ANNAMALAI UNIVERSITY

Annamalainagar

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF CHEMICAL ENGINEERING

B.E. Chemical Engineering

Four Year Degree Programme

Choice Based Credit System

(Full - Time)

HAND BOOK

2016 - 2017

ANNAMALAI UNIVERSITY
FACULTY OF ENGINEERING AND TECHNOLOGY
B.E. (Four Year) DEGREE PROGRAMME
Choice Based Credit System (CBCS)

REGULATIONS

1. Condition for Admission

Candidates for admission to the first year of the four year B.E. Degree programmes shall be required to have passed the final examination of the plus 2 Higher Secondary Course with Mathematics, Physics and Chemistry as subjects of study and candidates who have passed the Higher Secondary Examination through vocational stream under Engineering, conducted by the Board of Secondary Education, Government of Tamilnadu or an examination of any other authority accepted by the Syndicate of this University as equivalent thereto. They shall satisfy the conditions regarding qualifying marks, age and physical fitness as may be prescribed by the Syndicate of the Annamalai University from time to time.

Candidates who have passed the Diploma course in Engineering of the State Board of Technical Education, TamilNadu (listed in Annexure-1) will be eligible for admission to the second year of the four year degree programme in B.E. under the lateral entry scheme provided they satisfy other conditions.

2. Branches of Study in B.E.

BRANCH I	- Civil Engineering
BRANCH II	- Civil and Structural Engineering
BRANCH III	- Mechanical Engineering
BRANCH IV	- Mechanical Engineering (Manufacturing)
BRANCH V	- Electrical and Electronics Engineering
BRANCH VI	- Electronics and Instrumentation Engineering
BRANCH VII	- Chemical Engineering
BRANCH VIII	- Computer Science and Engineering
BRANCH IX	- Information Technology
BRANCH X	- Electronics and Communication Engineering

3. Courses of study

The courses of study and the respective syllabi are given separately.

4. Scheme of Examinations

The scheme of Examinations is given separately.

5. Choice Based Credit System (CBCS)

The curriculum includes six components namely Humanities/Social Sciences/Management, Basic Sciences, Engineering Sciences, Professional Core, Professional Electives and Open Electives in addition to Seminar & Industrial Training and Project. Each semester curriculum shall normally have a blend of theory and practical courses. The total credits for the entire degree Programme is 176 (135 for lateral entry students).

6. Eligibility for the Degree

A candidate shall be eligible for the degree of Bachelor of Engineering if the candidate has satisfactorily undergone the prescribed courses of study for a period of four academic years and has passed the prescribed examinations in all the four academic years. For the award of the degree, a student has to

1. Earn a minimum of 176 credits (135 for lateral entry students).
2. Serve in any one of the Co-curricular activities such as
    - National Cadet Corps (NCC)
    - National Service Scheme (NSS)
    - National Sports Organization (NSO) and
    - Youth Red Cross (YRC)

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

(OR)

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

- Student Chapters of Institution of Engineers (India)
- Student Chapters of other Professional bodies like ICI, ISA, IIChE

7. 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.

8. Duration of the programme

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

9. Registration for courses

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

Every other student shall 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 176 (135 for lateral entry students) credits in order to be eligible for obtaining the degree. However the student is entitled to enjoy an option to earn either more or less than the total number of credits prescribed in the curriculum of a particular semester on the following guidelines:

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

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

10. Seminar / Industrial Training

The student has to present a seminar on the chosen topic. However, the student can select a topic duly approved by the Seminar Coordinator and the Head of the Department concerned. The student who has presented the seminar has to submit a report and appear for viva-voce examination at the end of the semester.

11. Project Work

The student typically registers for project at the end of seventh semester and completes it at the end of the eighth semester along with the courses prescribed for study in the eighth semester. However a student who has registered and successfully completed the courses of eighth semester by acquiring additional credits in the earlier semesters can attempt to spend his / her period of study in an industry and complete his / her project work, submit the project report and appear for viva-voce examination at the end of eighth semester.

12. Industrial Training (Value added courses)

One credit courses shall be offered by a Department with the prior approval from the Dean, Faculty of Engineering and Technology. For one credit course, a relevant potential topic may be selected by a committee consisting of Head of the department concerned and the Board of Studies member from the Department and a senior faculty member from the department concerned. An expert from industry familiar with the topic chosen may be accordingly invited to handle classes for the students. The details of the syllabus, time table and the name of the industrial expert may be sent by the above committee to the Dean for approval. The credits earned through the one credit courses shall be over and above the total credit requirement prescribed in the curriculum for the award of the degree. Students can take a maximum of two one credit courses (one each in VI and VII semesters). They shall be allowed to take one credit courses offered in other Departments with the permission of Head of the Department offering the course. A separate mark sheet shall be issued for one credit courses.

13. 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 & 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.

Further, the student can also credit not more than two courses offered through the SWAYAM Portal of UGC with the approval of the Head of the Department concerned. These courses will be considered as equivalent of open electives.

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

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

15. Substitute Assessment

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

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

16. Student Counsellors (Mentors)

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

17. Class Committee

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

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

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

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

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

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

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

18. 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.

19. 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. In the case of short term employment/ training/ internship, the application for break of study shall be approved and forwarded by the Head of the department concerned to the Dean.

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

20. 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.

21. 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.

22. 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 176 credits within four years (135 credits within three years for lateral entry students) for 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 subjects from I Semester to VIII Semester (III Semester to VIII Semester for lateral entry students).
- For **First Class**, the student must earn a minimum of 176 credits within five years (135 credits within four years for lateral entry students) from the time of admission and obtain a CGPA of 6.75 or above for all the subjects from I Semester to VIII Semester (III Semester to VIII Semester for lateral entry students)..
- For **Second Class**, the student must earn a minimum of 176 credits within eight years (135 credits within seven years for lateral entry students) from the time of admission.

23. 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 subjects of study from I Semester to VIII Semester (III Semester to VIII Semester for lateral entry students).

The Candidates passing with First Class will be ranked next after those with distinction on the basis of CGPA for all the subjects of study from I Semester to VIII Semester (III Semester to VIII Semester for lateral entry students).

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

24. 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-1

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

Sl.No.	Branches of Study	Eligible Diploma Programme (FT / PT / SW)
1	**Civil Engineering**	i. Civil Engineering ii. Civil Engineering(Architecture) iii. Environmental Engineering and Pollution Control(Full Time) iv. Architectural Assistantship v. Civil Engineering (Rural Tech.) vi. Civil and Rural Engineering
2	**Civil and Structural Engineering.**	
3	**Mechanical Engineering**	i. Mechanical Engineering ii. Mechanical and Rural Engineering iii. Mechanical Design and Drafting iv. Production Engineering v. Production Technology vi. Automobile Engineering vii. Automobile Technology viii. Metallurgy ix. Mechatronics Engineering x. Machine Tool Maintenance and Repairs xi. Tool and Die making xii. Tool Engineering xiii. Tool Design xiv. Foundry Technology xv. Refrigeration and Air Conditioning xvi. Agricultural Engineering xvii. Agricultural Technology xviii. Marine Engineering xix. Mechanical Engineering(Production) xx. Mechanical Engineering(Tool &Die) xxi. Mechanical Engineering (Foundry) xxii. Mechanical Engineering(R & A.C.) xxiii. Electronics(Robotics) xxiv. Mining Engineering xxv. Agricultural Engineering and Farm xxvi. Equipment Technology
4	**Mechanical Engineering (Manufacturing Engineering)**	

5	**Electrical and Electronics Engineering**	i. Electrical and Electronics Engineering ii. Electronics and Communication Engg. iii. Electronics and Instrumentation Engg iv. Electronics Engineering(Instrumentation) v. Instrument Technology vi. Instrumentation and Control Engineering vii. Electrical Engineering (Instruments and Control) viii. Electrical Engineering ix. Instrumentation Technology x. Electronics (Robotics) xi. Mechatronics Engineering
6	**Electronics and Instrumentation Engineering**	
7	**Chemical Engineering**	i. Petrochemical Engineering ii. Chemical Engineering iii. Environmental Engineering and Pollution Control iv. Leather Technology (Footwear) v. Leather Technology vi. Plastic Technology vii. Polymer Technology viii. Sugar Technology ix. Textile Technology x. Chemical Technology xi. Ceramic Technology xii. Petro Chemical Technology xiii. Pulp & Paper Technology xiv. Petroleum Engineering
8	**Computer Science and Engineering**	i. Electronics and Communication Engineering ii. Computer Technology iii. Computer Science and Engineering iv. Information Technology v. Computer Engineering vi. Computer Networking vii. Electronics(Robotics) viii. Mechatronics Engineering
9	**Information Technology**	
10	**Electronics and Communication Engineering**	

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

COURSES AND CREDITS – SUMMARY

Semester	No. of Courses		HS	BS	ES	PC	PE	OE	S&IT	Proj.	Total Credits
	T+P	Total									
I	4+2	**6**	3*	9	5	-	-	-	-	-	19
			1**	3	2						
II	4+4	**8**	4	13	7	-	-	-	-	-	22
			1	5	2						
III	6+2	**8**	3	4	8	8	-	-	-	-	23
			1	1	3	3					
IV	6+2	**8**	-	4	3	16	-	-	-	-	23
				1	1	6					
V	6+3	**9**	-	-	-	17	8	-	-	-	25
						6	3				
VI	6+3	**9**	-	-	-	10	11	3	-	-	24
						4	4	1			
VII	5+3	**8**	3	-	-	5	8	3	1	-	20
			1			2	3	1	1		
VIII	2+1	**3**	-	-	-	-	-	6	-	14	20
								2	-	1	
Total Courses	39+20	**59**	**4**	**10**	**8**	**21**	**10**	**4**	**1**	**1**	-
Total credits		-	**13**	**30**	**23**	**56**	**27**	**12**	**1**	**14**	**176**

* - No of Credits

** - No of Courses

DETAILS OF COURSE CODE

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

Code (3rd and 4th Digits)	Details
HS	Humanities Theory
HP	Humanities Practical
BS	Basic Science Theory
BP	Basic Science Practical
ES	Engineering Science Theory
SP	Engineering Science Practical
PC	Professional Core Theory
CP	Professional Core Practical
PE	Professional Elective Theory
EP	Professional Elective Practical
ST	Seminar / Industrial Training
OE	Open Elective Theory
PV	Project and Viva-voce

5th digit represents the semester and 6th and 7th digits represent the serial number of courses

B.E. (Four Year) DEGREE PROGRAMME
Choice Based Credit System (CBCS)
Courses of Study and Scheme of Examinations

FIRST SEMESTER

Sl. No.	Category	Course Code	Course	L	T	P/D	Exam	CA	Total	Credits
1	HS-I	00HS101	Technical English	4	-	-	75	25	100	3
2	BS-I	00BS102	Engineering Mathematics I	4	-	-	75	25	100	3
3	BS-II	00BS103	Applied Physics I	4	-	-	75	25	100	3
4	BS-III	00BS104	Applied Chemistry I	4	-	-	75	25	100	3
5	**ES-I Lab**	00SP105	**Computer Programming Laboratory**	**-**	**1**	**3**	**60**	**40**	**100**	**3**
6	**ES-II Lab**	00SP106	**Engineering Graphics**	**-**	**2**	**3**	**60**	**40**	**100**	**4**
			Total	**16**	**3**	**6**	**420**	**180**	**600**	**19**

SECOND SEMESTER

Sl. No.	Category	Course Code	Course	L	T	P	Exam	CA	Total	Credits
1	BS-IV	00BS201	Engineering Mathematics II	4	-	-	75	25	100	3
2	BS-V	00BS202	Applied Physics II	4	-	-	75	25	100	3
3	BS-VI	00BS203	Applied Chemistry II	4	-	-	75	25	100	3
4	ES-I	00ES204	Basic Engineering*	4		-	75	25	100	3
5	HS-II	00HP205	Communication Skills and Language Laboratory	-	2	3	60	40	100	4
6	BS-I Lab	00BP206	Applied Physics Laboratory	-	-	3	60	40	100	2
7	BS-II Lab	00BP207	Applied Chemistry Laboratory	-	-	3	60	40	100	2
8	ES-III Lab	00SP208	Engineering Workshop	-	-	3	60	40	100	2
			Total	**16**	**2**	**12**	**540**	**260**	**800**	**22**

*** Basic Civil Engg. Subject** for Mech., Manuf., EEE, EIE, ECE, CSE & IT
Basic Electrical Engg. Subject for Civil, Civil and Structural, Mech., Manuf.,& Chem. Engg.
Basic Mechanical Engg. Subject for Civil, Civil and Structural, EEE, EIE, ECE, CSE, IT & Chem. Engg.
L-Lecture; **T**-Tutorial; **P**-Practical.
Exam-End Semester Examination; **CA**-Continuous Assessment

THIRD SEMESTER

Sl. No.	Category	Course Code	Course	L	T	P	Exam	CA	Total	Credits
1	HS-III	00HS301	Environmental Studies	4	-	-	75	25	100	3
2	BS-VII	00BS302	Engineering Mathematics III	4	1	-	75	25	100	4
3	**ES-II**	00ES303	Engineering Mechanics	**4**	**-**	**-**	**75**	**25**	**100**	**3**
4	ES-III	07ES304	Particle Mechanics and Mechanical Operations	4	-	-	75	25	100	3
5	PC-I	**07**PC305	Chemistry for Chemical Engineers	4	-	-	75	25	100	3
6	PC-II	07PC306	Process Calculations	3	1	-	75	25	100	3
7	ES-IV Lab	07SP307	Particle Mechanics and Mechanical Operations Laboratory	-	-	3	60	40	100	2
8	PC-I Lab	07CP308	Organic & Physical Chemistry Laboratory	-	-	3	60	40	100	2
			Total	**24**	**1**	**6**	**570**	**230**	**800**	**23**

FOURTH SEMESTER

Sl. No.	Category	**Course Code**	Course	L	T	P	Exam	CA	Total	Credits
1	BS-VIII	**07BS401**	Numerical Methods	**4**	**1**	**-**	**75**	**25**	**100**	**4**
2	ES-IV	07ES402	Material Technology	4	-	-	75	25	100	3
3	PC-III	07PC403	Fluid Mechanics for Chemical Engineers	3	1	-	75	25	100	3
4	PC-IV	07PC404	Heat Transfer	3	1	-	75	25	100	3
5	PC-V	07PC405	Mass Transfer	4	-	-	75	25	100	3
6	PC-VI	07PC406	Chemical Process Industries	4	-	-	75	25	100	3
7	PC-II Lab	07CP407	Fluid Mechanics Laboratory	-	-	3	60	40	100	2
8	PC-III Lab	07CP408	Chemical Technology Laboratory	-	-	3	60	40	100	2
			Total	**24**	**1**	**6**	**570**	**230**	**800**	**23**

FIFTH SEMESTER

Sl. No.	Category	Course Code	Course	L	T	P	Exam	CA	Total	Credits
1	PC-VII	07PC501	Chemical Reaction Engineering I	4	1	-	75	25	100	4
2	PC-VIII	07PC502	Chemical Engineering Thermodynamics I	4	-	-	75	25	100	3
3	PC-IX	07PC503	Momentum Transfer Operations	4	-	-	75	25	100	3
4	PC-X	07PC504	Process Instrumentation Dynamics & Control	4	-	-	75	25	100	3
5	PE-I	07PE505	Professional Elective –I	4	-	-	75	25	100	3
6	PE-II	07PE506	Professional Elective -II	4	-	-	75	25	100	3
7	PC-IV Lab	07CP507	Heat Transfer Laboratory	-	-	3	60	40	100	2
8	PC-V Lab	07CP508	Mass Transfer Laboratory	-	-	3	60	40	100	2
9	PE-I Lab	07EP509	Professional Elective –I Lab	-	-	3	60	40	100	2
			Total	**24**	**1**	**9**	**630**	**270**	**900**	**25**

SIXTH SEMESTER

Sl. No.	Category	Course Code	Course	L	T	P	Exam	CA	Total	Credits
1	PC-XI	07PC601	Chemical Reaction Engineering II	4	-	-	75	25	100	3
2	PC-XII	07PC602	Chemical Engineering Thermodynamics II	4	-	-	75	25	100	3
3	PE-III	07PE603	Professional Elective –III	4	-	-	75	25	100	3
4	PE-IV	07PE604	Professional Elective –IV	4	-	-	75	25	100	3
5	PE-V	07PE605	Professional Elective –V	4	-	-	75	25	100	3
6	OE-I	XXOE606*	Open Elective-I	4	-	-	75	25	100	3
7	PC-VI Lab	07CP607	Chemical Reaction Engineering Laboratory	-	-	3	60	40	100	2
8	PC-VII Lab	07CP608	Process Control Laboratory	-	-	3	60	40	100	2
9	PE-II Lab	07EP609	Professional Elective –II Lab	-	-	3	60	40	100	2
			Total	**24**	**-**	**9**	**630**	**270**	**900**	**24**

*First two digits indicates thecode of the dept. / branch offering the elective course.

