RVR & JC COLLEGE OF ENGINEERING::GUNTUR
(AUTONOMOUS)

REGULATIONS (R-12) FOR FOUR YEAR B.TECH. DEGREE COURSE

DEPARTMENT OF CHEMICAL ENGINEERING

(w.e.f. the batch of students admitted into first year B.Tech. from the academic year 2012-2013).

1.0. MINIMUM QUALIFICATIONS FOR ADMISSION

A candidate seeking admission into First Year of B.Tech. Degree Course should have passed either Intermediate examination conducted by the Board of Intermediate Education, Andhra Pradesh with Mathematics, Physics, and Chemistry as optional subjects (or any equivalent examination recognized by the Acharya Nagarjuna University) or Diploma in Engineering in the relevant branch conducted by the State Board of Technical Education & Training of Andhra Pradesh (or equivalent Diploma recognized by Acharya Nagarjuna University).

The selection is based on the rank secured by the candidate at the EAMCET / ECET (FDH) examination conducted by A.P. State Council of Higher Education. The candidate shall also satisfy any other eligibility requirements stipulated by the University and / or the Government of Andhra Pradesh from time to time.

2.0. BRANCHES OF STUDY

2.1. The B.Tech. Course is offered in the following branches of study:

1 Biotechnology
2 Chemical Engineering
3 Civil Engineering
4 Computer Science & Engineering
5 Electrical & Electronics Engineering
6 Electronics & Communication Engineering
7 Information Technology
8 Mechanical Engineering

2.2 In addition to the core electives, an open elective (non-departmental elective) is to be offered in the first semester of fourth year by all branches of B.Tech. courses.

3.0. DURATION OF THE COURSE AND MEDIUM OF INSTRUCTION

3.1 The duration of the course is four academic years consisting of two semesters in each academic year. The medium of instruction and examination is English.

3.2 The duration of the course for the students (Diploma Holders) admitted under lateral entry into II/IV B.Tech. is three academic years consisting of two semesters in each academic year. The medium of instruction and the Examination is English.

4.0. MINIMUM INSTRUCTION DAYS

Each semester shall consist of a minimum number of 90 days of instruction excluding the days allotted for tests, examinations and preparation holidays.

5.0 EVALUATION

The performance of the students in each semester shall be evaluated subject wise

5.1. The distribution of marks between sessionals (based on internal assessment) and Semester end Examination is as follows:

Nature of the subject	**Sessional Marks**	**End Semester Exam. Marks**
Theory subjects/Design and / or Drawing/Practicals	40	60
Mini Project/ Term paper	100	--
Project work	80	120 (Viva voce)

5.2. Ineach of the Semesters, there shall be two Mid Term examinations and two Assignment Tests in every theory subject. The Sessional marks for the midterm examinations shall be awarded giving a weightage of 15 marks out of 18 marks (80% approx.) to that midterm examination in which the student scores more marks and the remaining 3 marks (20% approx.) for other midterm examination in which the student scores less marks. Similarly a weightage of 10 marks (80% approx.) out of 12 marks earmarked for assignment tests shall be given for the assignment in which the student scores more marks and remaining 2 marks (20% approx.) shall be given for the assignment test in which the student scores less marks.

Five marks are allotted for attendance in the respective theory subjects in a graded manner as indicated in ***clause7.2.***The remaining 5 marks out of the 40 marks earmarked for the internal sessional marks are awarded (quiz/online examination) by the concerned teacher in the respective theory subjects.

5.3. The evaluation for Laboratory class work consists of a weightage of 25 marks for day to day laboratory work including record work and 15 marks for internal laboratory examination including Viva-voce examination.

In case of Project work, the sessional marks shall be awarded based on the weekly progress, the performance in two Seminars and the Project Report submitted at the end of the semester. The allotment of sessional marks for Seminars and day-to-day class work shall be30 and 50 respectively.

NOTE : A student who is absent for any Assignment / Mid Term Exam, for any reason whatsoever, shall be deemed to have scored zero marks in that Test / Exam and no make-up test / Exam shall be conducted.

