial derivative.

Unit IV

Interphase Transport in Isothermal Systems – Definition of friction factors, Friction factors for flow in tubes, Friction factors for flow around spheres, Friction factors for packed columns

Unit V

Macroscopic Balances for Isothermal Flow systems – The macroscopic mass balance, The macroscopic momentum balance, The macroscopic angular momentum balance, The macroscopic mechanical energy, Use of the macroscopic balances for steady-state problems, Use of the macroscopic balances for unsteady- state problems

Text Book

1. Byron Bird R, Stewart W.E and Edwin N.Lightfoot, Transport Phenomena, Second edition, Prentice hall, 2007

Reference Book

1. Welty J.R, Wicks C.E and Wilson R.E, Fundamentals of Momentum, Heat and Mass Transfer, Fifth edition, John Wiley & Sons, 2000.

Course Outcomes:

At the end, students can able to

1. Generalize the fluid property and illustrate law governing momentum transport.
2. Develop the shell momentum balance and solve for incompressible fluid flow systems.
3. Evaluate the equation of change for isothermal fluid flow systems.
4. Estimate the interphase transport property in isothermal flow systems.
5. Construct the macroscopic balances for fluid flow in large systems.

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

P07PC403	Chemical Reaction Engineering - II	L	T	P
		4	0	0

Course Objectives:

- To provide knowledge on Heterogeneous Reactors and Heterogeneous Catalysis.
- To familiarize the knowledge on Kinetics of fluid - solid catalytic reactions.
- To gain knowledge on Design of Multiphase reactors

Unit I

Heterogeneous Reactors – Types of Heterogeneous reactions; Heterogeneous catalysis - Characterization of catalyst: Catalysis: Introduction-Physical and chemical adsorption catalysts-

Preparation and properties-Promoters-Inhibitors-Poisons; Surface area by BET method-Pore size distribution; Catalysts deactivation.

Unit II

Kinetics of fluid - solid catalytic reactions- Rates of chemisorptions and Adsorption isotherms; External transport processes in Heterogeneous reactions-Mass and Heat transfer correlations in Fixed bed, Fluidized bed and slurry reactors

Unit III

Reaction and diffusion within porous catalysts: Internal transport processes-Diffusion and Reaction: Diffusion and Reaction in Spherical Catalyst Pellets, Internal Effectiveness Factor, Falsified Kinetics, Overall Effectiveness Factor, Estimation of Diffusion- and Reaction-Limited Regimes

Unit IV

Design of reactor for non catalytic reactions: Fluid-particle systems: Models for non-catalytic heterogeneous reactions, their limitations, selection and their applications to design.

Unit V

Design of reactors: Design outline and selection criteria of fixed bed, fluid bed and slurry reactors - Fluid solid non-catalytic reactors.

Text Books:

1. Smith,J.M., Chemical Engineering Kinetics, 3rd Edn., 1981, (Chapter 7 to 14).
2. K.A. Gavhane, Chemical Reaction Engineering 1, X edition, NiraliPrakashan, 2008.

Reference Books:

1. Fogler, Elements of Chemical Reaction Engineering, 3rd Edn., Prentice Hall India 2005.
2. O.Levenspiel, Wiley Eastern, Chemical Reaction Engineering. 3rd Edn., 2002.
3. T. J. Carberry, Chemical and Catalytic Reaction Engineering, McGraw Hill, 1976.

Course Outcomes:

At the end, students can able to

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

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

CO5	-	-	2	3	3	-	-	-	-	-	-	-	3	3	-

P07CP505	Chemical Reaction Engineering& Thermodynamics Laboratory	L	T	P
		0	0	3

CRE Laboratory

Course Objective:

- To determine experimentally the kinetics and rate constants of reactions in different types of reactors.

1. Batch Reactor
2. Semibatch Reactor I
3. Plug Flow Reactor
4. Continuous Stirred Tank Reactor
5. Adiabatic Reactor
6. Residence Time Distribution Studies in CSTR
7. Excess Property Determination
8. Heat of Solution by Solubility Method
9. Equilibrium Constant Determination
10. Liquid – Liquid Equilibrium
11. Isobaric VLE Data (Txy diagram)
12. Othmer VLE Still – Margules or Vanlaar Constant Determination
13. Test For Thermodynamic Consistency

Text books

1. Y. V. C. Rao, Introduction to Thermodynamics, Universities Press
2. Nag ,P.K. " Engg. Thermodynamics".Tata McGraw Hill.

Reference books

1. D.B. Spalding & E.H. Cole " Engg. Thermodynamics". Edward Arnold.
2. G.A. Hawkins,." Engg. Thermodynamics" .John Wiley & Sons.
3. G.H. Van Wylen, & R.E. Sonntag, "Fundamentals of Classical Thermodynamics". .John Wiley & Sons.
4. Hollman ,J.P. " Thermodynamics". McGraw Hill

Course Outcomes:

At the end, students can able to

1. Describe the basics of chemical reaction system and its practical application and principles
2. Apply these principles for the design of reactors and application in process industries
3. Express working knowledge on different types of reactors and design of chemical reactors with associated with Physical Parameters.
4. Classify different types of downstream processing
5. Select the separation operations which will be economical for the process

Mapping with POs & PSOs														
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	3	-
CO2	-	3	3	-	-	-	-	-	-	-	-	3	3	3	-
CO3	3	3	-	3	3	-	3	-	-	-	-	3	3	3	-
CO4	2	-	3	-	-	-	-	-	-	-	-	-	3	2	-
CO5	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2

SEMESTER V

P00HS501	Environmental Studies	L	T	P
		4	0	0

Course Objectives:

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

Unit I

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

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

Unit II

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

Unit III

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

Unit IV

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

landslides. Sustainable development - Urban problems related to energy - Water conservation, rain water harvesting, and watershed management - Resettlement and rehabilitation of people; its problems and concerns. - Environmental ethics: Issues and possible solutions - Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.
Wasteland reclamation - Consumerism and waste products - Environment Protection Act - Air (Prevention and Control of Pollution) Act - Water (Prevention and control of Pollution) Act - Wildlife Protection Act - Forest Conservation Act - Issues involved in enforcement of environmental legislation.

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

Text Books:
1. Agarwal, K.C. Environmental Biology, NidiPubl, Ltd. Bikaner, 2001
2. BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)
3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
4. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)

Reference books:
1. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
2. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
3. Down to Earth, Centre for Science and Environment (R)
4. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press. 473p
5. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
6. Heywood, V.H &Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.
7. Jadhav, H &Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284 p.
8. Mckinney, M.L. & School, R.M. 1996. Environmental Science systems & Solutions, Web enhanced edition. 639p.
9. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB)
10. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
11. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
12. Rao M N. &Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd. 345p.
13. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut
14. Survey of the Environment, The Hindu (M)
15. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB)

16. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Stadards, Vol I and II, Enviro Media (R)
17. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)
18. Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia, USA 499p

Course Outcomes:

At the end, students can able to

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

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

P07PC502	**Process Instrumentation Dynamics and Control**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- To introduce the field measuring instruments and their Principles.
- To analysis the static and dynamic behavior of chemical processing system and models employed through the use of Laplace transforms
- To develop block diagram using transfer functions for closed loop systems and stability analysis
- Emphasis on Frequency Response Analysis and its application in feedback controller settings
- Analysis and Design of advanced control systems, cascade control of chemical processes

Unit I

Principles of measurements and classification of process control instruments, measurements of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity and consistency,

pH, concentration, electrical and thermal conductivity, humidity of gases, composition by physical and chemical properties and spectroscopy.