SEVENTH SEMESTER

Sl. No.	Category	Course Code	Course	L	T	P	S	Exam	CA	Total	Credits
1	**HS-IV**	**00HS701**	**Engineering Ethics**	**4**	**-**	**-**	**-**	**75**	**25**	**100**	**3**
2	PC-XIII	07PC702	Process Engineering Economics	4	-	-	-	75	25	100	3
3	PE-VI	07PE703	Professional Elective –VI	4	-	-	-	75	25	100	3
4	PE-VII	07PE704	Professional Elective –VII	4	-	-	-	75	25	100	3
5	OE-II	XXOE705	Open Elective-II	4	-	-	-	75	25	100	3
6	PC-VIII Lab	07CP706	Chemical Plant Equipment Design	-		3	-	60	40	100	2
7	PE-III Lab	07EP707	Professional Elective –III Lab	-	-	3	-	60	40	100	2
8	S & IT	07ST708	Seminar / Industrial Training	-	-	-	1	60	40	100	1
			Total	**20**	**-**	**6**	**1**	**555**	**245**	**800**	**20**

EIGHTH SEMESTER

Sl. No.	Category	Course Code	Course	L	T	P	Exam	CA	Total	Credits
1	OE-III	XXOE801	Open Elective-III	4	-	-	75	25	100	3
2	OE-IV	XXOE802	Open Elective-IV	4	-	-	75	25	100	3
3	Proj.	07PV803	Project Work and Viva-voce	-	-	15	60	40	100	14
			Total	**8**		**15**	**210**	**90**	**300**	**20**

L-Lecture; **T**-Tutorial; **P**-Practical; **D**-Drawing
Exam-End Semester Examination; **CA**-Continuous Assessment

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. Waste Water Treatment
10. Environmental Engineering
11. Fluidization Engineering
12. Computational Fluid Dynamics
13. Mixing Theory And Practice
14. Petroleum Refining and Petrochemicals
15. Hydrocarbon Processing and Engineering
16. Distillation
17. Fluid Solid Reaction Engineering
18. Computer Aided Design in Chemical Engineering
19. Object Oriented Programming And C++
20. Membrane Science and Engineering
21. Analytical Techniques
22. Process Plant Utilities
23. Machine Theory, Design And Drawing
24. Agro Process Technology
25. Food Processing Technology
26. Industrial Biotechnology
27. Modern Separation Process
28. Drugs and Pharmaceutical Technology
29. Fertilizer Technology
30. Pulp and Paper Technology
31. Corrosion Engineering
32. Total Quality Management
33. Operational Research
34. Chemical Engineering Mathematics
35. Optimization of Chemical Processes

PROFESSIONAL ELECTIVE - LABS

1. Chemical Engineering Thermodynamics Laboratory
2. Computer Aided Chemical Equipment Design Laboratory
3. Petroleum Engineering Laboratory
4. Environmental Engineering Laboratory
5. Biochemical Engineering Laboratory
6. Food Processing Engineering Laboratory

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. Safety Prevention Techniques
6. Fuel Technology
7. Bioconversion and Processing of Waste
8. Hazardous Waste Management
9. Renewable Energy Technology
10. Biology for Engineers
11. Disaster Management
12. Entrepreneurship
13. Human Rights
14. National Service Scheme

DEPARTMENT OF CHEMICAL ENGINEERING

Vision

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

Mission

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

Program Educational Objectives (PEOs)

PEO 1:	To master the basic principles with ability to apply mathematics, physics, chemistry and biology and to understand and apply the same in the practice of modern technologies.
PEO 2:	To excel in designing and optimization of the processes and systems by analysis and evaluation with the knowledge of basic engineering sciences of mass and energy balances: Thermodynamics of physical & chemical equilibria: Heat, Mass & Momentum transfer with economic principles.
PEO 3:	To develop the ability to express ideas with understanding of social and cultural context of work associated with environmental, safety and economic aspects and high standards of ethical practice.

PEO 4:	To acquire the ability to solve problems in a broad range of career in multi-disciplinary professional team with effective management skills, moral responsibility applying critical thinking with leadership qualities at par with contemporary and global outlook.
PEO 5:	The ability to cater the needs of chemical industry, research organizations and academic institutes

B.E. (Chemical Engineering)

PO 1 Engineering Knowledge:

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

PO 2 Problem Analysis:

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

PO 3 Design/Development of Solutions:

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

PO 4 Conduct Investigations of ComplexProblems:

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

PO 5 Modern Tool Usage:

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

PO 6 The Engineer and Society:

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

PO 7 Environment and Sustainability:

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

PO 8 Ethics:

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

PO 9 Individual and Team Work:

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

PO 10 Communication:

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

PO 11 Project Management and Finance:

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

PO 12 Life-Long Learning:

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

PROGRAM SPECIFIC OUTCOMES (PSOs)

Graduates of Chemical Engineering Programme at Annamalai University will

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

PSO 2 Investigate and demonstrate innovative practices to develop processes and products and provide services with optimal utilization of resources with sustainability and ethics

.**PSO 3** Administer professional engineering competence to analyze and interpret data in engineering, economics and management to exhibit as an individual, leader and entrepreneur with ability to efficiently communicate, work effectively in diversified environments and pursue lifelong learning for careers in industry, academics and research.

SYLLABUS

FIRST SEMSTER

00HS101	TECHNICAL ENGLISH	L	T	P
		4	0	0

Course Objectives:

- English technical communication focuses on developing the proficiency of Engineering students in communicative skills, ensuring them to face the demand of their profession with high command in English.
- At the end of the course, the learners will be able to use English for all purposes of technical communication and come out in "flying colours".

Unit - I : Listening Strategies

This unit makes the students to get exposed to the listening exercises and get registered in their minds the nuances of listening and its importance.

1. Listening process.
2. Types of listening.
3. Barriers to listening.
4. Characteristics of good listeners.
5. Team listening and note making.

Unit - II : Critical Reading and Creative Writing Skills

This unit introduces communication model like courtesy, body language, role play and good presentation in an effective manner, where the students are given an opportunity to observe, analyze, interpret, imagine and implement their ideas too.

Poem : Road not taken – Robert Frost
Ulysses – Alfred Lord Tennyson.

Prose : Of Studies – Francis Bacon
Science – Destroyer or creator – J. Bronowski

Play : Pygmalion – Bernardshaw.

Unit - III : Speaking Skill

Students shall be motivated to speak in English on familiar or unfamiliar topics. It is a platform to train the students to achieve competency in oral expression.

1. Interview Techniques
2. Group discussion
3. Making presentation and Discussing on the presentation.
4. Sample interviews
5. Dialogue writing

Unit - IV : Professional Writing

Students shall be trained to create their own proficiency in writing like - calling for quotation, asking clarification, placing orders and so on.

1. Poster making
2. Letter writing (formal and E-mail)
3. Analytical writing
4. Format of memos.
5. Report Writing

Unit - V : Theoretical writing

The nuances of English grammar may be taught to the students so as to present flawless English both in their oral and written communication

1. Vocabulary – Homonyms, Homophones, Acronyms & Abbreviations, Idioms & Phrases.
2. Single word substitution
3. Concord
4. Tag Questions
5. Active voice and passive voice

Text Book:

1. Rizvi, Ashraf.2006. *"Effective Technical Communication"*. New Delhi. Tata Mc.Graw Hill Publication Company Ltd.

Reference books:

1. Raman, Meenakshi and Sangeetha Sharma.2004. *"Technical Communication: Principles and Practice"*. New Delhi: OUP.
2. Bailey, Stephen. "*Academic Writing: A practical guide for students*". New York: Rutledge.2011.
3. Gerson, Sharon J and Steven M. Gerson. 2007. "*Technical writing: Process and Product*". Delhi: Pearson prentice Hallan, 1980.

Course Outcomes:

1. Acquire an understanding of the techniques of listening.
2. Understanding the importance of comprehension skills.
3. Ensure the students to achieve competency in oral expression.
4. Understand the characteristics of formal writing and become familiar with the structure and layout of professional writing.
5. Able to present flawless English both in oral & written communication.

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

00BS102	ENGINEERING MATHEMATICS - I	L	T	P
		4	0	0

Course Objectives:

To acquaint the student with the concepts in

- matrices,
- differential calculus,
- multiple integrals,
- vector calculus, 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: Differential Calculus

Curvature in Cartesian and parametric co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes.

Unit III: Differential Calculus: Functions of Several Variables

Jacobians – Taylor's and Maclaurin's series expansions of functions of two variables – Maxima and Minima of functions of two variables – Constrained Maxima and Minima by Lagrange Method.

Unit IV: Multiple Integrals

Double integration – Cartesian and polar co-ordinates – change of order of integration – area as a double integral – triple integration – Volume as a triple integral.

Unit V: Laplace Transform

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

(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.

Erwin Kreysig, Advenced Engineering Mathematics, John Wiley & Sons, 8th Edition, 2002.

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

00BS103	**APPLIED PHYSICS – I**	L	T	P
		4	0	0

Course Objectives:

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

- Determine the different modulus of elasticity and viscosity of the less and highly viscous liquids.
- Design of acoustically good buildings.
- Interferometric techniques in metrology, communication and civil engineering.
- Application of quantum physics to optical and electrical phenomena.
- Application of ultrasonics and acoustics.
- Structure identification of engineering materials.
- Applications of Radio isotopes and power reactor systems.

Unit - I : Properties of Matter

Introduction to elasticity - Hook's law - Different modulii of elasticity - Bending of beams – Determination of Young's modulus by Uniform and Nonuniform bending – I-shapegirder – Torsional pendulum - Theory – Experiment and its applications. Introduction to Viscosity – streamline and turbulent flow – Poiseuille's equation- capillary flow method – Stoke's law – terminal velocity – determination of viscosity by Stoke's method.

Unit -II : Sound

Introduction to Acoustics - factors affecting acoustics of buildings and their remedies– absorption coefficient– Sabine's formula for reverberation time.

Introduction to Ultrasonics – production – magnetostriction and piezo electric methods – Detection of Ultrasonic waves (Acoustics grating) – Applications.

Unit – III : Optics

Interference – Air wedge – Michelson's interferometer – Diffraction - Dispersive power of prism and grating – Polarisation – Types of Polarisation - theory of plane, Circularly and elliptically polarized light – photo elasticity -Stress optic law – Effect of a stressed model in plane polariscope – Isoclinic and Isochromatic fringes – photo elastic bench – uses.

Unit – IV : Crystal Physics

Lattice - Unit cell - Bravais lattice - Atomic radius, co-ordination number, Packing factor and their calculations of SC,BCC,FCC and HCP crystal structures - Miller indices - Crystal imperfections (Point defect, Line defect, surface defect and volume defect).

Unit –V: Nuclear Physics

Introduction - General properties of Nucleus – Mass defect, Binding energy, Nuclear models – Liquid drop model and Nuclear shell model - Nuclear detector – G.M counter – Scintillation Counter – Ionisation Chamber – Fission, Fusion, Thermonuclear reaction and Stellar energy – Nuclear reactor – General nuclear reactor – Breeder nuclear reactor.

Text Books

1. Arumugam M., "Engineering Phyisics", Anuradha Agencies, Kumbakonam, 2000.
2. Gaur R.K. and Gupta S.L., "Engineering Physics", DhanpatRai Publishers, New Delhi, 2003.

Reference Books

1. Pillai S.O., "Solid State Physics", New Age International Publication, New Delhi, Seventh Edition, 2015
2. Palanisamy P.K. "Physics for Engineers", Scitech Publication (India) Pvt. Ltd., Chennai, Second Edition, 2005.
3. Mani. P. "Engineering Phyisics", Dhanam Publication, Chennai, 2011.
4. Rajendran V. and Marikani A., "Applied physics for engineers", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2004.
5. Theraja B.L, "Modern Physics", Chand & company Ltd. , Edition 1990.
6. Tayal D.G., "Nuclear Physics", Himalaya publishing house, 2007.
7. Ghoshal.S.N., "Nuclear Physics", S. Chand & Company Ltd., 2012.
8. Avadhanulu M.N. and Kshirsagar P.G., "A Text Book of Engineering Physics", S. Chand & Company Ltd., 7th Enlarged Revised Ed., 2005.

Course Outcomes:

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

1. Describe the concept Hook's law of elasticity and its application towards I shaped grider.
2. Develop innovative methods of construction noise free halls.
3. Understand the different properties of light waves.
4. Gain knowledge on the importance of packing factor in crystal structure.
5. Analyze the different nuclear models and nuclear detector.

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

00BS104	**APPLIED CHEMISTRY – I**	L	T	P
		4	0	0

COURSE OBJECTIVES

To make the student conversant with the

- Water treatment techniques and disinfection methods.
- Working principle of electrochemical cells.
- Sources, refining and various types of fuels.
- Mechanism, classification, applications of lubricants and introduction adhesives.
- Surface chemistry, principle and applications of chromatography.

Unit I :WATER TREATMENT

Water – Hardness of water – softening of water by ion-exchange process and zeolite process – boiler feed water – specifications – boiler troubles (Sludge and scale formation, priming and foaming, caustic embrittlement and boiler corrosion) – removal of dissolved CO_2, O_2 and acids – internal treatment of boiler feed water (colloidal, carbonate, phosphate, calgon and EDTA conditioning) – disinfection of water – break point chlorination – desalination of brackish water by reverse osmosis method - Determination of total hardness by EDTA method.

Unit II :ELECTROCHEMISTRTY

Electrochemical cell – EMF – determination of EMF of electrochemical cell – single electrode potential – standard electrode potential – Nernst equation – reference electrodes – standard hydrogen electrode, calomel electrode, glass electrode – electrochemical series – concentration cell.

Unit III :FUELS AND COMBUSTION

Classification of fuels – calorific value – HCV and LCV – Analysis of coal – proximate and ultimate analysis – carbonization of coal (HTC and LTC) – Manufacture of coke – properties of coke – flue gas analysis by Orsat's apparatus. Petroleum – Refining – Synthetic petrol – Fischer – Tropsch and Bergius process – cracking – polymerization process – knocking in petrol and diesel engines – octane number and cetane number – properties of straight run, cracked and polymer gasoline.