5.4. A student who could not secure a minimum of 50% aggregate sessional marks is not eligible to appear for the semester-end examination and shall have to repeat that semester.

6.0. LABORATORY / PRACTICAL CLASSES

In any semester, a minimum of 90 percent experiments / exercises specified in the syllabus for laboratory course shall be completed by the student and get the record certified by the concerned Head of the Department, to be eligible to face the Semester end Examination in that Practical subject.

7.0. ATTENDANCE REGULATIONS

7.1 Regular course of study means a minimum average attendance of 75% in all the subjects computed by totalling the number of hours / periods of lectures, design and / or drawing, practical's and project work as the case may be, held in every subject as the denominator and the total number of hours / periods actually attended by the student in all the subjects, as the numerator.

7.2 A weightage in sessional marks up to a maximum of 5 marks out of 40 marks in each theory subject shall be given for those students who put in a minimum of 75% attendance in the respective theory in a graded manner as indicated below:

Attendance of 75% and above but less than 80% - 1 mark
Attendance of 80% and above but less than 85% - 2 marks
Attendance of 85% and above but less than 90% - 4 marks
Attendance of 90% and above - 5 marks

7.3 Condonation of shortage in attendance may be recommended on genuine medical grounds, up to a maximum of 10% provided the student puts in at least 65% attendance as calculated in ***clause 7.1*** above, provided the Principal is satisfied with the genuineness of the reasons and the conduct of the student.

7.4 A student who could not satisfy the minimum attendance requirements as given above, in any semester, is not eligible to appear for the semester end examinations and shall have to repeat that semester.

8.0 DETENTION

A student, who fails to satisfy either the minimum attendance requirements as stipulated in ***Clause-7***, or the requirement of minimum aggregate sessional marks as stipulated in ***Clause 5***, shall be detained. Such a student shall have to repeat the same semester subsequently and satisfy the above requirements afresh to become eligible to appear for the semester-end examination.

9.0. SEMESTER END EXAMINATION

9.1. For each theory subject, there shall be a comprehensive semester end Examination of three hours duration at the end of each Semester, unless stated otherwise in the detailed Scheme of Instruction.

Question paper setting shall be entrusted to external examiners from the panels approved by the respective Boards of Studies.

9.2. For each Practical subject, the semester end examination shall be conducted by one internal and one external examiner appointed by the Principal of the College, the duration being that approved in the detailed Schemes of Instruction & Examination.

9.3 Viva-voce Examination in Project Work shall be conducted by one internal examiner and one external examiner appointed by the Principal.

10.0 CONDITIONS FOR PASS

A candidate shall be declared to have passed the Semester end Examination in individual subjects if he / she secures a minimum of 35% marks in theory and 50% marks in Practical subjects and drawing subjects (including Project Viva-voce).

11.0 AWARD OF CREDITS

Credits are awarded for each Theory/Practical Subjects. Each theory subject is awarded four credits and each practical subject is awarded two credits. Project work is awarded ten credits. However for some specific subjects more/less than four credits may be awarded by individual boards. The total number of credits for all the four years put together should be in the range of 218-224 for any branch.

11. 1 AWARD OF GRADES

S.No.	Range of Marks	Grade	Grade Points
1	≥85%	S	10.0
2	75%-84%	A	9.0
3	65%-74%	B	8.0
4	55%-64%	C	7.0
5	45%-54%	D	6.0
6	40%-44%	E	5.0
7	≤39%	F (Fail)	0.0
8	The grade "-W" represents withdrawal/absent (subsequently changed into pass or E to S or F grade in the same semester)	W	0.0

11.2 A Student securing 'F' grade in any subject there by securing zero grade points has to reappear and secure at least 'E' grade in the subsequent examinations for that subject.

11.3 After each semester, Grade sheet will be issued which will contain the following details:

- The list of subjects for each semester and corresponding credits and Grades obtained
- The Grade Point Average(GPA) for each semester and
- The Cumulative Grade Point Average(CGPA) of all subjects put together up to that semester from first semester onwards

GPA is calculated based on the following formula:

$$\frac{\sum [\text{No. of Credits X Grade Points}]}{\sum \text{of Credits}}$$

CGPA will be calculated in a similar manner, considering all the subjects enrolled from first semester onwards.