Unit II

P & I Diagrams (Piping & Instrumentation diagram): Symbols, P&I Diagram of reactors, Distillation column, Shell & tube heat exchanger, etc. Measurement of process variables; sensors, transducers and their dynamics.

Laplace transformation, transform of standard functions, derivatives and integrals, inversion, theorems in Laplace transformation, application.

Unit III

Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics, transfer function for chemical reactors and dynamics.

Unit IV

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulator problems, Transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transportation lag, transient response of closed-loop control systems and their stability.

Unit V

Introduction to frequency response of closed-loop systems, control system design by frequency, Bode diagram, Stability criterion, Nyquist diagram; Tuning of controller settings. Controller mechanism, introduction to advanced control systems, cascade control of chemical processes, computer control of chemical processes

Text Books:

1. Coughnowr and Koppel, "Process Systems Analysis and Control ", McGraw-Hill, New York, 1991.
2. D.P.Eckman, Industrial instrumentation, Wiely, 1978

Reference Books:

1. George Stephanopolous, " Chemical Process Control ", Prentice-Hall of India Pvt-Ltd., New Delhi, 1990.
2. P.Harriot, Process control, Tata McGraw Hill, New Delhi, 1977
3. Industrial Instrumentation & Control, S. K. Singh, Tata McGraw-Hill Education.

Course Outcomes:

At the end, students can able to

1. Distinguish the various order of Process control systems and also able to calculate output values.
2. Compare and classify the characteristics of different instruments utilized in process industries and also describe its principle of working.
3. Develop model equation for first and second order process control systems and can predict its response to different disturbances.
4. Compare the performance of different modes of control and can justify the proper selection of controllers for the given control system.
5. Design the proper controllers for the given process control system and also describe the real time

application of advanced control systems in process industries.

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

P07CP505	Process Control Laboratory	L	T	P
		0	0	3

- To introduce different types of Instruments
- To introduce different types of Controls
- To train students to measure parameters accurately

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

Course Outcomes:

At the end, students can able to

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

Mapping with POs & PSOs

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

SEMESTER VI

P07PC601	Process Engineering Economics	L	T	P
		4	0	0

Course Objective:

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

Unit I

Value of money and equivalence - Amortization – Types of Depreciation

Unit II

Capital requirements for process plants - Balance sheet chart - earnings, profits and returns - Economic production, Break even Analysis Charts - Cost accounting - Pre construction cost estimation - allocation of cost.

Unit III

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

Unit IV

General principles and method economic balance in single variable operation and in two variable operation in combined, variable feed and product grades, for variable recovery in fluid flow, heat transfer, evaporation and mass transfer multiple equipment units.

Unit V

Economic analysis of a complete process.

Text Books:

1. Schweyer, Process Engineering Economics, Mc Graw Hill.1955.

Reference Book:

1. Peter and Timmerhaus, Plant Design and Economics for Chemical Engineers 3rded. 1984.
2. S.N.Maheshwari, Principles of Management Accounting, Sultan Chand and Sons, New Delhi, 2000.

Course Outcomes:

At the end, students can able to

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

Mapping with POs & PSOs															
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

CO1	3	-	-	-	3	-	-	-	-	-	-	-	3	-	-
CO2	-	3	1	-	2	-	-	-	-	-	-	-	3	2	-
CO3	2	-	-	3	-	-	-	-	-	-	-	-	3	2	2
CO4	2	1	-	-	-	-	-	-	-	-	-	-	-	2	3
CO5	-	-	3	-	3	-	-	-	-	-	-	-	-	2	3

P07CP605	**Chemical Plant Design and Drawing Laboratory**	**L**	**T**	**P**
		0	**0**	**3**

Course Objectives:

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

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

Course Outcomes:
At the end, students can able to

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

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

SEMESTER VII

P00HS701	Engineering Ethics	L	T	P
		4	0	0

Course Objectives:

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

UNIT – I

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

UNIT – II

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

UNIT – III

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

UNIT – IV

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

UNIT – V

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

Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

Text Book:

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

Reference Book:

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

Course Outcomes:

At the end, students can able to

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

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

P07PV704	**PROJECT WORK AND VIVA-VOCE**	**L**	**P**	**S**
		0	**8**	**0**

COURSE OBJECTIVES:

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

METHOD OF EVALUATION

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

COURSE OUTCOME:

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

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

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

Professional Electives

07PEXXX	Process Modeling& Simulation	L	T	P
		4	0	0

Course Objectives:

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

UNIT – I

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

UNIT – II

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

UNIT – III

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

UNIT – IV

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

UNIT – V

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

Text Books:

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

Reference Book:

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

Course Outcomes:

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

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

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

07PEXXX	Polymer Engineering	L	T	P
		4	0	0

Course Objectives:

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

Unit-I

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

Unit-II

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

Unit-III

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

Unit-IV

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

Unit-V

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

Text Books:

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

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

Reference Books

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

Course Outcomes:

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

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

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

07PEXXX	Biochemical Engineering	L	T	P
		4	0	0

Course Objectives:

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

Unit I

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

Unit II

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

Unit III

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

Unit - IV

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

Unit - V

Equipments- operations, measurement and control of a typical fermentation unit equipments for mechanical separation. Unit equipments for mechanical separation and integration of cells for product recovery, enzyme engineering enzyme immobilization techniques, immobilized enzyme columns Effect of pH, temperature, space velocity and pressure drop on performance.

Text Books:

1. Aiba,S., Bio Chemical Engineering, Academic Press, 1973.
2. Bailey,J.E., and D.F.Ollis, Bio Chemical Engineering Fundamentals, 2nd Edn., McGrawHill, 1986.

Reference Books:

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

Course Outcomes:

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

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

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

07PEXXX	**Electrochemical Engineering**	**L**	P	T
		4	**0**	**0**

Course Objectives:

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

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Text Books:

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

Reference Books:

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

COURSE OUTCOMES:

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

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

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

07PEXXX	**Nuclear Engineering**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

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

Unit I - Nuclear Physics

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

Unit II - Nuclear Reactor

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

Unit III - Nuclear Reactions and Reaction Materials

Mechanism of nuclear fission and fusion- radio activity- chain reactions-critical mass andcomposition – nuclear fuel cycles and its characteristics – uraniumproductionandpurification.Zirconium,thorium, beryllium.

UNIT IV - Properties of irradiated fuel - separation of reactor products.

Uses of stable isotopes and methods of isotope separation principles of isotope separation - Separation of isotopes of light elements - separation of isotopes of heavy elements.

UNIT V - Safety and disposal

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

Text Book:

1. Thomas J.Cannoly, "Fundamentals of Nuclear Engineering" John Wiley 1978.

References:

1. Collier J.G., and Hewitt G.F, "Introduction to Nuclear power", Hemisphere publishing, New York, 1987
2. WakilM.M.El., "Power Plant Technology" – Mc Graw-Hill International, 1984.

Course Outcomes:

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

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

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

CO4	-	2	-	-	2	-	2	-	-	-	-	-	3	3	-
CO5	-	2	2	2	3	-	-	-	-	-	-	-	3	2	-

07PEXXX	Nanotechnology	L	T	P
		4	0	0

Course Objectives:

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

Unit I

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

Unit II

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

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Unit III

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

Unit IV

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

Unit V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

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

07PEXXX	Chemical Works Organization and Management	L	T	P
		4	0	0

Course Objectives:

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

UNIT - I

Industrial Relations – Introduction. Significance & conditions for good industrial relations- Causes of poor industrial relations & suggestions to improve it. Labour disputes in India. Industrial disputes act-1947 (only Salient Points). Types of industrial disputes – strikes – lockouts.Regulation of strikes & Lockouts.