Unit IV :ENGINEERING MATERIALS – I

Lubricants and their functions – Mechanisms of lubrication – classification of lubricants with example – lubricating oils – properties of lubricating oils (viscosity index, flash and fire points, cloud and pour points, oiliness, carbon residue and aniline point) – Solid lubricants – Greases – emulsion lubricants. Adhesives – Definition – adhesive action – development of adhesives strength – physical and chemical factors influencing adhesive action – bonding process of adhesives – adhesives for building and constructions – animal glues, casein glues.

Unit V :ANALYTICAL TECHNIQUE AND SURFACE CHEMSITRY

Chromatography – Definition – classifications – partition chromatography and adsorption chromatography.Surfacechemistry – Definition – types of adsorption – characteristics of adsorption – adsorption isotherms – Freundlich's adsorption isotherms and Langmuir's adsorption isotherms – applications of adsorption.

Text Books:

1. Sivasankar. B (2012)., '***Engineering Chemistry'***, Tata McGraw-Hill Publishing company Limited, NewDelhi.
2. Sivakumar. R and Sivakumar. N (2013)., '***Engineering Chemistry'***, Tata McGraw-Hill Company Limited, NewDelhi

Reference Books

1. Jain.P.C. and Monica Jain (2010)., '***Engineering Chemistry'***, DhanpatRai& Sons, New Delhi
2. Dara.S.S. and Umare.S.S (2014)., '***Text book of Engineering Chemistry***,' S.Chand& Co. Ltd., New Delhi.
3. Gopalan. R, Venkappayya. D, and Nagarajan. S (2008)., '***Engineering Chemistry'***, Tata McGraw Hill Publishing Company Limited, New Delhi.

Course Outcomes:

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

1. Develop innovative methods to produce soft water for industrial use and potable water at cheaper cost.
2. Apply the concepts of electrochemistry in electroplating and batteries.
3. Examine the properties and sources of fuels.
4. Categorize lubricants and adhesives according to their properties.
5. Predict chromatographic techniques and adsorption isotherms.

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

00SP105	COMPUTER PROGRAMMING LABORATORY	L	T	P
		0	1	3

Course Objectives:

- To enable the students to have a good understanding about the concepts of "C" programming.
- To provide the hands on experience in basic concepts of AUTOCAD to students.

C Programs based on the following concepts:

Basic structure of C Programs – Constants – Variables - Data Types - – Keywords – Identifiers - Operators - Expressions – IF, IF-ELSE, Nested IF-ELSE, Switch, WHILE, DO, FOR and GOTO statements - Arrays: one dimensional and two dimensional – Strings - Functions.

AUTOCAD:

Introduction – Terminology – Coordinates - Operations – Control keys – Commands – Utility Commands –File Commands – Edit and Inquiry Commands – Display Control Commands – Modes – Layers – Colors – Blocks.

Special Features – Dimensioning – Angular, Diameter and Radius – Hatching – Patterns – Slides – Attributes – Configuring – Plotting– Exercises in AUTOCAD (2D Drawings only)

Text Books:

1. E. Balagurusamy, Programming in Ansi C, Tata McGraw-Hill Education, (2012) 6th Edition.
2. Cheryl R. Shrock, AutoCAD Pocket Reference, BPB Publications,(2015)

Reference Books

1. Yashavant P. Kanetkar, Let us C, BPB Publications, 14th Edition, (2016)
2. David Byrnes, AutoCAD 2010 FOR DUMMIES, Wiley Publishing,Inc., (2010)

Course Outcomes:

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

1. Analyze program requirements and develop programs using conditional and looping statements.
2. Develop programs for handling arrays and strings.
3. Create programs with user defined functions.
4. Study and Practice the basic drawing and editing commands of AUTOCAD for creating 2D drawings.
5. Apply basic drawing and editing commands of AUTOCAD for 2D drawing including dimensioning, hatching, sliding and pattern creation.

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

00SP 106	ENGINEERING GRAPHICS	L	T	P
		2	0	3

Course Objectives:

- To develop the ability to produce simple engineering drawing and sketches based on current practice.
- To develop the means for communication of ideas, thoughts and design of objects, related to engineering applications, to others though drawing.
- To develop the skills to read manufacturing and construction drawings used in industry.
- To develop a working knowledge of the layout of plant and equipment.
- To develop skills in abstracting information from calculation sheets and schematic diagrams to produce working drawings for manufacturers, installers and fabricators.
- To expose the international standards of technical drawing

UNIT – I

Introduction to Engineering Drawing, Use of drafting instruments– Lettering and dimensioning.

Construction of conic sections -Ellipse, Parabola & Hyperbola (Eccentricity Method, Rectangle method, Intersecting arcs method) - Special curves- Simple cycloids and involutes– Tangent and normal at points on the curves only.

UNIT – II

Orthographic projections - Projections of Points- Projections of Straight lines (given the projections, to determine the true length and true inclinations).

UNIT – III

Projections of Solids like prism, pyramid, cylinder, cone, tetrahedron and octahedron in simple positions.

Auxiliary Projections of prism, pyramid, cylinder, cone when the axis is inclined to one plane only.

UNIT – IV

Sections of prism, pyramid, cylinder, cone in simple position – true shape of sections.Intersection of surfaces - cylinder to cylinder and cylinder to cone with axis intersecting at right angles. Development of lateral surfaces of prism, pyramid, cylinder, cone and cut solids.

UNIT – V

Isometric Projections of simple solids and combinations. Perspective Projections of simple solids. Conversion of Pictorial view of simple objects into Orthographic views

Text Books:

1. Bhatt, N.D Engineering Drawing -Charotar Bookstall, Anand – 388001.
2. Venugopal, K Engineering Drawing and graphics – New age international (P) Ltd., Publishers, Chennai.

Reference Books:

1. Gopalakrishna, K.R. Engineering Drawing Vol.I and Vol. II – Subhas stores, Avenue Road, Bangalore – 560002.
2. Kumar, M.S Engineering Graphics – DD Publications, Chennai – 6400048.

Course Outcomes:

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

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

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

SECOND SEMESTER

00BS201	ENGINEERING MATHEMATICS II	L	T	P
		4	0	0

Course Objectives

- To acquaint the student with the concepts in ordinary differential equations and vector calculus.
- To acquaint the student with the techniques in the theory of analytic functions and complex integration.
- Above topics are most important in connection with practical engineering problems.

Unit I : 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), Simultaneous first order linear equations with constant coefficients, method of variation of parameters.

Unit II : Vector Differentiation

Gradient, divergence and curl, directional derivative, unit normal vector, irrotational and solenoidal vector fields, expansion formulae for operators involving ∇.

Unit III: Vector Integration

Line, surface and volume integrals, Green's theorem in a plane, Gauss divergence theorem, Stoke's theorem – Verification of the above theorems and evaluation of integrals using them.

Unit IV: Analytic Functions

Functions of a complex variable, Analytic function, the necessary conditions (Cauchy-Riemann equations), sufficient conditions, Properties of analytic functions, harmonic functions, construction of Analytic function by Milne-Thomson method, Conformal mapping: $w = z^2$, $1/z$, e^z, sin z, cos z.

Unit V: Complex Integration

Statement and application of Cauchy theorem, Cauchy integral formulas, Taylor and Laurent expansion, Singularities – Classification; Residues – Statement and application of Cauchy residue theorem, Contour integration round the unit circle.

(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, Advanced Engineering Mathematics, John Wiley & Sons, 8th Edition, 2002.

Course Outcomes:

At the end of this course, students will able to

1. Solve double and triple integrals in finding area and volumes.
2. Apply line, surface and volume integrals in Gauss, Greens and Stoke's theorems.
3. Solve Second order linear differential equations with constant coefficients.
4. Construct analytic function and analyze conformal mappings.
5. Evaluate the complex integrals and contour integration.

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

00BS202	APPLIED PHYSICS – II	L	T	P
		4	0	0

Course Objectives

At the end of the course the students would be exposed to fundamental knowledge invarious materials and applications

- Application of lasers and fiber optics in engineering and technology.
- Astrophysics is the study of physics of the universe. In various objects, such as stars, planets and galaxies.
- To measure positions, brightness, spectra structure of gas clouds, planets, starts, galaxies, globular clusters, quasars etc.
- Physics of modern engineering materials.
- Electromagnetic phenomena and wave propagation
- Applications of nano materials, nano electronics and optoelectronic devices.
- Design of energy sources and applications of solar energy.

Unit I: Laser and Fiber Optics

Introduction to laser - Einstein co-efficients (A&B) – properties of Laser- Types of laser – CO_2, Nd-YAG and Semiconductor lasers - Applications – Holography - Construction and reconstruction of hologram - Applications.

Fiber optics - Principle and propagation of light in optical fibers - Numerical aperture and acceptance angle - Types of optical fibers (Material, Mode and refractive index) - Applications - Fiber Optic communication system.

Unit II :Dielectrics and Superconductors

Introduction to Dielectrics – Types of Dielectric materials - Dielectric constant – Determination of Dielectric constant (∑r) by Schering Bridge method – Different types of polarization – Local or Internal field – Clausius-Mosotti Equation – Dielectric Loss – Dielectric breakdown – Dielectric Properties and applications – Superconductivity – Properties – Meissner effect – Type I and Type II superconductors – BCS theory- High temperature Superconductors – Applications.

Unit III : Nano Materials

Introduction to Nanomaterials – properties – Types of nanomaterials – synthesis of nanomaterials - Top-down approaches – Mechanical grinding, Lithiography – Types of Lithiography - Bottomup approaches – physical vapour deposition method, Sol-gel method. Applications of nanomaterial. Carbon Nanotubes (CNT) – Introduction – Types of Carbon Nanotubes – Synthesis of Carbon Nanotubes – Properties and its application.

Unit IV : Quantum Mechanics

Heisenberg uncertainty Principle - Wave particle dual nature – De Broglie's matter Waves – wave Velocity and group velocity.

The wave Equation, Schrödinger's Time dependent wave equation, Schrödinger's time independent wave equation - The Wave function and its physical significance - The particle in a box – energy quantization – Eigen values and Eigen functions.

UnitV :Energy Physics

Introduction to energy source - Energy sources and their availability (Conventional &non-conventional energy sources) – Solar energy – Introduction – Methods of Harvesting Solar energy (Solar cells, Solar battery, Solar heat collectors and Solar water heater) - Wind energy – basic components of a WECS (Wind Energy Conversion System) – Classification of WEC Systems – Advantages and disadvantages of WECS - Biomass – Biomass conversion - Biogas Generation - Classification of Biogas plants.

Text Books

1. Arumugam.M. "Engineering Physics", Anuradha agencies, 2nd Edition, 1997.
2. Gaur R.K. and Gupta S.L., "Engineering Physics", DhanpatRai Publishers, New Delhi, 2003.

Reference Books

1. Rajendran.V, "Engineering Physics", Tata McGraw Hill publishers, 2009.
2. Rai G.D., "Non-conventional Energy sources", Khauna Publications, 1993.
3. Martin Harwit, "Astrophysical Concepts", Springer, 4th Edition, 2006.
4. Dimitri Mihalas. "Stellar Atmospheres", San Francisco, W.H, Freeman & Company, 1978.
5. Wilson M., Kannangara K., Smitt G., Simmons M. &Boguse B. "Nanotechnology", Basic science and emergine technology, Raguse Chapman hall Publications, 2002.
6. Kenneth Klabunde.J, "Nanoscale Materials in chemistry", A John Eiley& Sons, Inc., Publication, 2001.

7. Mani. P. "Engineering Phyisics", Dhanam Publication, Chennai, 2011.
8. Agarwal.M.P, "Solar Energy", S.Chand& Co., I Edn, New Delhi, 1983.
9. John Twidell& Tony Weir, " Renewable Energy Resources" , Taylor & Francis, 2005.
10. Carroll B.W. &D.A.Ostlie , "An introduction to Modern Astrophysics", 2nd Edition, 2011.
11. Avadhanulu M.N. and Kshirsagar P.G., "A Text Book of Engineering Physics", S. Chand & Company Ltd., 7th Enlarged Revised Ed., 2005.
12. Rai.G.D. "Solar Energy Utilization" Volume-1 & 2 by - Khanna Publishers, New Delhi.
13. Senthilkumar.G, Engineering Physics, VRB Publishers Pvt. Ltd., Chennai.
14. Ravikrishnan.A, Environmental Science and Engineering, Hitech Publishing Company PVT Ltd.
15. Rai.G.D. , "Non-Conventional Energy Sources" - Khanna Publishers.
16. Senthilnathan.S, Gnanapoongothai.T, Oudayakumar.K, Jayavarthanan.T, "Material Science", SSMP Publications.

Course Outcomes:

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

1. Description of different types of lasers and fibers optical materials and its application
2. Explain the diamagnetic properties of superconductor
3. Understand the different types of nanomaterials.
4. Evaluate the quantum mechanical concept of wave velocity and group velocity
5. Compared the different energy resources and their availability

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

00BS203	**APPLIED CHEMISTRY II**	L	T	P
		4	0	0

Course Objectives:

To make the students to understand the

- Types of polymers and polymerization processes.
- Phase rule with different kinds of systems.
- Different types of corrosion and their mechanism.
- Working principle and applications of primary and secondary batteries.
- Engineering materials such as refractories and abrasives.

Unit I :POLYMERS

High polymers: plastics – Thermoplastics and thermosetting resins. Addition polymerization and condensation polymerization – compounding of plastics – Moulding methods – Compression, injection and

blow moulding – Important engineering plastics – polyethylene, PVC, Teflon, Polystyrenes, Nylon 6,6, Bakelite, Polyurethane – Rubber – natural rubber – vulcanization of rubber – Synthetic rubber – buna-S, butyl rubber, neoprene and polyurethane foams.

Unit II :PHASE RULE

Phase rule – statements and explanation of the terms involved – condensed phase rule – construction of phase diagram – water system – sulphur system – phase rule for two component alloy systems – thermal analysis – eutectic system – Lead-Silver system – simple eutectic formation – Zinc – Magnesium alloy system.

Unit III :CORROSION AND PREVENTION

Corrosion: Dry and wet corrosion – Pilling-Bedworth rule – mechanism of wet corrosion – types of wet corrosion – galvanic corrosion – differential aeration corrosion – factors affecting corrosions. Corrosion control methods – design and material selection – cathodic protections – sacrificial anode and impressed current method – corrosion inhibitors – protective coatings – surface preparations – Galvanizations, Tinning – electroplating – anodizing, phosphate coating, hot dipping.

Unit IV :ENERGY STORAGE DEVICES

Types of battery – commercial voltaic cell – primary battery – secondary storage cell – lead – acid cell, nickel-cadmium cell, lithium battery – fuel cells – hydrogen-oxygen fuel cell – photovoltaic cell – principle, working and applications.

Unit V :ENGINEERING MATERIALS II

Refractories – classification (acidic, basic and neutral refractories) – properties (refractoriness, refractoriness under load, dimentional stability, porosity, thermal spalling) – fire clay bricks, alumina bricks and zirconia bricks. Abrasives – Moh's scale of hardness – natural abrasive (diamond, corundum, emery, garnets and quartz) – synthetic abrasives – silicon carbide, boron carbide and their uses.

Text Books:

1. Sivasankar. B (2012)., '***Engineering Chemistry'***, Tata McGraw-Hill Publishing company Limited, NewDelhi.
2. Sivakumar. R and Sivakumar. N (2013)., '***Engineering Chemistry'***, Tata McGraw-Hill Company Limited, NewDelhi.