12.0 CONDITIONS FOR PROMOTION

12.1 A student shall be eligible for promotion to II/IV B.Tech. Course if he / she satisfies the minimum requirements of attendance and sessional marks as stipulated in ***Clauses 5 and 7***, irrespective of the number of backlog subjects in I/IV B.Tech.

12.2 A student shall be eligible for promotion to III/IV B.Tech. Course if he / she secures a minimum of 70% of the total number of credits of I/IV B.Tech.(including practical subjects) by the time the classwork commences for III/IV B.Tech.,in addition to satisfying the minimum requirements of attendance and sessional marks stipulated in *Clauses 5 and 7* in II/IV B.Tech.

12.3 A student shall be eligible for promotion to IVIV B.Tech. course if he/she secures a minimum of 70% of the total number of credits of I/IV & II/IV B.Tech.(including practical subjects) by the time the classwork commences for IV/IV B.Tech., in addition to satisfying the minimum requirements of attendance and sessional marks stipulated in *Clauses 5 and 7* in III/IV B.Tech.

12.4 A student (Diploma Holder) admitted under lateral entry into II/IV B.Tech. shall be eligible for promotion to III/IV B.Tech. Course if he / she satisfies the minimum requirements of attendance and sessional marks as stipulated in ***Clauses 5 and 7***, irrespective of the number of backlog subjects in II/IV B.Tech.

12.5 A student (Diploma Holder) admitted under lateral entry into II/IV B.Tech. shall be eligible for promotion to IV/IV B.Tech. course if he/she secures a minimum of 70% of the total number of credits of II/IV B.Tech.(including practical subjects) by the time the classwork commences for IV/IV B.Tech., in addition to satisfying the minimum requirements of attendance and sessional marks stipulated in *Clauses 5 and 7* in III/IV B.Tech.

13.0 ELIGIBILITY FOR AWARD OF B.TECH. DEGREE

The B.Tech. Degree shall be conferred on a candidate who has satisfied the following requirements:

13.1 The candidate must have satisfied the conditions for pass in all the subjects of all the years as stipulated in ***clause 10.***

13.2 Maximum Time Limit for completion of B.Tech Degree

A Student, who fails to fulfil all the academic requirements for the award of the degree within eight academic years from the year of admission, shall forfeit his/her seat in B.Tech. course.

13.3 A student (Diploma Holder) admitted under lateral entry into II/IV B.Tech., who fails to fulfill all the academic requirements for the award of the degree within six academic years from the year of admission, shall forfeit his/her seat in B.Tech. course.

14.0 AWARD OF CLASS

A candidate who becomes eligible for the award of B.Tech. Degree as stipulated in *Clause 12* shall be placed in one of the following Classes.

S.No.	Class	CGPA
1	**First Class With Distinction**	**8.0 or more**
2	**First Class**	**6.5 or more but less than 8.0**
3	**Second Class**	**5.0 or more but less than 6.5**

15.0 IMPROVEMENT OF CLASS

15.1 A candidate, after becoming eligible for the award of the Degree, may reappear for the semester end Examination in any of the theory subjects as and when conducted, for the purpose of improving the aggregate and the class. But this reappearance shall be within a period of two academic years after becoming eligible for the award of the Degree.

Candidates shall not be permitted to reappear either for Sessional Examinations or for Semester end Examinations in Practical subjects (including Project Viva-voce) for the purpose of improvement. However, this facility cannot be availed by a candidate who has taken the Original Degree Certificate.

15.2 A single Grade sheet shall be issued to the candidate after incorporatingthe Credits and Grades secured in subsequent improvements.

15.3 A consolidated Grade Sheet shall be issued to the candidate indicating theCGPA of all the four years put together along with the Provisional Certificate.

16.0AWARD OF RANK

The rank shall be awarded based on the following:

16.1 Ranks shall be awarded in each branch of study for the top ten percent of the students appearing for the Regular semester end Examinations or the top ten students whichever is lower.