UNIT - II

Business organization - Various forms of private, ownerships, comparison and choice.
Industrial Organizations - Plant location - Factors influencing plant location - split and coupled locations- size of industrial units
Plant layout - Choice of equipment various types of layout - guarding of machineries - illumination, heating and ventilation.

UNIT – III

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

UNIT IV

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

UNIT V

Dynamics of communication – The communication process, structure of communication, Transactional Analysis, The five common communication networks in an organization. Group Dynamics – Synergy through groups, Group behaviour, group effectiveness, stages of group development. Properties and Characteristics of Highly effective groups

Text Books:

1. Sukla,M.C., Business Organization and Management, 2010.
2. Uma sekaran – "Organisational Behaviour – Text and Cases" – Tata McGraw Hill New Delhi, 2004.
3. Tripathi – "Personnel Management & Industrial Relations" - Sultan Chand and Sons New Delhi. 2013.

References:

1. Organization behavior - Texts and Cases - K.Aswathappa, Himalaya Publishing House – 1997
2. Industrial disputes act-1947
3. Chakraborty S K- Managerial Development & Appraisal –Macmillan India
4. Strauss & Sayles – Personnel Management

Course Outcomes:

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

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

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

07PEXXX	**Air Pollution and Control**	**L**	**T**	**P**

		4	**0**	**0**

Course Objectives:

- To study about the effects of air pollutants on human beings and environment, what their sources are, and their physical and chemical behavior in the atmosphere. Also, you will get exposed to a wide range of control technologies and future trends towards preventing air pollution.

Unit - I : Air Pollution
Air Pollution-Sources and Effects Definitions, Scope, Air Pollutants – Classifications – Natural and Artificial – Primary and Secondary, Sources of air pollution- stationary and mobile sources. Effects of Air pollutants on humans, materials and vegetation. Global effects of air pollution – Green House effect, Heat Islands, Acid Rains, Ozone Holes etc.

Unit – II: Air Quality Monitoring Management

Ambient Air Sampling- sampling procedures for collection of gases and particulates, High Volume Sampler. Stack monitoring- Sampling Techniques for Stack gases. Analysis of Air Pollutants: SOx, NOx, CO, Hydrocarbons and Particulate matter. Air quality standards and Emission standards

Unit – III:Meteorology and Plume Dispersion
Properties of atmosphere - Temperature, Pressure and Wind forces. Influence of Meteorological phenomena on Air Quality. Temperature lapse rates and Atmospheric Stability. Wind velocity and turbulence. Plume behaviour. Wind rose diagrams. Dispersion theories and models- stack height, plume rise.

Unit – IV: Air Pollution Control Methods
Source correction methods – Raw material changes, Process Changes and Equipment modifications, Particulate control equipments – Settling Chambers, Centrifugal separators, Fabric filters Wet scrubbers and Electrostatic precipitators. Collection efficiency and design problems.General Methods of Control of Gaseous emissions- Absorption, Adsorption and Combustion.Control of NOx and SOx emissions.

Unit – V: Air Pollution in Industries and Automobiles
Air pollution from major industrial operations: Mining and mineral processing, Cement manufacturing, Petroleum refinery, Metallurgical operations Thermal power plants. Air Pollution due to Automobiles: Emissions from automobiles, formation of photochemical smog, Combustion, Air-Fuel ratio, Control of Exhaust emissions.

Text Books:
1. M.N Rao and H.V.N Rao, Air Pollution, Tata McGraw- Hill Publishing Company Limited, 2007, New Delhi.
2. R.K Trivedy and P.K Goel, An Introduction to Air Pollution, (2009) BS Publications, Hyderabad.

Reference Books:

1. Richard W. Boubel. Fundamentals of Air Pollution, Academic Press, an imprint of Elsevier, New York
2. Noel De Nevers, Air Pollution control, McGraw – Hill publishing Co. Ltd., New York.
3. Peavy H.S, Rowe D.R. and Tchobanoglous, Environmental Engineering, Tata McGraw Hills, New Delhi
4. KVSG Murali Krishna, Air Pollution and Control, Kushal&Co, Kakinada
5. C.S Rao, Environmental Pollution Control Engineering, New Age International Publishers, New Delhi

Course Outcomes:

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

1. Understand about Air pollution
2. Measure and analyze the air pollutants concentration in the atmosphere.
3. Explain the dispersion of Air pollutant in atmosphere
4. Describe and explain different methods of removal of fine particles suspended in atmosphere.
5. Explain different methods of pollution control in process industry and automobiles

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

07PEXXX	Wastewater Treatment Technology	L	T	P
		4	0	0

Course Objectives:

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

Unit – I

Overview of waste water Engineering – Terminolgy, Wastewater characteristics, Physical characteristics, Inorganic Constituents, Organic constituents, Biological characteristics.

Unit – II

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

Chemical unit process – Chemical coagulation, Chemical precipitation, Chemical oxidation, Chemical neutralization, Scale control and Stabilization.

Unit – III

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

Unit – IV

Reactors in wastewater treatment: Principle, working, advantages and limitations of- Packed bed reactor, fluidized bed reactor, Inverse fluidized bed reactor, Air lift reactor, Anaerobicdigestor, Sequential batch reactor, UASB reactor, Membrane reactor.

Unit –V

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

Text Book:

1. Wastewater Engineering Treatment and Reuse by Metcalf & Eddy (2003) Tata McGraw –Hill IV Edition.

Course Outcomes:

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

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

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

07PEXXX	Environmental Engineering	L	T	P
		4	0	0

Course Objectives:

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

Unit I

The biosphere - the hydrologic cycle - the nutrient cycles-pollution of air, water and soil, air pollution laws and standards - water pollution laws and standards - water quality standards - MINAS. Effects and control of noise, thermal and radioactive pollution.

Unit II

Origin of wastewater, types of water pollutants and their effects, wastewater sampling and analysis, determination of organic and inorganic matters, physical, chemical characteristics, bacteriological measurements.

Unit III

Basic process of wastewater treatment - primary, secondary and tertiary treatments – advanced wastewater treatments; recovery of metals from process effluents.

Unit IV

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

Unit V

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

Text Books

1.GeorgeTchobanoglous, Franklin L. Burton , H. David Stensel, (2002). Wastewater Engineering: Treatment and Reuse, Metcalf & Eddy, Inc., McGraw-Hill Education, pp 1848.
2. Mahajan.S.P, (1985). Pollution control in process industries, Tata-McGraw Hill, pp 273.

Reference Books

1. Rao, C.S. (2007). Environmental Pollution Control Engineering, New Age International, pp. 442.
2. Noel de Nevers (2000). Air Pollution and Control Engineering, McGraw Hill, pp 586.
3. Glynn Henry J. and Gary W. Heinke, (2004). Environmental Science and Engineering, 2nd Edition, Prentice Hall of India, pp 778.
4. Rao M.N. and Rao H.V.N (1993). Air Pollution, Tata – McGraw Hill Publishing Ltd.
5. De A.K - Environmental Chemistry (1999), Tata – McGraw Hill Publishing Ltd.
6. Sawyer, C.N., McCarty, P.L., Parkin, G.F., (2000). Chemistry for Environmental Engineering, Tata McGraw-Hill.