Reference Books

1. Jain.P.C. and Monica Jain (2010)., '***Engineering Chemistry'***, DhanpatRai& Sons,New Delhi
2. Dara.S.S. and Umare.S.S (2014)., '***Text book of Engineering Chemistry'***, S.Chand& Co. Ltd., New Delhi.
3. Gopalan. R, Venkappayya. D, and Nagarajan. S (2008)., '***Engineering Chemistry'***, Tata McGraw Hill Publishing Company Limited, New Delhi.
4. Gowariker.V.R.,Viswanathan N.V. and JayadevSreedhar, (2006)., '***Polymer Science'***, New Age International P (Ltd.,), Chennai. (Unit I)
5. Puri. B. R, Sharma. L. R &Pathania. M. S (2013)., '***Principles of Physical Chemistry'***, Vishal Publishing Company, NewDelhi. (Unit II)

Course Outcomes:

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

1. Illustrate the synthesis and applications of polymers and moulding processes.
2. Describe the concept of phase rule and its applications in alloy preparation.
3. Relate the concept of corrosion with the protection of metals from corrosion.
4. Examine about energy storage devices including solar cells.
5. Interpret the knowledge on classification, synthesis and applications of abrasives and refractories.

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

00ES204	**BASIC ENGINEERING (CIVIL)**	L	T	P
		2	0	0

Course Objectives:

- To inculcate a knowledge on essentials of Civil Engineering
- To expose the students on the role, significance and contributions of Civil Engineering in satisfying societal needs
- To illustrate the concepts of various construction techniques

Module I

Introduction to Civil Engineering - various disciplines of Civil Engineering, relevance of Civil Engineering in the overall infrastructural development of the country. Introduction to various building materials – Stone, Bricks, Steel, Cement, Concrete, Timber – its characteristics, types and uses. Various types of buildings as per nbc; Selection of suitable site for buildings, Components of a residential building – its functions, Orientation of a building, simple definitions - plinth area / built up area, floor area / carpet area – floor space index.

Module II

Surveying - Principles and objectives of surveying; Types, Classifications of surveying, measurement of areas and distances – chain – compass: Introduction to Leveling, Total station, Remote sensing - fundamental principles and applications.

Building construction – foundations; Bearing capacity of soil, functions of foundations, Types - Shallow and Deep. Brick masonry – Header, Stretcher, Flemish and English Bond. Columns, Lintels, Roofs – functions, types, roofing materials, Floors – functions, types, flooring materials. Decorative finishes – plastering, interior design

Module III

Bridges – necessity - selection of site – components of a bridge: Dams – types – selection site - forces acting on a dam – Roads – uses - classification of roads – components of a road; Railways – basic components of permanent way – water supply – per capita requirement – sources – need for conservation of water – rain

water harvesting - basic water treatment – Sewage and its disposal – basic definitions – Septic tank - components and functions.

Text Books

1. Ramesh babu. V, A text book of Basic Civil Engineering, Anuradha Agencies, Kumbakonam, 1995.
2. Palanichamy M.S., Basic Civil Engineering, Tata McGraw Hill Publishing Company ltd, 2000.

Reference books

1. Ramamrutham V, Basic Civil Engineering, DhanpatRai Publishing Co. (P) Ltd., 1999.
2. Natarajan K V, Basic Civil Engineering, Dhanalakshmi Publications, Chennai, 2005.
3. SatheeshGopi, Basic Civil Engineering, Pearson Publications, 2010.

Course Outcomes:

1. Understand the basic knowledge on civil engineering materials
2. Develops the skill to satisfy the social needs
3. Describe the suitable method of construction technique

00ES204	BASIC ENGINEERING (ELECTRICAL)	L	T	P
		2	0	0

Course Objectives:

- PO1: To impart the basic principles of generation of electrical energy.
- PO2: To explain the operation of electrical machines and various measuring instruments.
- PO3: To understand the basic concepts of circuit analysis.
- PO4: To provide an overview of the principles, operation and application of semiconductor devices like diodes, BJT, FET and a basic knowledge of fundamentals of Communication Systems.

Module I

Sources of Electrical energy–Generation of electrical energy – working principles of DC generators and alternators– Advantages of electrical energy over other forms of Energy.

Operating principle of DC motors– Types of DC motors– Characteristics and uses of DC motors. Working principles of Single and Three phase transformers. Operating Principle of three phase and single phase induction motors– types and uses of induction motors.

Working principles of MC and MI voltmeters and Ammeters, Dynamo meter type wattmeter, Induction type energy meter and Multimeter–types of wiring– requirements for house wiring–typical layout for a small house– earthing.

Module II

DC Circuits: Definition of current, voltage, power and energy– DC voltage and current sources– resistance, types of resistors, series and parallel connections of resistors, current and voltage division–loop method of analysis of simple circuits.

AC Circuits: Sinusoidal signals – average, r.m.s values –inductance, capacitance and their V–I relationships. Analysis of simple single phase series circuits– power and power factor–phasor diagrams– Introductions to three phase AC circuits.

Module III

Basic Electronics: Principle and characteristics, uses of PN junction Diode, Zenerdiode, BJT, FET, UJT, Thyristors,-Operating principle of Half wave, Full wave and Bridge rectifiers.

Digital Electronics and Principles of Communication Systems: Symbol, truth table and functions of basic logic gates, universal gates, Half adder, Full adder. Communication systems–Microwave, Satellite, Fibreoptic and ISDN (block diagram description only).

TextBooks:

1) Nagrath, I.J., 2007. Elements of Electrical Engineering, 2nd Edition, 14th reprint, Tata McGraw Hill Publishing Co. Limited, New Delhi.

Reference Books:

1) Gupta, B. R., 2002. *Principles of Electrical Engineering*, S. Chand &Co, NewDelhi.
2) Theraja. B.L &Theraja. A.K., 2000. *Electrical Technology, Vol. I, II, and IV*, S. Chand and Co., NewDelhi.
3) Floyd & Jain, 2009. *Digital Fundamentals*, 8th Edition, Person Education.
4) Anok Singh, 2006. *Principles of Communication Engineering*, 6th reprint, S. Chand &Company Ltd., Ram Nagar, NewDelhi.

Course Outcomes:

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

1. CO1: Provide comprehensive idea about simple circuit analysis, working principles of machines and common measuring instruments
2. CO2: Analyze the behavior of any dc and ac circuits
3. CO3: Characterize semiconductor devices that include diodes, BJT and digital functions.
4. CO4: Understand fundamental principles of communication systems

00ES204	BASIC ENGINEERING (MECHANICAL)	L	T	P
		2	0	0

Course Objectives:

- To familiarize the students the functioning of different types of Boilers, the mountings and accessories.
- To provide basic knowledge about the use of various machine tools and the basic principles of welding, brazing and soldering.
- To illustrate the concepts of various metal forming operations and metal joining techniques.

Module I

Boilers:Classification – Description and working of Simple vertical boiler, Cochran boiler, Babcock and Wilcox boiler - Description and working of boiler mountings: water level indicator, Pressure gauge, Dead weight and Spring loaded Safety value, Fusible plug, Feed check value, Steam stop value and Blow–off cock - Description and working of boiler accessories: Economiser and Super heater.

Module II

Prime Movers: Steam turbines: Principles and working of Impulse and Reaction turbines – Comparison. Gas turbines: Principles and working of Open cycle and Closed cycle gas turbines. Internal Combustion Engines: Classification – principal parts – comparison of two strike and four stroke engines – working principle of petrol and diesel engines.

Module III

Machine Tools: Description of parts and operations performed – Lathe, Shaper and Drilling machine.

Metal Forming: Hot working versus cold working; Hand forging – Principle and operations; Rolling – Principle, rolling mill configurations; Extrusion – Direct versus indirect extrusion**.**

Metal Joining: Gas welding – principle, Oxy-acetylene welding – equipment, types of flames, advantages and disadvantages – Arc welding - principle, advantages and disadvantages – Brazing – Torch brazing, dip brazing, furnace brazing, resistance brazing – Soldering – Comparison of brazing and soldering.

Text Books:

1. Prabhu T J, Jaiganesh V and Jebaraj S, Basic Mechanical Engineering, Scitech Publications Pvt. Ltd., Chennai, 2000.
2. Venugopal and Prabhuraj T J, Basic Mechanical Engineering, ARS publishers, Sirkali, 1996.

Reference Books

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

Course Outcomes:

1. Understand the construction and working principles of boiler operations
2. Distinguish between steam turbines and gas turbines.
3. Select suitable manufacturing methods to produce a new component.

Course Outcomes for Basic Engineering:

1. Acquire Knowledge on the essentials of Civil, Mechanical and Electrical Engineering.
2. Familiarize with the various civil engineering materials, electrical equipment and machine tools.
3. Understand the working principle of boilers, turbines and electrical machines.
4. Gain overview on surveying, construction, bridges, electronic devices, communication systems, welding and soldering.
5. Develop skills to satisfy the societal needs.

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

00HS205	COMMUNICATION SKILLS AND LANGUAGE LABORATORY	L	T	P
		0	2	3

Course Objectives:

- The Language Lab focuses on the production and practices of sounds of language
- The Language Lab familiarizes the students with the use of English in everyday situations and contexts.

Theoretical Session (Internal Assessment only)

1. English sound pattern
2. Sounds of English
3. Pronunciation
4. Stress and Intonation
5. Situational Dialogues/ Role play
6. Oral presentations- Prepared or Extempore
7. 'Just a Minute' sessions (JAM)
8. Describing Objects /situations/ people
9. Debate
10. Giving Directions

Practical Session

- To make the students recognize the sounds of English through Audio Visual Aids
- To enable the students speak fluently without fear
- To develop their communicative skill with individual practice through the prescribed package
- The Globarena Package consists of the following exercises
    1. Reading comprehension
    2. Listening comprehension
    3. Vocabulary exercises
    4. Phonetics
    5. Role Play in dialogues
    6. Auto Speak

Minimum Requirement:

The English Language Lab shall have two parts:

The Computer aided Language Lab for 60 students with 60 systems, one master console, LAN facility and English language Globarena software for self- study by learners and Library with Books to improve their proficiency in English.

Suggested Software:

1. **Globarena** Package for communicative English
2. Cambridge Advanced Learner's English Dictionary

Books to be procured for English Language Lab Library:

1. Spoken English (CIEFL) in 3 volumes with 6 cassettes, OUP.
2. English Pronouncing Dictionary Daniel Jones Current Edition with CD.
3. Spoken English- R. K. Bansal and J. B. Harrison, Orient Longman 2006 Edn.
4. A Practical course in English Pronunciation, (with two Audio cassettes) by J. Sethi, KamleshSadanand& D.V. Jindal, Prentice-Hall of India Pvt. Ltd., New Delhi.
5. A text book of English Phonetics for Indian Students by T.Balasubramanian (Macmillan)
6. English Skills for Technical Students, WBSCTE with British Council, OL.

DISTRIBUTION AND WEIGHTAGE OF MARKS

English Language Laboratory Practical Paper:

1. The practical examinations for the English Language Laboratory shall be conducted as per the University norms prescribed for the core engineering practical sessions.
2. For the Language lab sessions, there shall be a continuous evaluation during the year for 40 sessional marks and 60 year-end Examination marks. The year- end Examination shall be conducted by the teacher concerned with the help of another member of the staff of the same department of the same institution.

Course Outcomes:

1. Realize the essentiality of the informal conversation.
2. Become familiar with different speaking skills.
3. Gain confidence to speak and write on similar topic.
4. Improve listening & speaking skills. Includes oral reports conference procedures and everyday conversations.
5. Continue to speak with reduced anxiety by recognizing and using communication strategies.

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

00BP206	APPLIED PHYSICS LABORATORY	L	T	P
		0	0	3

Course Objectives:

The ability to offer students a variety of research opportunities

- To determine the radius of curvature of the plano convex lens and the wavelength of the sodium light by measuring the diameter of Newton's rings.
- We can use a spectrometer to measure this angle of deviation.
- To measure the modulus of elastic material by torsional pendulum and bending of a beam.
- To determine the resistivity of a given steel and brass wire.
- To find the velocity of ultrasonic waves in a liquid.
- Less viscosity of the liquid by poiseuille's method.

List of Experiments (Any Ten)

1. Non-Uniform Bending - Determination of Young's modulus of the given scale or beam.
2. Newton's rings- Determination of Radius of curvature of the given Plano convex lens.
3. Viscosity –Determination of co-efficient of Viscosity of a highly viscous liquid by Stoke's method.
4. Spectrometer – Dispersive power of a given prism.
5. Torsional Pendulum – Determination of Moment of Inertia of the metallic disc and Rigidity Modulus of the material of a wire.
6. Field along the axis of a coil- Determination of horizontal earth magnetic flux density.
7. Air wedge – Determination of thickness of a given thin wire and paper.
8. Viscosity - Determination of co-efficient of Viscosity of a less viscous liquid by Capillary flow method
9. Uniform bending- Determination of Young's modulus of the given scale or beam.
10. Spectrometer – Determination of wavelength of the prominent spectral lines using Grating.
11. Semiconductor diode laser – Determination of wavelength of Laser source using Grating.
12. Band gap determination of a Semiconductor.

Course Outcomes:

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

1. Acquired the knowledge of torsional properties of metals wire.
2. Generalized the dispersion of light through the prism.
3. Calculate the wavelength of monochromatic and polychromatic source of light.
4. Analyze diffraction patterns can be formed by light passing through a series of fine lines.
5. Estimate the size and shape of given unknown fine powder using laser gratings.

Mapping of Course Outcomes with Program Outcomes

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

00BP207	APPLIED CHEMISTRY LABORATORY	L	T	P
		0	0	3

Course Objectives

- To appreciate the practical significance of acidimetry, alkalimetry and permanganometry
- To analyse quantitatively the amount of a substance present in a given sample.
- To assess the composition of an alloy
- To test the water quality standards.

LIST OF EXPERIMENTS

1) Estimation of Potassium hydroxide
2) Estimation of Acetic acid in vinegar
3) Estimation of Temporary hardness of water sample
4) Estimation of Total hardness of water sample
5) Estimate separate amount of sodium carbonate and sodium hydroxide in a mixture .
6) Estimation of Ferrous sulphate
7) Estimation of Mohr's salt
8) Estimation of ferrous iron
9) Estimation of Oxalic acid
10) Determination of available free chlorine in a water sample.
11) Estimation of copper in brass by iodometry
12) Estimation of iron by dichrometry
13) Estimation of nickel in an alloy

Course Outcomes:

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

1. Calculate the quantity of acids and bases in industrial waste water.
2. Estimate temporary and total hardness of water sample.
3. Estimate the available chlorine in industrial waste.
4. Determine the quantity of metals in alloy.
5. Determine the quantity of iron in solutions by permanganometric method.

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

00SP208	ENGINEERING WORKSHOP	L	T	P
		0	0	3

Course Objectives:

- To provide the students simple hands-on-experience in the basic aspects of production engineering in fitting, carpentry and sheet metal.

Workshop Practice in the Shops,

Carpentry: Use of hand tools – exercises in planning and making joints namely, half lap joint, dovetail joint, mortising and tenoning.

Fitting: Use of bench tools, vice, hammers, chisels, files, hacksaw, centre punch, twist drill, taps and dies – Simple exercises in making T joint and dovetail joints.
Sheet Metal Work: Use of hand tools – Simple exercises in making objects like cone, funnel, tray, cylinder.
Smithy: Demonstration of hand forging and drop forging.
Course Outcomes:

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

1. Use basic tools of fitting, carpentry and sheet metal fabrication.
2. Experience in the fabrication of simple carpentry joints.
3. Develop skill to make simple fitting joints.
4. Make simple shapes of sheet material.
5. Distinguish hand forging and drop forging operation.