16.2 Only such candidates who pass the Final year examination at the end of the fourth academic year after admission as regular final year student along with others in their batch and become eligible for the award of the Degree shall be eligible for the award of rank. The Rank will be awarded only to those candidates who complete their degree within four academic years.

16.3 For the purpose of awarding rank in each branch, the CGPA calculated based on the Grades secured at the first attempt only shall be considered.

16.4 Award of prizes, scholarships, or any other Honors shall be based on therank secured by a candidate, consistent with the desire of the Donor, wherever applicable.

17.0 SUPPLEMENTARY EXAMINATIONS

In addition to the Regular semester end Examinations held at the end of each semester, Supplementary Examinations will be conducted during the academic year. Such candidates taking the Regular / Supplementary examinations as Supplementary candidates may have to take more than one semester end Examination per day.

18.0 TRANSITORY REGULATIONS

A Candidate, who is detained or discontinued in the semester, on readmission shall be required to do all the courses in the curriculum prescribed for such batch of students in which the students joins subsequently. However, exemption will be given to those candidates who have already passed in such courses, which he / she had passed in the earlier semester(s).

18.1 A student, following the Acharya Nagarjuna University (ANU), Guntur curriculum, detained due to lack of academics/attendance at the end of the first semester of second year, shall join the autonomous batch of third semester. Such students will study all the courses prescribed for that batch, in which the student joins. The first year marks shall not be converted into course credits. However, the student has to clear all the first year backlog subjects by appearing the supplementary examinations, conducted by ANU, Guntur and courses prescribed by Autonomous stream for the award of Degree. The class will be awarded based on the academic performance of a student. Such candidates will be considered on par with lateral entry candidates of autonomous stream and will be governed by regulations applicable to lateral entry candidates' category.

18.2 A student, following ANU, Guntur curriculum, detained due to lack of academics / attendance at the end of the second semester of second year and also at the subsequent semesters, shall join with the autonomous batch at the appropriate semester. Such candidates shall be required to pass in all the courses in the programme prescribed by concerned BOS for such batch of students, to be eligible for

the award of degree. However, exemption will be given in all those courses of the semester(s) of the batch, which he / she had passed earlier. The student has to clear all his/her backlog subjects by appearing the supplementary examinations, conducted by ANU, Guntur and College (Autonomous stream) for the award of degree. The class will be awarded based on the academic performance of a student in the autonomous pattern. Such candidates will also be considered on par with lateral entry candidates of autonomous stream and will be governed by regulations applicable to lateral entry candidates' category.

19.0 CONDUCT AND DISCIPLINE

(a) Students shall conduct themselves within and outside the premises of the institute in a manner befitting the students of our institution.

(b) As per the order of Honourable Supreme Court of India, ragging in any form is considered as a criminal offence and is banned. Any form of ragging will be severely dealt with.

(c) The following acts of omission and / or commission shall constitute gross violation of the code of conduct and are liable to invoke disciplinary measures with regard to ragging.

(i) Lack of courtesy and decorum, indecent behaviour anywhere within or outside the campus.

(ii) Wilful damage of college / individual property

(iii) Possession, consumption or distribution of alcoholic drinks or any kind of narcotics or hallucinogenic drugs.

(iv) Mutilation or unauthorized possession of library books.

(v) Noisy and unseemly behaviour, disturbing studies of fellow students.

(vi) Hacking of computer systems (such as entering into other person's areas without prior permission, manipulation and / or damage of computer hardware and software or any other cyber-crime etc.)

(vii) Usage of camera / cell phone in the campus

(viii) Plagiarism of any nature

(ix) Any other acts of gross indiscipline as decided by the academic council from time to time.

(d) Commensurate with the gravity of offense, the punishment may be reprimand, fine, expulsion from the institute / hostel, debar from examination, disallowing the use of certain facilities of the institute, rustication for a specified period or even outright expulsion from the institute or even handing over the case to appropriate law enforcement or the judiciary, as required by the circumstances.