7. **Course Outcomes:**
8. After the completion of the course, the student should be able to

1. State that various environmental laws and realize the importance of biosphere
2. Evaluate the various types of pollution abatement techniques
3. Indicate the quality and characteristics of wastewater
4. Determine various water/air quality parameters
5. Explain the solid wastes collection, handling, waste management and Disposal

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

07PEXXX	Fluidization Engineering	L	T	P
		4	0	0

Course Objectives:

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

Unit-I :Basics Of Fluidization

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

Unit-II: Fluidized Bed Types

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

Unit-III: Design Aspects

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

Unit-IV: Heat And Mass Transfer In Fluidized Beds

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

Unit-V: Other Types Of Fluidization

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

Text Books:

Daizo Kunii, Octave Levenspiel," Fluidization Engineering" 2nd Edition, Butterworth – Heinmann, 1991.

References:

1. Rowe and Davidson, "Fluidization", Academic Press ,1971.
2. Leva, M., "Fluidization", McGraw Hill Book Co, 1959.
3. Wen-Ching Yang., "Handbook of Fluidization and Fluid-Particle Systems", Marcel Dekker Inc, 2003.

Course Outcomes:

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

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

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

07PEXXX	Mixing Theory and Practice	L	T	P
		4	0	0

Course Objectives:

- To teach the students about the importance of mixing in chemical process industries.
- To teach the students about the heat and mass transfer coefficient and its reaction.
- To provide basic knowledge about the Non Newtonian Liquids.

UNIT – I

Importance of mixing in chemical process industries

Examples of processes signifying importance of mixing - Goodness of mixing: Qualification - Significance of dimensionless groups - dimensional analysis - power number correlation - Expressions for NRe, NFr, NWe, NPr from their definitions as ratios applied to resisting forces - analogy between drag coefficient and power number

Mixing equipments and operations

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

Power curves

Power curves with and without baffles - power reduction - Power measurement techniques - Scale - up - principle of similarity - scale-up criteria - Operating characteristics of small blade and large blade agitators - Efficiency of agitator system experimental. Definition of mixing times.

UNIT –II

Purging of stirred tanks in series - Effect of mixing on chemical reactions - introduction -batch reactor and CSTR comparison - Residence time distribution - mixing concepts and models - RTD functions J(8) and J'(8) - Average residence time from RTD - RTD from response measurements - Interpretation of response data by mixing models - Imperfect mixing in Stirred tanks - transient analysis of chemical reactors in series.

UNIT –III

Heat transfer promotion by mixing - mixing and overall heat transfer coefficient - Heat transfer correlation for helical coils and jacketed vessels - transient analysis of heat transfer - isothermal heating or cooling medium - non isothermal cooling medium -external heat exchanger - isothermal/non isothermal heating/cooling medium - Design calculation for heat transfer in mixing vessels - Stirred tank scale-up heat transfer consideration - Scale up of batch and other reactors.

UNIT –IV

Mixing and mass transfer - introduction - Liquid liquid extraction - equipments - batch - continuous differential - Triangular representation of concentration - phase equilibrium diagram - Material balance for stage wise contact - counter current continuous and differential contact - problems - Interfacial phenomena - drop size distribution -coalescence - breakage - emulsion - surfactant - Mass transfer coefficient - two film concept - mass transfer modeling - Correlation for mass transfer coefficient - stage efficiency.

UNIT - V

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

Text Books:

1. Holland and Chapman, Liquid Mixing and processing in Stirred Tanks, Reinhold Publishing Co-operation, New York and London, 1966.

Reference Books:

1. Uhl and Gray, Mixing theory and practice, Vol.1 and II, Academic Press, NewYork and London 1967.
2. Shinji Nagata, Mixing Principles and Applications, HoltedPress , Tokyo, 1975.

Course Outcomes:

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

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

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

07PEXXX	Petroleum Engineering and Petrochemicals	L	T	P
		4	0	0

Course Objectives:

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

UNIT I

Origin, Formation and Evaluation of Crude Oil- Testing of Petroleum Products and its properties. Refining of Petroleum – Atmospheric and Vaccum Distillation processes.

UNIT II

Thermal and Catalytic cracking- Thermal cracking process, Coking, VisbreakingOperations,Fixed bed, Moving Bed, Fluidized Bed Catalytic Cracking Processes.

UNIT III

Reforming- Thermal and Catalytic reforming processes- Polyforming, Platforming, Hydro forming, Alkylation, Polymerisation and Isomerisation processes.

UNIT IV

Treatment techniques for removal of objectionable gases, Odours, to improve performance, Extraction of aromatics, Olefins and Production of Lube oil Stock, Wax and Asphalt.

UNIT V

Production of Petrochemicals like Dimethyl Terephathalate (DMT), Ethylene Glycol, Synthetic Glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol and Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and Production of Carbon Black.

Text Books:

1.W.L. Nelson, "Petroleum Refinery Engineering", 4th Edn., McGraw Hill, New York,1985.
2.B. K. Bhaskara Rao, "Modern Petroleum Refining Processes", 2nd Edn., Oxford and IBH Publishing Company, New Delhi, 1990.
3.Bhaskara Rao, B. K. "A Text on Petrochemicals", 1st Edn., Khanna Publishers, NewDelhi, 1987.

Reference Books:

1.G. D. Hobson and W. Pohl., "Modern Petroleum Technology", Gulf Publishers, 2nd Edn., 1990.
2.R. A. Meyers, "Hand book of Petroleum Refining Processes", McGraw Hill, 1st Edn.,1980.

Course Outcomes:

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

1. Develop overview of petroleum processing and know about the origin, composition, formation and fractionation of crude in to useful petroleum products.
2. Describe and compare various Thermal and Catalytic cracking operations
3. Enumerate and distinguish among the different Reforming Processes.
4. Explain and select suitable treatment methods to eliminate pollutants, wax & asphalt from petroleum products
5. Illustrate and explain the production of various petrochemicals from refining by-products

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

07PEXXX	Hydrocarbon Processing and Engineering	L	T	P
		4	0	0

Course Objectives:

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

Unit-I

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

Unit-II

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

Unit-III

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

Unit-IV

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

Unit-V

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

Text book

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

Reference Books:

1. B.K. Bhaskararao "Modern Petroleum Refining Processes", 2008.
2. Warren L. Mccabe, Julian C. smith, Peter Harriott "Unit Operations of Chemical Engineering", Seventh edition, McGraw-Hill, 2005.
3. G.N. Sarkar, " Advancedpetrochemicals"Khanna Publishers.
4. SukumarMaiti," Introduction to Petrochemicals", Second edition , Oxford & IBH
5. Publishing Co.Pvt. Ltd., New Delhi-2002.

Course Outcomes:

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

1. Identify the methods and challenges in value addition of petroleum products & differentiate various separation processes used in petrochemical industries.
2. Classify catalysts and explain recent advancement of catalyst development with their properties used in different petrochemical processes.
3. Describe recent developments of Fluidized bed Catalytic Cracking process in catalyst preparation, reactor and regenerator design.
4. Explain the recent developments of catalytic reforming process including catalyst preparation, deactivation and regeneration
5. Describe the hydrocracking process technology developments and other fuel option, including

national fuel policy.

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

07PEXXX	Distillation	L	T	P
		4	0	0

Course Objectives:

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

Unit I

Gibbs phase rule, phase equilibrium, ideal and non-ideal gas mixtures, Raoult's law, nonideal liquid - liquid mixtures; phase diagrams, effect of pressure on phase equilibria; Vapor Liquid Equilibria: Ideal and non-ideal binary and multi-component systems - Correlation and prediction –consistency tests; VLE of complex system-true boiling point curves-ASTM distillation, equilibrium flash vaporization curves.

Unit II

Equilibrium and simple distillation: flash vaporization of binary and multi-component systems, differential vaporization and condensation; steam distillation; fractionation of binary systems-analytical and graphical methods of determination of number of equilibrium stages.