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

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

.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:**

  Designsolutionsforcomplexengineeringproblemsanddesignsystemcomponentsorprocesses thatmeetthespecifiedneedswithappropriateconsiderationforthepublichealthandsafety,and the cultural, societal, and environmental considerations.

- **PO 4 Conduct Investigations of Complex Problems:**

  Useresearch-basedknowledgeandresearchmethodsincludingdesignofexperiments,analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

- **PO 5 Modern Tool Usage:**

  Create,select,andapplyappropriatetechniques,resources,andmodernengineeringandITtools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- **PO 6 The Engineer and Society:**

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

- **PO 7 Environment and Sustainability:**

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

- **PO 8 Ethics:**

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

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

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

- **PO 10Communication:**

  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.

SEMESTER III

00HS301	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.

Field work

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

Text Books:

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

00BS302	Engineering Mathematics – III	L	T	P
		4	0	0

Course Objectives:

- The students will be trained on the basics of chosen topics of mathematics, namely, partial differential equations, Fourier series, Boundary value problems, Fourier transform and Z-transform. The above topics introduced in this course will serve as basic tools for specialized studies in engineering.

.UNIT-I: Partial Differential Equations

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

UNIT-II: Fourier Series

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

UNIT-III: Boundary value problems

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

UNIT-IV: Fourier Transform

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

UNIT-V: Z – Transform and difference equations

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

Text Books:

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

Reference Books:

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

Course Outcomes:

At the end, students can able to

1. Relate and acquire basic understanding of the most common partial differential equations.
2. Illustrate the solution based Fourier series and limitations.
3. Distinguished learning of methods of solving problems using Fourier transforms.
4. Describes the boundary value problems and able to solve.
5. Observe the solution based Z-transform

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

00ES303	**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 and Nagan, S (2010), Engineering Mechanics (Statics and Dynamics), Tata McGraw Hill Publishing Company, Ltd., New Delhi.
2. Beer, F.P and Johnson, R (2004), Vector Mechanics for Engineers (Statics), McGraw- Hill Book company, New Delhi.

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	-

07ES304	**Particle Mechanics and Mechanical Operations**	**L**	**T**	**P**
		3	**1**	**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	-

07PC305	Chemistry for Chemical Engineers	L	T	P
		4	0	0

Course Objectives:

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

Unit I

Quantifying systems, Atoms and Bonding, The periodic table, Molecular structure, Mass and Volume

Unit II

hemole, Stoichiometry, Acid-basechemistry, Basicorganicchemistry, Basicthermodynamics

Unit III

Kinetictheoryofgases, Physicalpropertiesofgases, Equilibriaandkinetics

Unit IV

Effectofreactionconditionsontheequilibriumposition, Liquidsandsolutions, Colligativeproperties

Unit V

Chemicalreactions, Hess'slawandtemperaturedependenceofequilibria, Materialbalances and Energybalances

Text Books:

1. Dr.Ashleigh J. Fletcher, Chemistry for Chemical Engineers, Ventus Publishing Aps, 2012, (**ISBN:** 978-87-403-0249-3)
2. Jain & Jain, Engineering Chemistry, Dhanpat Rai Pulishing Compnay, 16th Edition, 2015. (**ISBN:**9352160002)

Reference Books

1. R.P.Singh, Handbook of Chemistry, Arihant Publications, 3rd Edition, 2015. (**ISBN:**9350941791)

Course Outcomes:

At the end, students can able to

1. Extend knowledge on basic principles of chemistry applicable to chemical engineering.
2. Express the basics of gases and liquids
3. Predict the basic reaction concepts.
4. Define the basic terms of reaction engineering.
5. Evaluate the material and energy balances of reactions.

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

07PC306	**Process Calculations**	**L**	**T**	**P**
		3	**1**	**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 Vapour pressure plots. Vapour pressure of immiscible Liquids. Raoult's law, relative vapor pressure.

Unit - II

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

Unit - III

Material Balance: Calculation for Batch and Continuous Processes, Recycling Process, by pass and purging operation. 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	-

07SP307	**Particle Mechanics and Mechanical Operations Laboratory**	**L**	**T**	**P**
		0	**0**	**3**

Course Objective:

- To understand basic principles of various mechanical operations, construction and working of the equipments
- To impart practical knowledge and have on experience on various separation techniques.

List of Experiments

1. Settling
2. Sedimentation
3. Decantation
4. Leaf Filter
5. Ball Mill
6. Cyclone Separator

7. Vibrating Screen
8. Double Roll Crusher
9. Jaw Crusher
10. Drop weight crusher

Course Outcomes:
At the end, students can able to

1. Analyze the area required for settling of solid from liquid by thickening and clarifying process
2. Interpret the specific surface area of particles with sieve analysis
3. Compute the fractional and overall efficiency of mesh by vibrating screen and cyclone separator
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	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	3	2	-
CO2	2	2	2	-	-	-	-	-	-	-	-	-	2	2	-
CO3	2	2	1	-	-	-	-	-	-	-	-	-	2	2	-
CO4	2	2	1	-	-	-	-	-	-	-	-	-	2	2	-
CO5	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-

07CP308	**Organic and Physical Chemistry Laboratory**	**L**	**T**	**P**
		0	**0**	**3**

Course Objectives:

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

Organic chemistry

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

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

Physical Chemistry

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

Reference Books:

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

Course Outcomes:

At the end, students can able to

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

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

SEMESTER IV

07BS401	Numerical Methods	L	T	P
		3	1	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	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**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	-	-

07ES402	**Material Technology**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- To familiarize the students about basic things of Engineering Materials.
- To provide basic knowledge about the use of various types and application areas of Materials.
- To illustrate the concepts of Material science.

Unit I

Nature and properties of materials, phases, binary phase diagrams, Iron-Carbon equilibrium diagram, time temperature - transformation curves, methods of fabrication and failure under service conditions testing of materials.

Unit II

Heat treatment of ferrous metal and alloys: Quenching, tempering, normalizing, carburizing, nit riding, carbonitriding, cyaniding and chormizing, siliconizing.

Unit III

Corrosion - mechanisms of corrosion - Dry corrosion - wet corrosion - polarization and corrosion rates, passivity, galvanic corrosion -concentration cell, corrosion Atmospheric corrosion - Underground corrosion - Micro biological corrosion - stray current corrosion pitting, erosion corrosion - stress corrosion - corrosion fatigues - selective corrosion, oxidation and tarnish.

Unit IV

Application of the following materials: Iron and steel, Copper, Nickel, Chromium, Aluminum and Zinc and their alloys, Timber, Rubber, Plastics and Glass.

Unit V

Corrosion control and prevention: Cathodic protection, anodic protection, metallic coatings, organic coatings, inorganic coatings, inhibitors, Smart materials.

Text Books:

1. Jasrrzebski,Z.D., Nature and properties of Engineering Materials, John Wiley & Sons, 1987.
2. Khanna.O.P, A Text Book Of Material Science and Metallurgy, Dhanpat Rai Publications (P) LTD

Reference Books

1. Uhlig.H, and R.Winston Reive, Corrosion and Corrosion Control, 3rd Edn., John Wiley, 1991.
2. Cremer and Davies,Chemical Engineering Practice, Vol. 9 Butterworths, 1965.
3. Raghavan,V., Materials science and Engineering, Prentice Hall India, New Delhi, 1998.

Course Outcomes:

At the end, students can able to

1. Explain about properties of materials, Interpret phase diagrams and describe failure of materials under service conditions.
2. Describe the principle of heat treatment for materials and select appropriate process to achieve desired properties for specific applications
3. Classify different forms of corrosion and explain mechanisms involved.
4. Explain about commercial applications and properties requirement of materials
5. Describe corrosion preventive methods and select suitable material & method for different conditions.

Mapping with POs & PSOs														
Cos	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	3	3	-	-	1	-	-	-	-	-	2	3	-
CO2	2	2	3	3	-	-	1	-	-	-	-	-	2	3	-
CO3	3	3	2	-	-	1	2	-	-	-	-	-	3	2	-
CO4	3	3	2	-	-	2	-	-	-	-	-	-	3	2	-
CO5	3	2	1	-	-	2	2	-	-	-	-	-	3	3	-

07PC403	**Fluid Mechanics for Chemical Engineers**	**L**	**T**	**P**
		3	**1**	**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	-	-

07PC404	**Heat Transfer**	**L**	**T**	**P**
		3	**1**	**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, 7th Edn., 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	-

07PC405	**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.

Unit III

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	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**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	-	-

07PC406	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	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**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	-	-

07PC407	**Fluid 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. Variable Speed Centrifugal Pump
12. Packed Bed
13. Fluidized Bed

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. Demonstrate the ability to write clear lab reports.
5. Demonstrate the ability to produce a working model through hands on experience in fluid mechanics design and explain its operation in terms of what was learned in the course

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

07PC408	**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	-

SEMESTER V

07PC501	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, Nirali Prakashan, 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

07PC502	**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.,Van Ness,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:

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	-	-	-	-	-	-	-	-	-	-	-

07PC503	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. Develope 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	-	-	-	-	-	-	-	-	-	-

07PC504	**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

07CP507	**Heat Transfer Laboratory**	**L**	**T**	**P**
		0	**0**	**3**

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. Jacketed Kettle
4. Horizontal Condenser
5. Critical Heat Flux Apparatus

6. Stefen-Boltzmann Apparatus
7. Parallel And Counter Flow Heat Exchanger
8. Natural Convection
9. Thermal Conductivity Of Insulating Material
10. Emmisivity Measurement
11. Drop Wise And Film Wise Condensation
12. Finned Tube Heat Exchanger

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. Determine important data for the design and operation of the heat transfer
5. Analyze the various heat exchanger equipments and divide them based on their operations

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

07CP508	**Mass Transfer Laboratory**	**L**	**T**	**P**
		0	**0**	**3**

Course Objective:

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

1. Air Drying
2. Rotary Dryer
3. Simple Distillation
4. Steam Distillation
5. HETP Determination
6. Leaching Cross Current
7. Leaching Counter Current
8. Leaching Stage Wise
9. Adsorption

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

Course Outcomes:

At the end, students can able to

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

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

SEMESTER VI

07PC601	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, Nirali Prakashan, 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	-

07PC602	**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-Duhem equation. 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.,Van Ness,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:

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

07CP607	**Chemical Reaction Engineering Laboratory**	**L**	**T**	**P**
		0	**0**	**3**

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. Semibatch Reactor II
4. Plug Flow Reactor
5. Laminar Flow Reactor
6. Continuous Stirred Tank Reactor
7. Heterogeneous Reactor
8. Adiabatic Reactor
9. Residence Time Distribution Studies in CSTR
10. Determination of Activation Energy.

Course Outcomes:
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. Explain variations between Experimental and Theoretical results based on technical knowledge.
5. Develop skills to choose the right kind of reactor among single, multiple, flow reactor, etc. schemes.

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

07CP608	**Process Instrumentation and 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 VII

07PC701	Ethics in Engineering	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's Two principles 4. Rights Ethics John Locke: Liberty Rights A.I.Melden: Liberty and welfare Rights Uses of Ethical Theories in resolving moral dilemmas

UNIT – II

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

UNIT – III

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

UNIT – IV

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

UNIT – V

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

Text 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

07PC702	**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

07CP706	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 design parameter, complete knowledge of design procedures for commonly used process equipment and their 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

DESIGN - CASE STUDIES

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

Course Outcomes:

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	-	-

07ST707	SEMINAR / INDUSTRIAL TRAINING	L	TR	S	C
		0	1	2	2

COURSE OBJECTIVES

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

METHOD OF EVALUATION

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

COURSE OUTCOMES:

After the completion of Seminar /Industrial Training, students able to

1. Develop the oral presentation skills by facing the audience and interact with them
2. Know real time operation of the processes in industry
3. Carry out literature survey to collect the technical information
4. Write technical reports
5. Aware of recent advances in the areas of chemical engineering

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

07PV803	PROJECT WORK AND VIVA-VOCE	L	PR	S	C
		0	8	4	10

COURSE OBJECTIVES:

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

METHOD OF EVALUATION

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

COURSE OUTCOME:

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

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

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

PROFESSIONAL ELECTIVES

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

Course Objectives:
To study the
- 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. William Landel Ferry equation.

Unit-V

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

Text Books:

1.F.W.Billmeyer, Text Book of Polymer Science, 3rd Edn., 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												
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 and composition-nuclear fuel cycles and its characteristics-uranium production and purificationZirconium, 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. Wakil M.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.

.

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.
- To study the 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.
- To expose 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, theory and techniques for the wastewater treatment process.

Unit – I

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

Unit – II

Physical unit operations – Screening, Coarse Solids reduction, Flow equalization, Mixing and flocculation, Gravity separation, Grit removal, Sedimentation, Clarification and flotation.
Chemical unit process – Chemical coagulation, Chemical precipitation, Chemical oxidation, Chemical neutralization, Scale control and Stabilization.

Unit – III

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

Unit – IV

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

Unit –V

Advanced 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.George Tchobanoglous, 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.

Course Outcomes:

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

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

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

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	Computational Fluid Dynamics	L	T	P
		4	0	0

Course Objectives:

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

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

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

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, Holted Press , Tokyo, 1975.

Course Outcomes:

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

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

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

07PEXXX	**Petroleum Refining 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, Visbreaking Operations,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, New Delhi, 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. Dawe R.A.,"Modern Petroleum Technology part-I", by Institute of petroleum(IP), John wiley
2. Lueas.A.G.,"Modern Petroleum Technology part-II" by Institute of petroleum(IP), John wiley.

Reference Books:
1. B.K. Bhaskara rao "Modern Petroleum Refining Processes", 2008.
2. Warren L. Mccabe, Julian C. smith, Peter Harriott "Unit Operations of Chemical Engineering", Seventh edition, McGraw-Hill, 2005.
3. G.N. Sarkar, " Advanced petrochemicals"Khanna Publishers.
4. Sukumar Maiti," 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, VIIth Edn., 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	Fluid Solid Reaction Engineering	L	T	P
		4	0	0

Course Objectives:

- To familiarize with the models commonly used for heterogeneous and complex reactors, analyze different reactions using reaction kinetics
- To learn the principles of catalytic and multi-phase reaction and reactor design.

Unit I

Elements of reaction kinetics. Gas-solid, gas-liquid and gas-liquid on solid reactions. Kinetics of heterogeneous catalytic reactions.

Unit II

Rate equations for fluid-solid catalysed reactions. Transport process with fluid-solid heterogeneous reactions.

Unit III

Non-catalytic fluid-solid reactions. Catalyst deactivation.

Unit IV

Regression and other statistical methods for Kinetic Parameter Estimation.

Unit V

Determination of transport and reaction parameters by experimental methods.

Text Books:

1. J. M. Smith, Chemical Engineering Kinetics, McGraw-Hill Int. Edn., 2002.
2. James J. Carberry, Chemical and Catalytic Reaction Engineering, Courier Corporation, 2001.

Reference Books:

1. Octave Levenspiel, Chemical Reaction Engineering, 3rd edition, Wiley Eastern, 2006.
2. Fogler, Elements of Chemical Reaction Engineering, 3rdEdn., Prentice Hall India, 2005.

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	**Computer Aided Design in Chemical Engineering**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- To study the design of process equipment using special softwares for Chemical Engineering systems.