(e) For an offence committed in (i) a hostel (ii) a department or in a class room and (iii) elsewhere, the chief warden, the head of the department and the principal respectively, shall have the authority to reprimand or impose fine.

(f) Cases of adoption of unfair means and / or any malpractice in an examination shall be reported to the principal for taking appropriate action.

(g) All cases of serious offence, possibly requiring punishment other than reprimand, shall be reported to the academic council.

(h) The institute level standing disciplinary action committee constituted by the academic council shall be the authority to investigate the details of the offence, and recommend disciplinary action based on the nature and extent of the offence committed.

(i) The principal shall deal with any academic problem, which is not covered under these rules and regulations, in consultation with the programmes committee in an appropriate manner, and subsequently such actions shall be placed before the academic council for ratification. Any emergency modification of regulation, approved by the appropriate authority, shall be reported to the academic council for ratification.

(j) "Grievance and Redressal Committee" (General) constituted by the Principal shall deal with all grievances pertaining to the academic / administrative / disciplinary matters.

20.0 MALPRACTICES

20.1 The Principal shall refer the cases of malpractices in internal assessment tests and semester-end examinations to a malpractice enquiry committee constituted by him / her for the purpose. Such committee shall follow the approved scales of punishment. The principal shall take necessary action, against the erring students basing on the recommendations of the committee.

20.2 Any action on the part of a candidate during an examination trying to get undue advantage or trying to help another, or drive the same through unfair means is punishable according to the provisions contained hereunder. The involvement of the staff, who are in-charge of conducting examinations, valuing examination papers and preparing / keeping records of documents relating to the examinations in such acts (inclusive of providing incorrect or misleading information) that infringe upon the course of natural justice to one and all concerned in the examination shall be viewed seriously and recommended for award of appropriate punishment after thorough enquiry.

21.0 AMENDMENTS TO REGULATIONS

The College may, from time to time, revise, amend, or change the Regulations, Schemes of Examinations, and / or Syllabus.

R.V.R. & J.C. COLLEGE OF ENGINEERING, GUNTUR - 522019
(AUTONOMOUS)

DEPARTMENT CHEMICAL ENGINEERING

(Scheme of Instruction and Examination w.e.f. 2012-2013)

I/V B.Tech.

1st Semester

Sl. No.	Course Details		Scheme of Instruction		Scheme of Examination				Credits
	Code No.	Subject Name	Periods per week		Duration of Semester End Exam.(hrs)	Maximum Marks		Total Marks	
			Lectures + Tutorials	Practicals/ Drawing		Sessional	Semester End		
1	ChE 111	Engineering Mathematics-I	4+1	-		40	60	100	4
2	ChE 112	Engineering Physics-I	3+1	-	3	40	60	100	3
3	ChE 113	Inorganic Chemistry	3+1	-	3	40	60	100	3
4	ChE 114	Technical English & Communication Skills	4+1	-	3	40	60	100	4
5	ChE 115	Physical Chemistry	4	-	3	40	60	100	4
6	ChE 151	Physics Laboratory	-	3	3	40	60	100	2
8	ChE 152	English Language Laboratory	-	3	3	40	60	100	2
7	ChE 153	Engineering Graphics Laboratory	2	4	3	40	60	100	4

Total	20+4	10		320	3	800	26

2nd Semester

Sl. No.	Course Details		Scheme of Instruction		Scheme of Examination				Credits
	Code No.	Subject Name	Periods per week		Duration of Semester End Exam.(hrs)	Maximum Marks		Total Marks	
			Lectures + Tutorials	Practicals/ Drawing		Sessional	Semester End		
1	ChE 121	Engineering Mathematics-II	4+1	-	3	40	60	100	4
2	ChE 122	Engineering Physics - II	3+1	-	3	40	60	100	3
3	ChE 123	Analytical Chemistry	3+1	-	3	40	60	100	3
4	ChE 124	C-Programming	4+1	-	3	40	60	100	4
5	ChE 125	Introduction to Chemical Engineering	4	-	3	40	60	100	4
6	ChE 161	Chemistry Laboratory	-	3	3	40	60	100	2
7	ChE 162	Workshop	-	3	3	40	60	100	2
8	ChE 163	C-Programming Laboratory	-	3	3	40	60	100	2
Total			18+4	9	-	320	480	800	24

II / IV B.Tech.