Unit III

Ternary systems and multi-component systems- Sorel method, Lewis-Matheson method, Thiele-Geddes method, short cut methods, graphical evaluation of number of stages for ternary systems. Complex system fractionation: Pseudo-component design method, fraction with sidestreams.

Unit IV

Azeotropic distillation and extractive distillation: separation of homogeneous azeoptropes, separation of heterogeneous azeotropes, selection of addition agents-design of azeotropic distillation process, design of extractive distillation process; Reactive Distillation and Case studies.

Unit V

Design methods: fractionation devices, bubble cap, sieve and other types of trays-plate and column hydraulics and efficiency- plate fractionation column design methods, packed column design

Text Books:

1 Van Winkle,M., Distillation, McGraw Hill publications. 2nd ed. 1967
2 Doherty, M.F and Malone, M.F., Conceptual Design of Distillation systems, McGraw Hill International Edn., 2006..

Reference Books

1 Holland, Multi-component Distillation. First Edn., 1963
2 Treybal,R.E.,Mass Transfer Operation, 3rd Edn., McGraw Hill, 1981.
3 McCabe,W.L., Smith,J.C. and P.Harriot, Unit Operations in Chemical Engineering, VIIthEdn., McGraw Hill, 2005.
4 Sherwood,T.K.,Pigford,R.L and Cr.Wilke., Mass Transfer, McGraw Hill

Course Outcomes:

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

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

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

07PEXXX	Membrane Science and Engineering	L	T	P
		4	0	0

Course Objectives:

- To make students understand the various types of Membrane compositions.
- To familiarize the students of various Membrane configuration Units.
- To provide knowledge about the various Membrane separations technics.
- To illustrate the various membrane synthesis techniques and its applications

Unit I

Synthetic Membranes - configuration, morphology, principles of permeation and separation, membrane materials.

Unit II
Processing: Phase-inversion process, anisotropic membranes, isotropic porous membranes. Polymer blends and alloys, dynamic membranes, liquid membranes, biomimetic membranes ion exchange membranes, electro dialysis, bipolar membranes, mosaic membranes.

Unit III
Separation processes: Electro dialysis, micro filtration, ultra filtration, reverse osmosis, hemodialysis, hem filtration.

Unit IV
Membrane systems: Plate and frame, spiral-wound Unit, hollow fiber Units.

Unit V
Membrane Applications: Wastewater treatment, bioseparation, biomedical.

Text Book
1. R.B. Kesting., Synthetic Polymeric Membranes, Second Edn., Wiley- Interscience, New York, 1985.

Course Outcomes:
At the end, students can able to
1. Describe and distinguish advanced reaction engineering
2. Develop the kinetic rate expression by applying reaction mechanism for fluid-solid catalyzed reactions
3. Describe the transport process in heterogeneous reactions and predict the rate controlling steps in non-catalytic fluid-solid systems.
4. Create statistical methods for Kinetic Parameter Estimation
5. Design the reactors and determine the transport and reaction parameters.

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

07PEXXX	ANALYTICAL TECHNIQUES	L	T	P
		4	0	0

COURSE OBJECTIVES:

- The course is practical oriented giving the introduction on the principle and working of various analytical instruments used in Biotechnology.
- Finds application in the analysis of biological macromolecules especially proteins and nucleic acids

UNIT I: Basic instrumentation

Cell disruption techniques, Basics of Microscope and its types - Bright field Microscope, Dark field Microscope, Phase contrast Microscope, Fluorescent Microscope, Electron Microscope (TEM, SEM, Tunnelling EM) & Confocal Microscope, Microtechnique, pH meter.

UNIT II: Basic spectroscopy

Principles and Working of colorimetry, Spectroscopy : Basic principles, nature of electromagnetic radiation, Beer-Lambert laws- UV- Visible Spectrophotometry, Fluorescence Spectrophotometry, Atomic Absorption Spectrophotometry, FTIR, Raman Spectroscopy, Mass Spectrometry, Nuclear Magnetic Resonance (NMR) -Electron Spin Resonance(ESR).

UNIT III: Separation and purification techniques

Centrifugation - Principles & types - Differential, Rate zonal and Isopycnic centrifugation. Electrophoresis of nucleic acids - Agarose , PAGE and Pulse field Electrophoresis. Electrophoresis of proteins - SDS-PAGE, IEF and 2D PAGE. Protein purification methods, Chromatography - Principles, methodology and applications of chromatography: paper, Thin layer, column (gel filtration, ion exchange, affinity), GC and HPLC. Basics of flow cytometry

UNIT IV: **Radio isotope techniques**

Radioactive isotopes - storage, safety, handling and radioactive waste management. Liquid Scintillation counter - α-counter and β-counter. X- ray Diffraction, Crystallography, Autoradiography. Magnetic Resonance Imaging (MRI) and CT scan.

UNIT V: Molecular techniques

Quantification of proteins, DNA and RNA. Blotting techniques - Southern, Northern and Western blotting. Gene transfer and transfection methods. PCR and its types. Biosensors and types Biosensors

TEXT BOOKS:

1. W.H.Freeman, Readings In Scientific American, 1985-1993.
2. R.Gopalan , P.S.Subramanian and K.Rangarajan ., "Elements of Analytical Chemistry"
3. G.W.Ewing –Instrumental Methods of Chemical analysis – McGraw Hill Book company, 1989.
4. Keith Wilson and John Walker- Practical Biochemistry principles and Techniques, Fifth Edition, Cambridge University press, 2000.

5. Upadhyay, K. Upadhyay and N.Nath, Biophysical Chemistry, Himalaya Publishing House, Mumbai.

REFERENCE BOOKS:

1. Wilhard, Instrumental methods in Chemical analysis, 5th Edition, D Van Nostrand, New York, 1974.
2. Skoog DA, Principles of Instrumental Analysis, Thomas Pvt Ltd, 6th Edition, Van Nostrand, Newyork 1981.
3. Keith Wilson and John Walker, Practical Biochemistry - Principles and Techniques, 5th Edition, Cambridge University Press, 2003.
4. Biophysical chemistry : Principles and Techniques – Upadhayay and Nath – Himalaya publishing house , 2nd Review Edition, 2009.

Course Outcomes:

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

1. Analysis of different microscopes for basic instrumentation
2. Summaries the working principle of spectroscopy and determination methods
3. Facilitate the various separation and purification technique for chemical and biochemical analysis
4. Originate the radioactive material analysis and waste management with different instrumentations
5. Generalize the molecular analysis techniques and biosensor applications

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

07PEXXX	Food Processing Technology	L	T	P
		4	0	0

Course Objectives:

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

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Text Book

1. Norman N. Potter and Joseph H. Hotchkins, Food Science, V Edition, CBS Publishers & Distributors, New Delhi.1998.

Reference Books

1. W.C. Frazier & D.C. Westhoff, Food Microbiology, Tata McGraw Hill, 1986
2. Arthur W. Farrall, Engineering for Dairy and Food Products, Wiley Eastern Private Ltd, 1967.
3. Preservation of Fruits and Vegetables, G.S.Siddappa. ICAR, New Delhi, 1986
4. Fish processing Technology by K.Gopakumar. Indian Council of AgriMetual Research, New Delhi, 2002

5. **Course Outcomes:**
6. After the completion of the course, the student should be able to

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

Mapping with POs & PSOs															
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

CO1	-	3	-	-	-	-	-	-	-	-	-	-	2	3	-
CO2	-	3	-	-	-	2	-	-	-	-	-	-	2	3	-
CO3	-	3	-	-	-	-	-	-	-	3	-	-	-	2	-
CO4	2	3	-	-	-	-	2	-	-	-	-	-	-	2	3
CO5	-	3	-	-	-	-	3	-	-	-	-	-	-	2	3

07PEXXX	Industrial Bio-Technology	L	T	P
		4	0	0

Course Objectives:

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

UNIT-I Overview Of The Cell:
Cell, structure and properties, prokaryotic and eukaryotic cells, structural organization and function of intracellular organelles; Cell wall, Nucleus, Mitochondria, Golgi bodies, Lysosomes, Endoplasmic reticulum, Peroxisomes and Chloroplast.