Unit I

Introduction And Properties Evaluation: Spread sheeting, Hierarchy of Process Design and the Onion model - Flow sheeting - Typical units of CAD system - Process synthesis - Physical properties evaluation – Transport properties & thermodynamic properties of gases and binary mixtures

Unit II

Basic Model Development For Preliminary Systems: Methods of calculating vapour liquid equilibrium data for ideal and non-ideal mixtures - Bubble point and Dew point - Flash and distillation calculations - Equipment design - Development of software programmes for the following systems - Piping system, single phase & two phase.

Unit III

Cad Model For Fluid Moving Machinery & Storage Design : Separator system - Two phase and three phase - Storage system - Atmospheric, pressurised & cryogenic.

Unit IV

Cad Model For Heat Transfer Equipment Design: Double pipe - Shell and tube heat exchanger - PHE - Air cooler - Heat integration of evaporators.

Unit V

Cad Model For Mass Transfer Equipment And Safety Devices Design: Binary mixtures - Psudo binary - Multistage distillation system - Heat integration of distillation columns - Absorber and strippers - Liquid-liquid extractors - Safety devices-pressure safety valve & flare system

Text Books:

1. Bhattacharyya, B.C. and Narayanan, C.M., "Computer Aided Design of Chemical Process Equipment", I Ed., New Central Book Agency (P) Ltd., New Delhi, 1992.
2. Dougles, J.M., "Conceptual Design of Chemical Processes". McGraw Hill, NY, 1988.

References :

1. Brownell, L.E. and Young, E.H., Process Equipment Design: Vessel Design, Wiley Eastern, 1959.
2. Joshi, M.V.and Mahajani V.V., Process Equipment Design, 3rd Ed., Mac-Millan & Co India, 1999.
3. Westerberg, A. W., H. P. Hutchison, R. L. Motard, and P. Winter, Process Flow Sheeting, 2nd Edition, McGraw-Hill, New York, 1990.
4. Hanna, O.T. and Scandell, O.C., "Computational methods in Chemical Engineering", Prentice Hall, 1995.
5. Leasley, M.E., "Computer Aided Process Plant Design" Gulf Publishing, 1982.
6. Sinnott, R.K. "Coulson & Richardson's Chemical Engineering" Volume 6: Chemical Engineering Design, Butterworth-Heinemann, 1996.

Course Outcomes:

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

1. Describe the Hierarchy of Process Design
2. Describe the Hierarchy of Process Design and develop the basic model for preliminary systems
3. Create a Cad model for Fluid Moving Machinery and Design the Storage system
4. Create a Cad model and Design the various Heat transfer process equipments
5. Create a Cad model and Design the various Mass transfer process equipments

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

07PEXXX	**OOPS and C++**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- To make students understand the need for computer programming in solving Engineering problems.
- To familiarize the students the concepts of constant, Data types, variables, array.
- To provide knowledge about the use of various functions and its uses.
- To illustrate the concepts of Classes and objects, Operator Overload and Type Conversion, Inheritance, Pointers, Virtual Functions and Polymorphism, Working with files

UNIT – I: Principles of Object-Oriented Programming

Software crisis - software Evolution - A Look at procedure - Oriented Programming - object - Oriented Programming Paradigm - Basic concepts of Object – Oriented Languages-Application of OOP.

Introduction to C++

Introduction - Applications of C++ - A simple C++ program - More C++ statements – An example with class - structure of C++ program - creating the source File - compiling and Linking.

Tokens, Expressions and control Structures

Introduction - Tokens - Keywords - Identifiers - Basic Data Types - User Defined Data Types - Derived Data Type - Symbolic constant - Type compatibility - Declaration of variables - Dynamic initialization of variables - Reference variables - Operators in C++ - Scope resolution operators - Member de referencing operators - Memory management operators Manipulators - Type cast operator - Expressions and implicit conversions - Operator overloading operators precedence - Control structure.

Functions in C++

Introduction - The main function - Function prototyping - Cell by reference - Return by reference - Inline functions - Default Arguments - Const arguments – Function overloading - Friend and Virtual function.

UNIT – II: Classes and Objects

Introduction - C structure revised - Specifying a class - Defining member functions – A C++ program with class - Making an outside function Inline- Nesting of member functions - Private member functions - Array with a class - Memory allocation for objects - Static data members - Static member functions - Array of objects - Object as function arguments - Friendly functions - Returning objects - Const member functions - Pointers to members.

Constructors and Destructors

Introduction - Constructors - Parametrized Constructors - Multiple constructors in a class - Constructors with Default arguments - Dynamic initialization of objects – Copy constructors - Dynamic constructors - Constructing Two-Dimensional Arrays - Destructors.

UNIT – III: Operator Overload and Type Conversion

Introduction - Defining operator overloading - Overloading unary operators - overloading binary operators - overloading binary operator using friends – Manipulation of strings using operators - Rules for overloading operators type conversions.

Inheritance

Extending Classes Introduction - Defining Derived class - Single inheritance - Making a private member inheritable - multilevel inheritance - Multiple inheritance - Hierarchical inheritance - Hybrid inheritance - Virtual base classes - Abstract classes - Constructors in drive classes - member class : Nesting of classes.

UNIT – IV: Pointers, Virtual Functions and Polymorphism

Introduction - Pointers to objects - This pointer - Pointers to derived classes – Virtual function - Pure Virtual functions. Managing console I/O Operation : Introduction - C++ Streams - C++ Stream classes - unformatted I/O operations - Formatted console I/O Managing output with manipulators.

UNIT – V: Working with files

Introduction - classes for file stream operation - opening and closing a file - Detecting end - of - file - more about open ( ) file modes - file pointers and the manipulations - sequentials input and output operations - updating a file - random access- error handling during file operations - command - line arguments Object -

Oriented System Development Introduction - procedure - oriented para diagrams - procedure - oriented development tools - object - oriented para diagrams - Object - oriented notations and graphs - steps in object - oriented analyses - steps in object - oriented design - implementation – proto typing para dia - wrapping up.

Text Books:

1. Balagurusamy.E., (Object Oriented Programming with C++) Tata McGraw Hill, 2013.

Reference Books:

1. Ravichandren.D, Programming with C++.TMH.
2. Greg Voss, Object Oriented Programming,TMH, 1990.
3. Venugopal KR, Ravishankar T and Rajkumar, Mastering C++, Tata McGraw-Hill, 1997.

Course Outcomes:

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

1. Analyze and design a computer program based on Object Oriented Principles.
2. Solve a real world problems based on Object Oriented Principles.
3. Gain the basic knowledge on Object Oriented concepts
4. Develop applications using Object Oriented Programming Concepts
5. Implement features of object oriented programming to solve real world problems

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

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:

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

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

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

07PEXXX	Analytical Techniques	L	T	P
		4	0	0

Course Objectives:

- To study the various analytical instruments used in Biotechnology.
- To find 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	-

03PEXXX	**Process Plant Utilities**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- Importance and need of utilities like boiler, turbine, fans and compressors
- Principles of water desalination. Co generation systems in plants
- Principles of cryogenics and refrigeration

UNIT – I

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

UNIT – II

Boilers - Classification; Boilers - Fittings and Accessories.

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

UNIT – IV
Compressed air and Vacuum - Compressors and Vacuum pumps and their performance characteristics. Boosters, air receivers, piping systems, air leaks, Lubrication oil removal.

UNIT – V
Refrigeration, cryogenic systems, Principle, types, selection and operations of pump, fans and compressor selection - Safety Aspects.

Text Books
1. Khurmi,R.S., J.K.Gupta. Thermal Engineering, S.Chand & Co., 2008.
2. Ballaney, Heat Engines, Khanna Publishers. 1998.

Reference Books
1. Ballaney, Thermal Engineering,Khanna Publishers.
2. . Rase,H.F, M.H.Barrow, Project Engineering for Process Plants, John Wiley & Sons, 1957.

Course Outcomes:
After the completion of the course, the student should be able to
1. Explain the water softening methods
2. Describe the types of boilers and its accessories
3. Illustrate the properties of steam and explain about steam engines and turbines
4. Discuss about compressors, vacuum pumps, boosters and piping systems
5. Enumerate about the types of cryogenic and refrigeration systems

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

03PEXXX	**Machine Theory, Design and Drawing**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- Principles of machine theory
- Design of simple components of machine
- Working principle of transmission components

UNIT – I: Kinematics

Kinematic link- Kinematic pair-slider crank mechanisms and inversions-double slider crank mechanisms and inversions-velocity and acceleration diagrams of simple kinematic mechanisms by relative velocity method-coriolis component.

UNIT – II: Friction and Bearings

Friction-dry friction -friction in screw threads-power transmission by screws-rolling friction -oil film bearings-rolling contact bearings-types, constructional details, loads carrying capacity, power losses-elementary treatment only.

UNIT – III: Transmission components

Clutches and brakes-single and multiple plate clutches-power transmission capacitydrum brakes and disk brakes-dynamometers for power measurement(simple types only). Belt and chain drives-velocity ratio-slip - power transmission capacity-selection from catalogues-simple compound and epicyclic gear trains.

UNIT – IV: Design preliminaries

Design philosophy-phases in design process-design criteria-strength, stiffness and life - material properties-failure modes (fatigue, creep and impact-elementary ideas only)-Static and dynamic loads-simple stresses-stress concentration and its effects-endurance strength selection of factor of safety.

UNIT – V: Design of simple components

Members under combined loading-principal stresses-failure theories- design and drawing of simple machine components-brackets, bolts, keys, shafts, flange coupling and welded joints-simple cylinder with cover and stuffing box(elementary treatment only).

Text Books:

1. Gupta and Khurmi, Theory of machines, Khanna publishers,New Delhi. 2005
2. Gupta and Khurmi, Machine design, Khanna publishers, New Delhi. 2005

Reference Books :

1. P.L.Ballaney, Theory of machines, Khanna publishers,New Delhi 23rd ed 2003
2. T.J.Prabhu, Design of Transmission elements 4th edition. 2000

Course Outcomes:

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

1. Illustrate the kinematic mechanisms , and represent velocity and acceleration diagrams
2. Describe about the concept of friction and types of bearings
3. Explain about the working principle of different transmission components
4. Enumerate about preliminary concepts in design and types of load
5. Design simple machine components like welded joints and stuffing box

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

07PEXXX	**Agro Process Technology**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- To enable the students to learn the Agro Process Engineering and Technology including new or modified processing, products and new techniques.

Unit I

Post Harvest Technology of Cereals, Pulses and Oil seeds. Processing of oil seeds, solvent extraction, utilization of rice bran .Storage of food grains.

Unit II

Food chemistry - Development of food chemistry.Edible oils and fats: physical and chemical properties, Carbohydrates, Proteins, Flavours and aroma of food.

Unit III

Food processing: Nutritive aspects of food, food additives, Food adulteration and simple detection techniques, Soilage of food, food poisoning, micro-organisms in foods, Sanitation and cleaning requirements for food processing plants Quality control and quality assurance.

Unit IV

Food preservation : principles and methods, Fruits and fruit products, Vegetables and vegetable products. By-product utilization, Waste utilization. Packaging and packaging materials.

Unit V

Biomass utilization – Alcohol production from agro residues - Solvent extraction of oil and by products from seeds, solvent extraction of jojoba oil, Solvent extraction of hops.

Text Books:

1. Modern technology of agro processing and agricultural waste products, NIIR Board of Technologists, National Institute of Industrial Research, New Delhi.2000.
2. K M Sahay, K. K. Singh, Unit Operations of Agricultural Processing, Vikas Publishing House Pvt Limited, 2004.

Reference Books:

1. R. N. Reddy, Agricultural Process Engineering, Daya Publishing House, 2010.
2. Young, Agricultural Process Engineering, John Wiley & Sons Inc, 2002.
3. Akash Pare, B. L. Mandhyan, Food Process Engineering and Technology, NIPA, 2010.

Course Outcomes:

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

1. Explain Agro processing techniques
2. Classify food preservation techniques
3. Describe the Utilization of biomass in value added products
4. Design the equipment used in agro and food processing industry
5. Explain and invent the solvent extraction from various sources

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

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 Agri Metual Research, New Delhi, 2002

Course Outcomes:

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

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

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

07PEXXX	**Drugs and Pharmaceutical Technology**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- To give the students an understanding of the polytechnical nature of engineering and drug discovery in the pharmaceutical industry involving Chemical Engineering.

UNIT I Introduction

Development of drugs and pharmaceutical industry; organic therapeutic agents uses and economics

UNIT II Drug Metabolism And Pharmaco Kinetics & Microbiological And Animal Products

Drug metabolism; physico chemical principles; pharma kinetics-action of drugs on human bodies. Antibiotics- gram positive, gram negative and broad spectrum antibiotics; hormones

UNIT III Important Unit Processes And Their Application

Chemical conversion processes; alkylation; carboxylation; condensation andcyclisation; dehydration, esterification, halogenation, oxidation, sulfonation; complex chemical conversions fermentation.

UNIT IV Manufacturing Principles & Packing And Quality Control

Compressed tablets; wet granulation; dry granulation or slugging; advancement in granulation; direct compression, tablet presses formulation; coating pills; capsules sustained action dosage forms; parential solutions, oral liquids; injections; ointments; standard of hygiene and manufacturing practice. Packing; packing techniques; quality control.

UNIT V Pharmaceutical Products & Pharmaceutical Analysis

Vitamins; cold remedies; laxatives; analgesics; nonsteroidal contraceptives; external antiseptics; antacids and others. Analytical methods and tests for various drugs and pharmaceuticals – spectroscopy, chromatography, fluorimetry, polarimetry, refractometry, pHmetry

Text book:

1. Rawlines, E.A.; " Bentleys Text book of Pharmaceutics ", III Edition, Bailliere Tindall, London, 2010.

Course Outcomes:

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

1. Have knowledge to transform raw materials into useful pharmaceutical and fine chemical products with commercial interest through systematic use of engineering concepts and methods.
2. Acquire basic knowledge of preformulation and formulation of drugs
3. Gain knowledge on unit processes and its application
4. Attain knowledge on packaging and quality control of pharmaceutical dosage forms
5. Have knowledge on pharmaceutical products & pharmaceutical analysis

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

07PEXXX	**Fertilizer Technology**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- To enable the students to learn the fertilizer manufacturing including new or modified fertilizer products and new techniques.
-

Unit I: Nitrogenous Fertilisers

Methods of production of nitrogenous fertilizer-ammonium sulphate, nitrate, urea and calcium ammonium nitrate; ammonium chloride and their methods of production, characteristics and specifications, storage and handling.

Unit II: Phosphatic Fertilisers

Raw materials; phosphate rock, sulphur; pyrites etc., processes for the production of sulphuric and phosphoric acids; phosphates fertilizers – ground rock phosphate; bone meal-single superphosphate, triple superphosphate, triple superphosphate, thermal phosphates and their methods of production, characteristics and specifications.

Unit III: Potassic Fertilisers

Methods of production of potassium chloride, potassium schoenite, their characteristics and specifications.

Unit IVMixed Fertilizers

Methods of production of ammonium phosphate, sulphate diammonium phosphate, nitrophosphates, urea, ammonium phosphate, mono-ammoniumphosphate and various grades of NPK fertilizers produced in the country.

Unit V: Miscellaneous Fertilisers

Mixed fertilizers and granulated mixtures; biofertilisers, nutrients, secondary nutrients and micro nutrients; fluid fertilizers, controlled release fertilizers,controlled release fertilizers.

Text Books:

1. "Handbook of fertilizer technology", Association of India, New Delhi, 1977.
2. Menno, M.G.; "Fertilizer Industry - An Introductory Survey", Higginbothams Pvt. Ltd., 1973.