3rd Semester

S. No	Code No.	Subject Name	Scheme of Instruction		Scheme of Examination				Credits
			Periods per week		Duration of Semester End Exam.(hrs)	Sessional Marks University Marks		Total Marks	
			Lectures	Tutorial + Practical's		Sessional	Semester End		
01	ChE 211	Computational Techniques	4	-	3	40	60	100	4
02	ChE 212	Environmental Studies	4	-	3	40	60	100	4
03	ChE 213	Electrical & Electronics Engineering	4	-	3	40	60	100	4
04	ChE 214	Organic Chemistry	4	-	3	40	60	100	4
05	ChE 215	Chemical Process Calculations	4	-	3	40	60	100	4
06	ChE 216	Momentum Transfer	4+1	-	3	40	60	100	4
07	ChE 251	Electrical & Electronics Engineering Laboratory	-	3	3	40	60	100	2
08	ChE 252	Organic Chemistry Laboratory	-	3	3	40	60	100	2
09	ChE 253	Momentum Transfer Laboratory	-	3	3	40	60	100	2
Total			24+1	9	-	360	540	900	30

4th Semester

S. No.	Code No.	Subject Name	Scheme of Instruction		Scheme of Examination				
			Periods per week		Duration of Semester End Exam.(hrs)	Maximum Marks		Total Marks	Credits
			Lectures	Tutorial + Practical's		Sessional	Semester End		
01	ChE 221	Probability & Complex Analysis	4	-	3	40	60	100	4
02	ChE 222	Applied Mechanics & Mechanical Engineering	4	-	3	40	60	100	4
03	ChE 223	Professional Ethics & Human Values	4	-	3	40	60	100	4
04	ChE 224	Process Heat Transfer	4+1	-	3	40	60	100	4
05	ChE 225	Mechanical Operations	4	-	3	40	60	100	4
06	ChE 226	Chemical Engineering Thermodynamics-I	4	-	3	40	60	100	4
07	ChE 261	Mechanical Operations Laboratory	-	3	3	40	60	100	2
08	ChE 262	Computational Programming Laboratory	-	3	3	40	60	100	2
09	ChE 263	Communication Skills Laboratory	-	3	3	40	60	100	2
Total			24+1	9	-	360	540	900	30

III/IV B.Tech.

5th Semester

S. No.	Code No.	Subject Name	Scheme of Instruction		Scheme of Examination				
			Periods per week		Duration of Semester End Exam.(hrs)	Maximum Marks		Total Marks	Credits
			Lectures	Tutorial+ Practical's		Sessional	Semester End		
01	ChE 311	Material Technology	4	-	3	40	60	100	4
02	ChE 312	Mass Transfer operations-I	4	-	3	40	60	100	4
03	ChE 313	Inorganic Chemical Technology	3+1	-	3	40	60	100	3
04	ChE 314	Chemical Reaction Engineering-I	4	-	3	40	60	100	4
	ChE315	Chemical Engineering Thermodynamics – II	4	-	3	40	60	100	4
06	ChE 316	Process Instrumentation	4	-	3	40	60	100	4
07	ChE 351	Process Heat Transfer Laboratory	-	3	3	40	60	100	2
08	ChE 352	Mass Transfer Operations Laboratory-I	-	3	3	40	60	100	2
09	ChE 353	Advanced Communication Skills Laboratory	-	3	3	40	60	100	2
Total			24	9	-	360	540	900	29