UNIT-II Microbial Growth: Pure Culture Techniques:
Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.The definition of growth, mathematical expression of growth, Growth curve, availability of oxygen, culture collection and maintenance of cultures.

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

UNIT-III Management Of Waste:
Management of Contaminated land**,** lake sediments and Solid Waste, Anaerobic digestion, Biostimulation, Bioaugmentation, Phytoremediation, Natural attenuation, Vermicomposting

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

UNIT-VBioenergy&Biomining:
BIO ENERGY: Energy and Biomass Production from wastes, biofuels, bio hydrogen and biomass.

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

Text Books:

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

Reference Book:

1. Environmental Biotechnology - Allan Stagg.

Course Outcomes:

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

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

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

07PEXXX	Modern Separation Processes	L	T	P
		4	0	0

Course Objectives:

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

Unit I

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

Unit II

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

.

Unit III

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

Unit IV

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

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

Unit V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

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

CO5	3	3	1	-	-	-	-	-	-	-	-	2	3	2	1

OPEN ELECTIVES

07OEXXX	Industrial safety and occupational health	L	T	P
		4	0	0

Course Objectives:

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

UNIT- I

Industrial Safety - Fire- Types of fire- fire hazards-hazards of flammable liquids and gases-ignition hazards-fire extinguishers-fire exits. Explosion-Fire and explosion index-dust explosion and prevention

Toxic releases-Toxicity and its measurements-release control- reduction and removal methods-maintenance-emergency management plans. Personal protective equipment-Types-helmets-respirators-air purification-chemical protective clothing – gloves -eye glasses- foot and knee protection-skin care

Unit II

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

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

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

Unit III

Hazard Analysis - Types of hazard analysis-hazard identification-hazard survey-hazard and operability studies-fault tree analysis-event tree analysis-technique of operation review-safety audit-hazard evaluation. Health and safety-ergonomics

Unit IV

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

Unit V

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

Text Books:

1. McCornick, E.J. and Sanders, M.S., Human Factorsin Engineering and Design, Tata McGraw-Hill, 1982.
2. Dan Patterson, Techniques of Safety Management, IV edition, Mc Graw Hill, Kogakusha, 2003.

References

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

Course Outcomes:

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

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

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

07OEXXX	**Solid waste management**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

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

Unit-I

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

Unit-II

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

Unit-III

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

Unit-IV

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

Unit-V

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

Text Books:

1. Tchobanoglous, G., Theisen, H. M., and Eliassen, R. "Solid. Wastes: Engineering Principles and Management Issues". McGraw Hill, New York, 1993.
2. Vesilind, P.A. and Rimer, A.E., "Unit Operations in Resource Recovery Engineering", Prentice Hall, Inc., 1981
3. Paul T Willams, "Waste Treatment and Disposal", John Wiley and Sons, 2000

References:

1. Government of India, "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of Urban Development, New Delhi, 2000.
2. Bhide A.D. and Sundaresan, B.B. "Solid Waste Management Collection", Processing and Disposal, 2001
3. Manser A.G.R. and Keeling A.A.," Practical Handbook of Processing and Recycling of Municipal solid Wastes", Lewis Publishers, CRC Press, 1996
4. George Tchobanoglous and Frank Kreith"Handbook of Solid waste Management", McGraw Hill, New York, 2002

Course Outcomes:

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

1. An understanding of the nature and characteristics of municipal solid wastes
2. Understand the regulatory requirements regarding municipal solid waste management

3. Ability to plan waste minimization and design storage, collection, transport, processing and disposal of municipal solid waste
4. Describe about treatment of solid wastes.
5. Explain about landfill and management.

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

07OEXXX	Project Engineering and Industrial Safety	L	T	P
		4	0	0

Course Objectives:

- To familiarize the students on project engineering, operations and contracts.
- To provide knowledge about the selection of heat exchangers, pumps, compressors turbines etc.
- To illustrate the concepts of pipe design and thermal insulation.
- To impart knowledge on fire, explosion and other industrial hazards and to provide basic knowledge on personal protective equipments and their applications.
- To gain knowledge on hazard analysis, its types, hazard evaluation, health, safety and ergonomics

UNIT – I

Preliminary data for construction projects- process Engineering - process flow and PI diagrams, scheduling the project; procurement operations - contracts.

UNIT – II

Selection of heat exchangers, pumps, compressors, vacuum pumps, motors turbines and other process equipment.

UNIT – III

Piping design - pipes and fittings, pipe supports, selection of valves - piping layout and arrangement.

Thermal insulation: types and characteristics, Selection and erection of insulation.

UNIT – IV

FireTypes of fire- fire hazards-hazards of flammable liquids and gases-ignition hazards-fire extinguishers-fire exits.

ExplosionFire and explosion index-dust explosion and prevention

Toxic releases

Toxicity and its measurements- release control- reduction and removal methodsmaintenance-emergency management plans.

Personal protective equipment

Types-helmets-respirators-air purification-chemical protective clothing-gloves-eye glasses- foot and knee protection-skin care.

UNIT – V

Hazard analysis

Types of hazard analysis-hazard identification-hazard survey-hazard and operability studies-fault tree analysis -event tree analysis-technique of operation review-safety audit-hazard evaluation. Health and safety-ergonomics.

Text Books:

1. Rase,H.F.,andM.H.Barrow, Project Engineering of process plants, John Wiley & Sons, 1957.
2. Dan Patterson, Techniques of Safety Management, 2nd edition, Mc Graw Hill, Kogakusha,1978.1996.

Reference Books:

1. Chemical Process Synthesis and Engg. Design - Anilkumar, Tata McGraw Hill Pub.Co.New Delhi - 1987.
2. Safety in Chemical Industry in Chemical Technology - I, R.V.Betrabeta and TPS.Rajan, Chemical Engg. Division center IIT, Chennai.
3. Methodologies in Hazard Identification and Risk Assessment, K.V.Ragavan and A.A.Khan, Manual by CLRI - 1990.

Course Outcomes:

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

1. Convince with project engineering and process equipments.
2. Select heat exchangers, pumps, compressors turbines based on process conditions.
3. Apply the concepts of pipe design and thermal insulation.
4. Express knowledge on fire, explosion, industrial hazards and Evaluation.
5. Recommend relevant personal protective equipments, safety and ergonomics.

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

07OEXXX	**Materials of Construction in the Process industries**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

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

Unit I

Properties and Corrosion Of Material: Mechanical, Electrical and magnetic properties of materials- Deformation of materials- Heat Treatment techniques -corrosion, theories of corrosion - control and prevention of corrosion.

Unit II

Metals: Engineering materials - ferrous metals - Iron and their alloys Iron and steel Iron carbon equilibrium diagram. Non ferrous metals and alloys.

Unit III

Aluminium, copper, Zinc, lead, Nickel and their alloys with reference to the application in chemical industries.

Unit IV.

Non Metals: Inorganic materials: Ceramics, Glass and refractories

Unit V

Organic materials: wood, plastics, and rubber and wood with special reference to the applications in chemical Industries.