References:

1. Sauchelli, V.; "The Chemistry and Technology of Fertilizers", ACS MONOGRAPH No. 148, Reinhold Publishing Cor. New York, 1980.
2. Fertiliser Manual, "United Nations Industrial Development Organisation", United Nations, New York, 1967.
3. Slack, A.V.; Chemistry and Technology of Fertilisers, Interscience, New York, 1966.

Course Outcomes:

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

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

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

07PEXXX	Pulp and paper technology	L	T	P
		4	0	0

Course Objectives:

- Gaining Knowledge of pulp & paper industry, mill Operations, products, process variables, equipment, and terminology.
- Increasing knowledge of how the Pulp&Paper processes affect product properties, in order to improve product quality and troubleshoot variations in quality.
- To illustrate the concepts of various unit operations steps appropriately in manufacturing of paper.

UNIT I Introduction

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

UNIT II Woodyard Operation

Woodyard operation - Mechanical pulping – Chemical pulping – Secondary fibre pulp processing.

UNIT III Paper Machine

Paper Machine wet and addition paper machine dry and operation – Paper machine - Wet and operation.

UNIT IV Paper And Paperboard

Paper and paperboard frames and products – Surface treatments – Finishing operation– End uses.

UNIT V Properties And Testing Of Pulp And Paper

Properties and Testing of pulp and paper Process control – Quality assurance – Water and air pollution control.

Textbook:

1. Pulp and paper chemistry and Technology Monica ER Monica, Goran Gellerstcdt Gunnar Hennksson De Gneyter 2009.
2. Dryden's outlines of Chemical Technology, Rao, M.Gopal, Sitting, Marshall, Affilated East- West Press Pvt. Ltd. 3rd Edition
3. Shreves' Chemical Process Industries, Austin, George T., McGraw-Hill Education India Pvt. Ltd - New Delhi, 5th Edition
4. Environmental Pollution and Control in Chemical Process Industries, Bhatia, S.C. Second Edition 2011(ISBN: 8174091068)
5. Pollution Management in Industries, Trivedi, R.K., Environmental Publication, Karad, India

Reference Books

1. Handbook of Pulping and Papermaking, Biermann, Christopher J.,ISBN-13: 978-0120973620
2. Wastewater Engineering, Treatment, Dispose and Reuse - Metcalf & Eddy, Inc. IV EDN, 2002.

Course Outcomes:

At the end, students can able to

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

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

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

Course Objectives:

- The course is aimed at investigating the underlying fundamental causes of corrosion problems and failures..
- Emphasis is placed on the electrochemical reactions occurring and the tools and knowledge necessary for predicting corrosion, measuring corrosion rates, and combining this with prevention and materials selection.

UNIT I

Basic principles of corrosion and its control – Forms of corrosion, uniform, Galvanic, Crevis, pitting, selective leaching, erosion, stress-corrosion, cracking – Cavitation phenomena & their effects – Corrosion testing – Field testing – Electrochemical techniques for measurement of corrosion rates, corrosion detection and components examination – Accelerated salt-spray testing.

UNIT II

Corrosion inhibitors, electroplated coatings, conversion coatings, anodizing, hot dipping, spray metal coatings, zinc coating by alloying, electrophoteric coatings and electropainting, powder coating, electrical methods of corrosion protection, composite materials in corrosion minimization – Cathodic and Anodic protections.

UNIT III

Corrosion damage to concrete in industrial and marine environments and its protection;biological corrosion, halogen corrosion of metals, environmental degradation of materials, corrosion and inspection managements in chemical processing and etrochemical industries.

UNIT IV

Corrosion in structure – corrosion of stainless steels – corrosion in power equipments, corrosion in electrical and electronic industry – corrosion and selection of materials of pulp and paper plants – corrosion aspects in nuclear power plants – corrosion of surgical implants and prosthetic devices.

UNIT V

Corrosion protection management–process maintenance procedures under corrosion Environments

Text Book

1. Fontana, M.G., "Corrosion Engineering", Edn 3, McGraw Hill, 1989

References

1. Roberge, P.R., Handbook of Corrosion Engineering, McGraw-Hill,2000

Course Outcomes:

At the end, students can able to

1. Explain the causes and mechanisms of various types of corrosion and environmental aspects of the surface treatment
2. Judge and predict the influence of a material's composition and microstructure on its corrosion performance.
3. Identify materials that will exhibit adequate corrosion resistance in a particular environment.
4. Describe the corrosion in various industrial devices and equipments.
5. Categorize the corrosion protection management and develop the process maintenance procedures under corrosion Environments

Mapping with POs & PSOs															
Cos	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	-	2	3	-	-	-	-	-	-	-	-	-	-	2	-
CO 2	-	2	3	-	3	-	-	-	-	-	-	-	-	2	-
CO 3	-	2	3	-	-	-	-	-	-	-	-	-	-	2	-
CO 4	-	2	-	-	3	-	-	-	-	-	-	-	-	2	
CO 5	-	2	3	3	-	-	3	-	-	-	3	3	-	2	3

07PEXXX	**Total Quality Management**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

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

UNIT I Introduction

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

UNIT II TQM Principles

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

UNIT III TQM Tools & Techniques I

The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

UNIT IV TQM Tools & Techniques II

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

UNIT V Quality Systems

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

Text Books:

1. Dale H.Besterfiled, , Carol Besterfield-Michna, Glen Besterfield , Mary Besterfield-Sacre, "Total Quality Management", Pearson Education Asia, Third Edition, Indian Reprint , 2006.

References Books:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", (6th Edition), South-Western (Thomson Learning), 2005.
2. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition , 2003.
3. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006 .

Course Outcomes:

At the end, students can able to

1. Know prerequisites of evolution of total quality management and significancecontributions of quality gurus' to the management of modern organizations.
2. Evaluate the principles of quality management and to administer how these principles can beapplied within quality management systems.
3. Identify the key aspects of the quality improvement cycle and to select and use appropriatetools and techniques for controlling, improving and measuring quality.
4. Identify and prioritize customers' expectations quickly and effectively and to enlist the factors for improving the "Overall Equipment Effectiveness"

5. Describe the various elements of quality systems and Critically appraise the teamwork requirements for effective quality management.

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

07PEXXX	**Operations Research**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

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

Unit-I

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

Unit-II

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

Unit-III

Dynamic programming; Non linear programming

Unit-IV

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

Unit-V

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

Text Books:

1. Gupta P.K, Hira D.S, Problems in Operations Research – First Edition 1991, S.Chand & Company Ltd. new Delhi.
2. Rudd, F., C. Watson, Strategy of Process Engineering, John Wiley, 1968.

Reference Books

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

Course Outcomes:

At the end, students can able to

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

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

07PEXXX	**Chemical Engineering Mathematics**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- The course is aimed at developing the skills of engineering students in Chemical data interpolation. The learners will be enabled to appreciate the important role of mathematical concepts in engineering and industrial application.

Unit I

Classification, estimation and propagation of errors. Presentation of data.

Unit II

Statistical methods: sample and population distributions, testing of hypothesis, analysis of variance. Design of experiments.

.

Unit III

Vector spaces, basis, matrices and differential operators. Eigen values, vectors and functions.

Unit IV

Solvability conditions for linear equations. Frobenius method for ordinary differential equations.

Unit V

Sturm-Louiville Theorom: Separation of variables and Fourier transform. Green's function and its applications.

Text Books:

1. S. Pushpavanam, Mathematical methods in chemical engineering, PHI Learning Pvt. Ltd. 2008.

Reference Books:

1. N. W. Loney, Applied Mathematical Methods for Chemical Engineers, 2nd edn, CRC Press, 2006.
2. R. G. Rice, D. D. Do, Applied Mathematics and Modeling For Chemical Engineers, John Wiley & Sons, 2012.

Course Outcomes:

At the end, students can able to

1. Organize the present data in appropriate method
2. Analyze and estimate the error component in data by statistical methods
3. Analyze the data using linear algebraic, ordinary differential and partial differential equations by analytical methods.
4. Organize the ordinary differential equations solvability for linear equations and Frobenius method
5. Calculate the one-dimensional time-independent problem and quantum mechanics.

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

07PEXXX	Optimization Of Chemical Processes	L	T	P
		4	0	0

Course Objectives:

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

Unit I :Objective And Formulation Of Optimization

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

Unit II :Basic Concepts Of Optimization

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

Unit III : Optimization Of Unconstrained Functions

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

Unit IV: Unconstrained Multivariable Optimization

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

Unit V: Application Of Optimization In Chemical Engineering

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

Flow sheet Optimization - Case studies.

.

Text Books:

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

Reference Books:

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

Course Outcomes:

At the end, students can able to

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

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

PE-LAB - PROFESSIONAL ELECTIVE LABS

07EPXXX	Chemical Engineering Thermodynamics Laboratory	L	T	P
		0	0	3

Course Objective:

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

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

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

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

07EPXXX	Computer Aided Plant Design Lab	L	T	P
		0	0	3

Course Objective

- To study the design of process equipments using special softwares for chemical engineering systems.

General: General design consideration, Optimum design, Property estimation and Material and Energy balance introduction to special software for steady and dynamic simulation of chemical engineering systems, Aspen Plus, Design II, PRO II, MATLAB.

Optimal design of the following equipments:
1. Shell and Tube heat exchangers , Plate type Heat Exchanger & Condensers.
2. Double Pipe Heat Exchangers, Finned Heat Exchangers.
3.Condensers (Shell and Tube) : Vertical condensers, horizontal condensers.
4. Reboilers & Vaporisers: Kettle type, Vertical Thermosyphon type.

Phase separation equipment design: Design of filter press, Centrifuge, Cyclone (Hydro as well as air) Drier and Crystallizer.

Design of mass transfer equipments: Design of distillation column, Absorption tower both plate as well as packed type, cooling tower and extraction columns

Text Books:

1. A.W. Westerberg, et al, "Process Flow Sheeting", Cambridge University Press, 1990.
2. James M. Douglas “Conceptual Design of Chemical Processes”, McGraw Hill, New York, 1988.

References:

1. B.C. Bhattacharyya and C.M. Narayanan, “Computer Aided Design of Chemical Process Equipment", Ist Edn., New Central Book Agency (P) Ltd., New Delhi, 1992.
2. A. Hussein, “Chemical Process Simulation", Wiley Eastern, 1986.

Course Outcomes:

At the end, students can able to

1. Gain the basic knowledge on process equipments using special softwares
2. Solve complex chemical engineering problems by applying suitable numerical methods
3. Design the process equipment using design software
4. Apply the principles of Engineering and Technology
5. Design a system, component or process for the needs of industry

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

07EPXXX	Petroleum Engineering Laboratory	L	T	P
		0	0	3

Course Objective:

- The students should be conversant with the theoretical principles and experimental procedures for quantitative estimation

1. Estimation of Specific gravity
2. Estimation of Viscosity
3. Estimation of Viscosity index
4. ASTM Distillation
5. Estimation of Flash and Fire point
6. Estimation of Pour point and Cloud point
7. Estimation of Smoke point
8. Estimation of Sulphur content
9. Estimation of Calorific value
10. Estimation of Moisture content
11. Estimation of Aniline point and Diesel index
12. Estimation of Carbon Residue

Text Book:

1. BhaskaraRao. B.K., *"Modern Petroleum Refining Process*", 3rd Edn., Oxford& IBH, New Delhi, 1984
2. Nelson W.L. "*Petroleum Refinery Engineering*", 4th Edn., McGraw Hill, NewYork, 1958

References:

1. 1.Watkins. R. N. "*Petroleum Refinery Distillations*", 2nd Edition, Gulf PublishingCompany, Texas, 1981.
2. Hobson. G. D. "*Modern Petroleum Refining Technology*", 4th Edition,Institute of Petroleum, U. K. 1973.

Course Outcomes:

At the end, students can able to

1. Design Qualitative and Quantitative Laboratory Experiments including analytical Instrumentation
2. Differentiate various Petroleum Products by performing Specific tests.
3. Analyze the Physical and Chemical Properties of different Petroleum Products.
4. Evaluate different petroleum testing methods.
5. Estimate and Analyze petroleum compounds.

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

07EPXXX	Environmental Engineering Laboratory	L	T	P
		0	0	3

Course Objective

- Study of sampling and preservation methods and significance of characterization of water and waste water

1. Determination of pH
2. Determination of Chlorides
3. Determination of Hardness
4. Determination of Acidity and Alkalinity
5. Determination of Sulphates
6. Determination of Ammonia Nitrogen
7. Determination of Dissolved Oxygen
8. Determination of Chlorine
9. Determination of Iron and Fluoride
10. Determination of Chemical Oxygen Demand
11. Determination of Biological Oxygen Demand
12. Determination of Total Dissolved Solids and Suspended Solids
13. Determination of Total Organic and Inorganic Solids
14. Determination of Sludge Volume Index
15. Determination of Optimum Coagulant Dosage
16. Determination of Coli Form Test
17. Introduction to Bacteriological Analysis

Text Books:

1. Rose. G.R.D, *Air pollution and Industry,* Van Nostrand Reinhold Co., NewYork 1972.
2. Pandey G.N. and Carney G.C., Environmental Engineering, Tata McGraw Hill,New Delhi,1989.

References:

1. Kapoor .B.S, Environmental Engineering, 3rd Edn.,Khanna publishers,1997.
2. Mahajan S.P., Pollution Control in Process Industries, 1st Edn., Tata McGrawHill Publishing Company Ltd., New Delhi, 1995.

Course Outcomes:

At the end, students can able to

1. Analyze the methods of pollution in industries.
2. Design and life cycle assessment for environment cleaner technologies and sustainability.
3. Explain adequate mastery of principles and processes involved in various industries to control the pollution.
4. Identify and synthesis of innovative sustainable solutions to real-time engineering problems understanding the global, economic, environmental and societal context.
5. Apply techniques, skills and tools effectively for modern engineering practice and communicate effectively.

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

07EPXXX	**Biochemical Engineering Laboratory**	**L**	**T**	**P**
		0	**0**	**3**

Course Objectives:

- Understand and use basic biology, biochemistry, molecular biology and genetics principles
- Apply kinetics and reactor theory to biological systems and processes

1. Maintenance and Identification of Microorganisms
2. Biochemical characteristics of Microorganisms
3. Quantification of microorganisms from oil, air and water
4. Fermentation – Growth curve
5. Solid state fermentation technique
6. Immobilization studies with conventional enzymes and microorganisms
7. Kinetic study for conversion of glucose to ethanol
8. Estimation of protein
9. Estimation of nucleic acid
10. Estimation of vitamin
11. Principle and practical application of freeze and vacuum drying
12. Lyophilisation of milk and egg white

Text Books:

1. Shuler. M.L. and Kargi. F, "*Bioprocess Engineering: Basic Concepts*",2ndEdition, PHI,2002.
2. Bailey. J.E, and Ollis. D.F. "*Biochemical Engineering Fundamentals*" 2ndEdition, McGraw– Hill, 1988.

References:

1. Lee, James .,. "*Biochemical Engineering*", PHI, 1992.
2. Blanch, H.W. and Clark, D.S. "*Biochemical Engineering*", Marcel Decker Inc

Course Outcomes:
At the end, students can able to

1. To introduction about Basic concepts of bioreactor design
2. To study the Biochemical characteristics of Microorganisms
3. To teach the Methods and strategies for fermentation control
4. Principle and practical application ofLyophilisation
5. To study the Modern bio technological 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	-	-
CO2	-	2	-	3	-	-	-	-	-	-	-	-	3	-	2
CO3	-	2	1	-	-	-	-	-	-	-	-	-	3	-	2
CO4	3	1	-	-	-	-	-	-	-	-	-	-	3	-	-
CO5	2	-	-	-	3	-	-	-	-	-	-	-	3	-	-

07EPXXX	**Food Processing Engineering Laboratory**	**L**	**T**	**P**
		0	**0**	**3**

Course Objectives:

- To study the drying and rehydration characteristics of food materials
- To study the properties and pretreatment of food materials.

1. Determination of Ash content in milk
2. Determination of calcium in milk
3. Estimation of free fatty acid
4. Estimation of protein in milk
5. Determination of moisture content in meat
6. Estimation of chlorophylls in bitter guard
7. Estimation of gluten
8. Manufacture of bread
9. Determination of peroxide value
10. Estimation of Curcumin in Turmeric powder
11. Estimation of acidity of Tomato pulp
12. Estimation of lactose in skimmed milk powder

Text Books:
1. Potter. JH, Hotchkiss NN, "*Food Science"*, 5th edn., The CBS PublishingCo, Delhi, 2007.
2. Toldeo. RT, "*The Fundamentals of Food Engineering"*, The CBS PublishingCo, Delhi, 2000.

References:
1. Sivasankar.,B, "Food Processing and Preservation", Prentice-Hall of India,New Delhi, 2002.
2. "Desrosier, NW., "*The Technology of Food Preservation*," The CBSPublishers& Distributors, 1998.

Course Outcomes:

At the end, students can able to

1. Estimate various constituents of milk
2. Determine the free fatty acid content of oils
3. Analyze the moisture content of various food materials
4. Develop and analyze food products like breads and buns
5. Analyze food safety and food preservation techniques

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

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 Labour Organisation, 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 egronomics

UNIT – I

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

UNIT – II

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

UNIT – III

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

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

UNIT – IV

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

Explosion Fire and explosion index-dust explosion and prevention

Toxic releases

Toxicity and its measurements- release control- reduction and removal 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.,and M.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	**Loss Prevention Techniques**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- To understand the basic concepts and causes of accidents
- To learn the various techniques of hazard analysis
- To know the procedure of accident investigation and first aid technique

Unit I

Safety organizations in loss prevention – role, objectives, types, functions and advantages. Safety Education and Training – Safety Promotion and Publicity schemes.

Unit II

Human factors contributing to Accidents – Causes for unsafe acts – Safety and Psychology – Theories of Motivation and their application to safety.

Unit III

Hazard Identification and analysis – Fault Tree Analysis – Event Tree Analysis – Failure modes and effects analysis, HAZOP studies, Job Safety Analysis – Examples.

Unit IV

Plant Safty Inspection – Objectives and types – Check list procedure – Inspection Report. Safety Audit – elements and standards – advantages.

Unit V

Accident investigation – Classification of accidents – purpose and steps of investigation – accident reports – remedial measures and rehabilitation of workers. First Aid Principles – General rules – Training – electric shocks, respiratory problems, cardiac massage, fainting, poisoning, wounds, burns, bleedings, insect bites, etc.

Text Books:

1. Industrial Safety, Health and Environment Management Systems, Khanna Publishers, New Delhi, 2006.

2. Loss Prevention in Process Industries, frank P Lees, Vol.1, 2 &3, Butterworth-Heinemann Ltd., London, 1996.

Reference Books:

1. Industrial Safety Management, L M Dheshmukh, Tata Mc Graw Hill Publishing Company Ltd., New Delhi, 2005.
2. Industrial Safety: Management and Technology, David A Colling, Prentice Hall, 1990
3. Industrial Safety Management: A Practical Approach, Jack E Daugherty, Government Institutes, 1999.
4. Safety Management in Industry, N V Krishnan, Jaico Publishing House, New Delhi, 1996.

Course Outcomes:

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

1. Identify the loss prevention techniques to be adopted in the process industries.
2. Discuss the human factors contributing to accidents & Theories of Motivation and their application to safety.
3. Analyze the hazards by different studies.
4. Develop plant safety inspection procedures & Report.
5. Propose remedial measures and rehabilitation of workers after accident investigation.

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

CHOESCN	FUEL TECHNOLOGY	L	T	P	C
		3	0	0	3

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., 2014, Academic Press.
2. John Griswold, Fuels Combustion and Furnaces, 1946, Mc-Graw Hill Book Company Inc.
3. Samir Sarkar, Fuels and Combustion, 3rd. ed 2010, Universities Press.
4. W.L. Nelson, Petroleum Refinery Engineering, 4th ed. 1958.,Mc-Graw Hill Book Company.

REFERENCES:

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

Course Outcomes:

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.

Unit-I

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

Unit-II

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

Unit-III

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

Unit-IV

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

Unit-V

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

Text Books:

1. Desai, Ashok V., Non Conventional Energy, 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	
	1	1	1.8										2.2	2	1

CHOESCN	**HAZARDOUS WASTE MANAGEMENT**	**L**	**P**	**0**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

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

UNIT I

Introduction

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

UNIT II

Nuclear wastes and e-waste

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

UNIT III

Biomedical and chemical wastes

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

UNIT IV

Hazardous wastes management

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

UNIT V

Waste disposal

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

TEXT BOOKS:

1. Hazardous waste management by Charles A. Wentz. Second edition 1995, McGraw Hill International.
2. Harry M. Freeman, Standard handbook of Hazardous waste treatment and disposal, 1996, McGraw Hill.

REFERENCES:

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

Course Outcomes:

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	-	-

07OEXXX	**Renewable Energy Technology**	**L**	**P**	**T**
		3	**0**	**0**

Course Objectives:

The course will,

- Describe the various types of conventional & renewable energy resources and present scenario with energy conservation objectives and regulations.
- Illustrate the aspects in utilization of different renewable energy sources for domestic and industrial applications.

- Contribute knowledge for description, selection, sizing and performance of existing and new systems at basic level.
- Outline the basic design and economic analysis of the renewable energy systems.
- Serve as foundation course, who wish to opt a specialty of renewable energy in the continuing education.

Unit I: Introduction To Energy

Indian Energy Scenario – Types & Forms of Energy - Primary / Secondary Energy Sources – Energy Conservation – Need – EC Act 2003 : Salient Features – Energy Intensive Industries – Barriers -Roles & Responsibility of Energy Managers – Energy Auditing : Preliminary & Detailed - Benchmarking .

Unit II : Solar Energy

Solar radiation at the earth's surface – solar radiation measurements – estimation of average solar radiation - solar thermal flat plate collectors - concentrating collectors – solar thermal applications - heating, cooling, desalination, drying, cooking, etc – solar thermal electric power plant - principle of photovoltaic conversion of solar energy, types of solar cells - Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping etc - solar PV power plant – Net metering concept.

Unit III: Wind Energy

Nature of the wind – power in the wind – factors influencing wind – wind data and energy estimation - wind speed monitoring - wind resource assessment - Betz limit - site selection - wind energy conversion devices - classification, characteristics, applications – offshore wind energy – Hybrid systems - safety and environmental aspects – wind energy potential and installation in India - Repowering concept.

Unit IV: Bio-Energy

Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - direct combustion – biomass gasification - pyrolysis and liquefaction – biochemical conversion - anaerobic digestion - types of biogas Plants - applications - alcohol production from biomass – bio diesel production – Urban waste to energy conversion - Biomass energy programme in India.

Unit V : Other Types Of Energy

Ocean energy resources - principle of ocean thermal energy conversion (OTEC) - ocean thermal power plants - ocean wave energy conversion - tidal energy conversion – small hydro – geothermal energy - geothermal power plants – hydrogen production and storage - Fuel cell – principle of working - various types - construction and applications.– Energy scenario in India – Growth of energy sector and its planning in India.

Text Books:

1. Sukhatme, S.P., J.K.Nayak, Solar Energy, Tata McGraw Hill, III Edn. 2008.
2. Twidell, J.W. and Weir, A., Renewable Energy Sources, EFN Spon Ltd., 1986.
3. Yogi Goswami, Kreith, F and Kreider, J. F., Principles of Solar Engineering, McGraw-Hill, II Edn. 2000.
4. Veziroglu, T.N., Alternative Energy Sources, Vol 5 and 6, McGraw-Hill, 1990
5. Anthony San Pietro, Biochemical and Photosynthetic aspects of Energy Production, Academic Press, 2012.

References:

1. Kishore VVN, Renewable Energy Engineering and Technology, Teri Press, New Delhi, 2012
2. Peter Gevorkian, Sustainable Energy Systems Engineering, McGraw Hill,2007
3. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K, 1996.

Course Outcomes:

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

1. Explain the environmental aspects & impacts of non-renewable and renewable energy resources with their prospects and limitations.
2. Illustrate the different renewable energy systems and identify the appropriate technology for both stand alone and integrated systems about opportunities and barriers to their use.
3. Analyze the functionality of components of the different renewable energy systems and their behavior in operation.
4. Demonstrate the skills necessary for pre-feasibility study and perform an initial design with details.
5. Identify, define, present and communicate issues within the area and know the main line of research in the field of technologies to harness renewable energy.

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

07OEXXX	**BIOLOGY FOR ENGINEERS**	**L**	**T**	**P**
		4	**-**	**-**

Course Objective

- The course acts as a bridge between engineering and biology to provide basic understanding of biological mechanisms of living systems from engineering perspective.
- It will illustrate the many possible means to utilize living things' relevance to engineering principles.
- With substantial knowledge and continuing interest will make a student into a specialist in the technical diversity.

Unit I: Requirements of Biological Systems
Biological Units Need Water; Biological Units Need the Right Amount of Oxygen; Biological Units Need Food and Nutrients; Biological Units Become Ill in the Presence of Wastes; Biological Units Need Heat Sources and Sinks.

Unit II: Behavior of Biological Systems
Biological Units Adapt to Their Environments; Biological Units Modify Their Environments; Adaptations Require Extra Energy and Resources; Biological Units, If Possible, Move to Friendlier Environments; Biological Units Evolve under Environmental Pressures.

Unit III: Response to Stress by Biological Systems
Crowding of Biological Units Produces Stress; Biological Units Are Affected by Chemical Stresses; Biological Units Respond to Mechanical Stresses; Optimization Is Used to Save Energy and Nutrient Resources; Biological Units Alter Themselves to Protect against Harsh Environments.

Unit IV: Existence of Biological Systems
Biological Units Cooperate with Other Biological Units; Biological Units Compete with Other Biological Units; Biological Units Reproduce; Biological Units Coordinate Activities through Communication; Biological Units Maintain Stability with Exquisite Control; Biological Units Go through Natural Cycles; Biological Units Need Emotional Satisfaction and Intellectual Stimulation; Biological Units Die.

Unit V: Scaling Factors and Biological Engineering Solutions
Allometric Relationships from Evolutionary Pressure; Dimensional Analysis; Golden Ratio; Fractal Scaling within an Organism; Self-Similarity for Tissues and Organs; Self-Similarity in Populations; Systems Approach; Relationships between Engineering and Biology; The Completed Design.

Text Books:

1. Arthur T. Johnson, " Biology for Engineers", CRC Press, 2010

Reference Books:

1. Aydin Tözeren, Stephen W. Byers, New Biology for Engineers and Computer Scientists, Pearson/Prentice Hall, 2004
2. S. Thyaga Rajan, N. Selvamurugan, M. P. Rajesh, R. A. Nazeer, Richard W. Thilagaraj, S. Barathi, and M. K. Jaganathan, "Biology for Engineers," Tata McGraw-Hill, New Delhi, 2012.

Course Outcomes:
After the completion of the course, the student should be able to

1. Understand the information known about familiar living systems.
2. Anticipate the properties of an unfamiliar group of living things from knowledge about a familiar group.
3. Demonstrate the relevance of engineering to biological systems.
4. Exhibit knowledge about biological responses and it is scaling with respect to scientific principles that cannot be related back.
5. Demonstrate biological principles and generalizations that can lead to useful products and processes.

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

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. Davide Wikersheimer *Windstorm Mitigation Manual for Light Frame Construction*, DIANE Publishing Co: (Paperback-May 1997)
2. Brown D *Redevelopment After 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	-

XXOEXXX	**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	

00EXXX	**HUMAN RIGHTS**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- At the end of this course the student is expected to understand what is human rights, how to obey the rights, what is the role of a human being in making a good society for the future generations.

UNIT-I Definition of Human Rights - Nature, Content, Legitimacy and Priority - Theories on Human Rights - Historical Development of Human Rights.

UNIT-II International Human Rights - Prescription and Enforcement upto World War II - Human Rights and the U .N .O. - Universal Declaration of Human Rights - International Covenant on Civil and Political Rights - International Convenant on Economic, Social and Cultural Rights and Optional Protocol.

UNIT-III Human Rights Declarations - U.N. Human Rights Declarations - U.N. Human Commissioner.

UNIT-IV Amnesty International - Human Rights and Helsinki Process - Regional Developments -European Human Rights System - African Human Rights System - International Human Rights in Domestic courts.

UNIT-V Contemporary Issues on Human Rights: Children's Rights - Women's Rights -Dalit's Rights - Bonded Labour and Wages - Refugees - Capital Punishment. Fundamental Rights in the Indian Constitution - Directive Principles of State Policy - Fundamental Duties - National Human Rights Commission.

Course Outcomes:

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

1. Describe the evolution of human rights concepts and progress over the years
2. Understand the human rights on global perspective
3. Know the details pertaining to organization and declarations of the United Nations
4. Acquire knowledge on International Human Rights systems
5. Understand the human rights on social, industrial, economical, individual related issues

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
CO2						2	3		2						2
CO3						2	2	3							3
CO4						2	3		2						3
CO5						2	2		2						2

00OEXXX	**NATIONAL SERVICE SCHEME**	**L**	**T**	**P**
		4	**0**	**0**

Course Objectives:

- Understand the community in which they work and their relation
- Identify the needs and problems of the community and involve them in problem-solving
- Develop capacity to meet emergencies and natural disasters
- Practice national integration and social harmony and
- Utilize their knowledge in finding practical solutions to individual and community problems.

UNIT-I: National Service Scheme

A) History and its Objectives
B) Organizational structure of N.S.S. at National, State, University and College Levels
C)Advisory committee and their functions with special reference to college principal, Programme officer, N.S.S. group leader and N.S.S. volunteers in the implementation**.**

UNIT-II: National Integration

A) Need of National integration
B) Various obstacles in the way of National Integration; such as caste, religion, language and provisional problems etc.

UNIT-III: Special Programme

A) Legal awareness
B) Health awareness
C) First-aid
D) Career guidance
E) Leadership training - cum - Cultural Programme
F) Globalization and its Economic Social Political and Cultural impacts.

UNIT-IV: Special Camping Programme

A) Nature and its objectives
B) Selection of camp site and physical arrangement
C) Organization of N.S.S. camp through various committees and discipline in the camp.
D) Activities to be undertaken during the N.S.S. camp.
E) Use of the mass media in the N.S.S. activities.

UNIT-V: n.s.s. Regular activities

A) Traffic regulation
B) Working with Police Commissioner's Office
C) Working with Corporation of Chennai
D) Working with Health Department

E) Blind assistance
F) Garments collection
G) Non-formal education
H) 'Environmental Education, Awareness and Training (EEAT)'
I) Blood donation

Course Outcomes:

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

1. Acquire knowledge on the history, organization of NSS and the roles/responsibilities of Coordinators, POS and volunteers
2. Understand the need for national integration breaking the diversity based on caste, religion, language, etc.
3. Develop / enhance leadership attires, team management, health awareness
4. Organize and coordinate events on team basis social activities in rural areas
5. Develop extracurricular capabilities, service mind, entrepreneurship abilities, etc.

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