Text Books:

1. Lawrence H. Van Vlack, "Elements of Material Science and Engineering", VI Edn. 1989.
2. S. K. Hajra Choudhury, "Material Science and processes", 1st Edn. , 1977. Indian Book Distribution Co., Calcutta.

References:

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

Course Outcomes:

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

1. Discuss the properties of materials and the theories of corrosion.
2. Comparing ferrous and non-ferrous metals and their alloys.
3. Propose the application of metals in chemical industries.
4. Explaining the non-metals.
5. Identify the application of organic material in chemical industries.

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

CO3	3	-	3	-	3	-	-	-	-	-	-	-	3	3	3
CO4	3	-	2	-	-	-	-	-	-	-	-	-	3	2	-
CO5	3	-		3	3	-	-	-	-	-	-	-	3	3	3

07OEXXX	Fuel Technology	L	T	P
		4	0	0

Course Objectives:

- To know about the history of Fuels and its Types
- To know about & Distillation Techniques
- To know about Combustion Technology and calculations of calorific values

Unit I

Introduction -History of Fuels - Solid fuels, Liquid fuels and Gaseous fuels - Production- Present scenario - Consumption pattern of fuels - Fundamental definitions, properties and various measurements- Definitions and Properties of Solid fuels, Liquid fuels and Gaseous fuels - Various measurement techniques

Unit II

Solid Fossil Fuel - Coal classification - Composition and basis - Coal mining - Coal preparation and washing- Combustion of coal and coke making- Action of heat on different coal samples- Different types of coal combustion techniques- Coal tar distillation- Coal liquefaction- Direct liquefaction- Indirect liquefaction - Coal gasification

Unit III

Liquid Fossil Fuel - Exploration of crude petroleum - Evaluation of crude - Distillation - Atmospheric distillation - Vacuum distillation - Secondary processing - Cracking - Thermal cracking-Visbreaking - Coking- Catalytic cracking - Reforming of Naphtha -Hydro treatment - Dewaxing -Deasphalting - Refinery equipments

Unit IV

Gaseous Fuels-Natural gas and LPG - Producer gas - Water gas- Hydrogen - Acetylene- Other fuel gases

Unit V

Combustion Technology- Fundamentals of Thermo chemistry - Combustion air calculation - Calculation of calorific value of fuels - Adiabatic flame temperature calculation - Mechanism and kinetics of combustion - Flame properties - Combustion burners - Combustion furnaces - Internal combustion engines

Text Books:

1. Glassman, Yetter and Glumac, Combustion, V edn., Academic Press, 2014.
2. John Griswold, Fuels Combustion and Furnaces, Mc-Graw Hill Book Company Inc, 1946.
3. Samir Sarkar, Fuels and Combustion, 3rd. ed Universities Press, 2010.

4. W.L. Nelson, Petroleum Refinery Engineering, 4th ed. Mc-Graw Hill Book Company, 1958.

Reference Books:

1. B.K. Bhaskar Rao, Modern Petroleum Refining Processes, 4th ed., Oxford & IBH Publishing Co. Pvt. Ltd, 2008.
2. Richard A. Dave, IP, Modern Petroleum Technology, Vol 1, Upstream, 6th ed., John Wiley & Sons. Ltd, 2000.
3. Alan G. Lucas, IP, Modern Petroleum Technology, Vol 2, Downstream, 6th ed., John Wiley & Sons. Ltd. 2002.
4. Report on the project "Coal Combustion Study", sponsored by Tata Tron and Steel Company Ltd., Jamshedpur.

Course Outcomes:

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

1. Provides an idea about the Fuels and its Types
2. Describe the coal liquefaction and gasification
3. Describe and assess the liquid fossil fuels
4. Knowledge about Mechanism of corrosion
5. Knowledge on kinetics of Combustion

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

07OEXXX	Bioconversion and Processing of Waste	L	T	P
		4	0	0

Course Objectives:

- To give an idea about different biomass and other solid waste materials as energy source and their processing and utilization for recovery of energy and other valuable products.
- A comprehensive knowledge of how wastes are utilized for recovery of value would be immensely useful for the students from all fields.

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Unit-I

Biomass resources and biomass properties – biomass – definition – classification – availability – estimation of availability, consumption and surplus biomass –energy plantations. Proximate analysis, Ultimate analysis, thermo gravimetric analysis and summative analysis of biomass briquetting

Unit-II

Biomass pyrolysis – pyrolysis – types, slow fast – manufacture of charcoal, methods, yields and application – manufacture of pyrolytic oils and gases, yields and applications.

Unit-III

Biomass gasification – gasifiers – fixed bed system – downdraft and updraft gasifiers – fluidized bedgasifiers – design, construction and operation – gasifier burner arrangement for thermal heating – gasifier engine arrangement and electrical power – equilibrium and kinetic consideration in gasifier operation.

Unit-IV

Biomass combustion – biomass stoves – improved chullahs, types, some exotic designs – fixed bed combustors – types, inclined grate combustors – fluidized bed combustors – design, construction and operation and operation of all the above biomass combustors.

Unit-V

Introduction to Energy from waste -classification of waste as fuel – agro based, forest residue, industrial waste, MSW – conversion devices – incinerators, gasifiers, digestors. Separation of components of solid wastes and processing techniques, Bioconversion into biogas, mechanism, Composting technique, Bioconversion of substrates into alcohols, Bioconversion into hydrogen, Solvent extraction of hydrocarbons, Fuel combustion into electricity, case studies

Text Books:

1. Desai, Ashok V., Non Conventional Energy, Wiley Eastern Ltd., 1990.
2. H.D.Joseph, P.Joseph, H.John, Solid Waste Management, New York, Van Nostrand, 1973

Reference Books

1. Khandelwal, K. C. and Mahdi, S. S., Biogas Technology -A Practical Hand Book -Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Challal, D. S., Food, Feed and Fuel from Biomass, IBH Publishing Co. Pvt. Ltd., 1991.
3. C. Y. WereKo-Brobby and E. B. Hagan, Biomass Conversion and Technology, John Wiley & Sons, 1996.
4. G.Tchobanoglous, H.Theisen, S.V.Tchobanoglous, G.Theisen, H.V.Samuel, Integrated Solid Waste management: Engineering Principles and Management issues, New York, McGraw Hill, 1993

Course Outcomes:

At the end, students can able to

1. Illustrate biomass, characteristics and classification.
2. Explain the process of pyrolysis, efficiency and applications.
3. Explain the process of gasification, efficiency and applications and types of gasifiers.
4. Explain the process of biomass combustion, efficiency and applications.
5. Discuss bioconversion of biomass through different technologies

Mapping with POs & PSOs															
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1										3	2	

CO2	1	1	1									2		
CO3	**1**	1	1									2		2
CO4	1	1	3									2		
CO5	1	1	3									2	2	

07OEXXX	**Hazardous Waste Management**	**L**	**P**	**0**
		4	**0**	**0**

Course Objectives:

- To impart knowledge and skills in the collection, storage, transport, treatment, disposal and recycling options for hazardous wastes including the related engineering principles, design criteria, methods and equipment.

Unit I Introduction

Need for hazardous waste management – Sources of hazardous wastes – Effects on community – terminology and classification – Storage and collection of hazardous wastes – Problems in developing countries – Protection of public health and the environment.

Unit II Nuclear wastes and e-waste

Characteristics – Types – Nuclear waste – Uranium mining and processing – Power reactors– Refinery and fuel fabrication wastes – spent fuel – Management of nuclear wastes – Decommissioning of Nuclear power reactors – Health and environmental effects. E-waste – sources and management.

Unit III Biomedical and chemical wastes

Biomedical wastes – Types – Management and handling – control of biomedical wastes Chemical wastes – Sources – Domestic and Industrial - Inorganic pollutants – Environmental effects – Need for control – Treatment and disposal techniques – Physical, chemical and biological processes – Health and environmental effects.

Unit IV Hazardous wastes Management

Sources and characteristics: handling, collection, storage and transport, TSDF concept. Hazardous waste treatment technologies - Physical, chemical and thermal treatment of hazardous waste: solidification, chemical fixation, encapsulation, pyrolysis and incineration.

Unit V Waste Disposal

Waste disposal options – Disposal in landfills - Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – Rehabilitation of open dumps – landfill remediation

Text Books:

1. Hazardous waste management by Charles A. Wentz. Second edition 1995, McGraw Hill International.

2. Standard handbook of Hazardous waste treatment and disposal by Harry M. Freeman, McGraw Hill 1997.
3. Hazardous waste management by Prof.Anjaneyulu.

Reference Books

1. Criteria for hazardous waste landfills – CPCB guidelines 2000.
2. Environmental Sciences by Daniel B. Botkin and Edward A. Keller, Wiley student, 6thEdn 2009.
3. Biomedical waste (Management and Handling) Rules, 1998.
4. Waste Treatment and Disposal by Paul T Williams, Wiley, 2005
5. Environmental Science and Engineering, J. Glynn Henry and Gary. W. Heinke, Prentice Hall of India, 2004.

Course Outcomes:

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

1. Know the need for hazardous waste management and sources of hazardous wastes and its effects on community
2. Understand the characteristics and effects of Nuclear wastes and e-waste
3. Explain the characteristics and effects ofBiomedical and chemical wastes
4. Understand the characteristics and effects ofHazardous wastes management
5. Understand the Waste treatment technologies

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

02OEXXX	Disaster Management	L	T	P
		4	0	0

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Course Objectives:

- To provide basic concepts of disasters and
- To give a thorough knowledge and experience to reduce disaster risks.

UNIT I

Introduction – Disaster-Characteristics and types of Disasters- Causes and effects of Disaster - Risk- Vulnerability – Preparedness- Disaster mitigation and disaster management- Classification of mitigation measures-Vulnerability Analysis- Observation and Perception of Vulnerability- Socio-Economic Factors of Vulnerability- Vulnerability in India- Disaster related policy goals of UNDP UNDRO and Govt. of India- Appraising disaster needs- Needs for technical expertise- Role of various Agencies in Disaster Management and Development -Disaster risk reduction planning-Role of Developmental Planning for disaster Management

UNIT II

Earthquake - Cause of Earthquake- General characteristics- Measuring Earthquakes- Distribution pattern of Earthquakes in India-Earthquake prone areas- case studies of important Indian earthquakes - Forecasting techniques and risk analysis- Possible risk reduction measures- earthquake resistance buildings and re-engineering techniques in India.

UNIT III

Tsunamis-Causes of a Tsunami- General Characteristics- Tsunami warning system-Distribution pattern of Tsunami in India- Possible risk reduction measures- Integrated coastal zone management.

Landslides- Rock falls- Avalanches-Mud flows and glaciers- Landslides and rock falls- landslide hazard zonation- Instrumentation and monitoring-Techniques for reducing landslide hazards.

UNIT IV

Tropical cyclones- Structure of tropical cyclones- Nature of tropical cyclones- Cyclone experience in India and Tamilnadu- Preparedness- Tropical cyclones and their warning systems- Tropical cyclone warning strategy in India special nature of the problem in the region- Classification- Protection of buildings from cyclones of India- Precautions during and before cyclones.

UNIT V

Coastal floods- Intensification of hazards due to human interference- Management-River and coastal floods- Temperature extremes and wild fires- Physiological hazards- Flood forecasting- mitigation- planning- management- flood prone areas the Indian scenario-Flood experience in India and Tamilnadu.

Environmental hazards- Typology- Assessment and response- Strategies-The scale of disaster- Vulnerability- Disaster trends- Paradigms towards a balanced view- Chemical hazards and toxicology-Biological hazards- Risk analysis- Other technological disasters.

Text books:

1. David R. Godschalk (Editor), Timothy Beatiey, Philip Berke,.David J. Browt:r, Edward J. Kaiser Charles C. Boh, R. Matthew Goebel,*Natural Hazard Mitigation: Recasting Disaster Policy and Planning*Island Press; (January 1999), ISBN) 559636025
2. Sinha, P.C. *Wind & Water Driven Disasters*, 1998, 250pp, Anmol Publications

References:

1. DavideWikersheimer*Windstorm Mitigation Manual for Light Frame Construction*, DIANE Publishing Co: (Paperback-May 1997)
2. BrownD*RedevelopmentAfter the Storm: Hazard Mitigation Opportunities in the Post Disater Setting.* (Paperback – June 1985) Publisher: John Wiley & Sons ISBN:047191505X
3. Sinha, P.C. *Technological Disasters*, 1997, 516 pp Anmol Publications Trivedi,

COURSE OUTCOMES

Students will be able to

1. Develop an understanding of the key concepts, definitions key perspectives of all Hazards Emergency Management
2. Develop a basic under understanding of Prevention, Mitigation, Preparedness, Response and Recovery
3. Explain about Tsunami, landslides and effects.
4. Explain about earthquake forecasting and risk assessment.
5. Discuss the environmental effects of coastal floods.

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

00OEXXX	Entrepreneurship	L	T	P
		4	0	0

Course Objectives:

- Develop an entrepreneurship sprit
- Help to identify business opportunities within an organization or independently
- Initiate action on the business plan from the prospective business through EDC

UNIT – I

Meaning – Characteristics of management – Nature of management – Process of management – Functional areas of management – Management and administration – Role of management – Level of management – Evolution of management.

UNIT – II

Meaning - Nature of planning – Importance of planning – Types of planning – Steps in planning – Decision making – Meaning and definition of organizing – Steps in organizing – Nature of organization – Organization structure – Purpose of organization – Principles of organization – Delegation of authority – Nature and importance of staffing.

UNIT – III

Meaning and nature of direction – Principles of directing – Leadership and leadership style – Motivation – Communication – Need and feedback in communication – Importance of communication – Channels of communication – Types of communication – Forms of communication.

UNIT – IV

Evolution of concept of entrepreneur – Concept of entrepreneur – Characteristics of entrepreneur – Distinction between entrepreneur and manager – Technical entrepreneur – Charms of being an entrepreneur – Types of entrepreneur – Role of entrepreneurship in economic development – Barriers in entrepreneurship.

UNIT – V

Meaning of project – Project classification – Project identification – Meaning and significance of project report – Contents of a project report – Formulation of project report – Planning commission guidelines – Identification of opportunity – Project feasibility study.

Text books:

1. Veerabhadrappahavinal,*Management and entrepreneurship*, New age International, New Delhi, 2008.
2. Peter f. Drucker; I*nnovation and entrepreneurship, B*utterworth – Heinemann, London, 1985.

References:

1 **"***Creativity, innovation, entrepreneurship and enterprise in construction and development*", University of Reading, Alan Barrell – Entrepreneur in Residence Entrepreneur in Residence, University of Xiamen, Xiamen 2012.
2 "*Entrepreneurship Studies*", National University Commission (Nigerian University System), 2010.

Course Outcomes:

At the end, students can able to

1. Understanding about entrepreneurship, management and administration.
2. Formulation of project reports
3. Identification of opportunities
4. Develop leadership qualities as well as leadership style
5. Knowledge about the principles of planning and staffing

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