6th Semester

S. No.	Code No.	Subject Name	Scheme of Instruction		Scheme of Examination				
			Periods per week		Duration of Semester End Exam.(hrs)	Maximum Marks		Total Marks	Credits
			Lectures	Tutorial+ Practical's		Sessional	Semester End		
01	ChE 321	Industrial PollutionControl	4	-	3	40	60	100	4
02	ChE 322	Mass Transfer Operations-II	4	-	3	40	60	100	4
03	ChE 323	Organic Chemical Technology	3+1	-	3	40	60	100	3
04	ChE 324	Chemical Reaction Engineering-II	4	-	3	40	60	100	4
05	ChE325	Process Dynamics & Control	4	-	3	40	60	100	4
06	ChE 326	Elective-I	4	-	3	40	60	100	4
07	ChE 361	Instrumentation & Process control Laboratory	-	3	3	40	60	100	2
08	ChE 362	Mass Transfer Operations Laboratory-II	-	3	3	40	60	100	2
09	ChE 363	Chemical Technology Laboratory	-	3	3	40	60	100	2
Total			24	9	-	360	540	900	29

IV / IV B.TECH

7th Semester

S. No.	Code No.	Subject Name	Scheme of Instruction		Scheme of Examination				
			Periods per week		Duration of Semester End Exam.(hrs)	Maximum Marks		Total Marks	Credits
			Lectures	Tutorial+ Practical's		Sessional	Semester End		
01	ChE 411	Computer Applications in Chemical Engineering	4	-	3	40	60	100	4
02	ChE 412	Chemical Process Equipment Design	5	-	3	40	60	100	5
03	ChE 413	Transport Phenomena	4+1	-	3	40	60	100	4
04	ChE 414	Bio-Chemical Engineering	4	-	3	40	60	100	4
05	ChE415	Elective-II (Open to other branches)	3+1	-	3	40	60	100	3
06	ChE 451	Mini Project	-	3	-	100	--	100	2
07	ChE 452	Chemical Reaction Engineering Laboratory	-	3	3	40	60	100	2
08	ChE 453	Computer Applications in Chemical Engineering Laboratory	-	3	3	40	60	100	2
09	ChE 454	Industrial PollutionControl Laboratory	-	3	3	40	60	100	2
Total			20+2	12	-	420	480	900	28

8th Semester

S. No.	Code No.	Subject Name	Scheme of Instruction periods per week		Scheme of Examination				
			Periods per week		Duration of Semester End Exam. (hrs)	Maximum Marks		Total Marks	Credits
			Lectures	Tutorial+ Practical's		Sessional	Semester End		
01	ChE 421	Process Economics & Industrial Management	4	-	3	40	60	100	4
02	ChE 422	Process Modeling and Simulation	4	-	3	40	60	100	4
	ChE 423	Elective – III	4	-	3	40	60	100	4
04	ChE 424	Elective – IV	4	-	3	40	60	100	4
05	ChE461	Computer Aided Process Equipment Design Laboratory	-	3	3	40	60	100	2
06	ChE 462	Project Work	-	9	3	40	60	100	10
Total			16	12	-	240	360	600	28

ELECTIVE SUBJECTS:

Elective – I

ChE 326 (A)	Electro-Chemical Engineering.
ChE 326 (B)	Textile Engineering
ChE 326 (C)	Membrane Technology
ChE 326 (D)	Corrosion Engineering
ChE 326 (E)	Nuclear Chemical Engineering
ChE 326 (F)	Fluidization Engineering

Elective-II (Open Elective to be selected from other branches of Engineering)

Open Elective offered by the Dept. to other Branches of Engineering

ChE 415(A)	Energy Engineering
ChE 415(B)	Bio-fuels

Elective – III

ChE 423 (A)	Polymer Technology
ChE 423 (B)	Fertilizer Technology
ChE 423 (C)	Technology of Edible Fats
ChE 423 (D)	Nanotechnology
ChE 423 (E)	Computer Aided Design
ChE 423 (F)	Petroleum Refinery Engineering

Elective – IV

ChE 424 (A)	Catalyst Science and Technology
ChE 424 (B)	Food Technology
ChE 424 (C)	Optimization of Chemical Process
ChE 424 (D)	Fuel cell Technology
ChE 424 (E)	Industrial Bio-technology
ChE 424 (F)	Industrial Hazards & Safety Analysis

I/IV Year B.Tech.::First Semester

ChE 111 ENGINEERING MATHEMATICS – I

(Common to all branches)

Lectures : 4 periods / week	*Sessional Marks : 40*
Tutorials : 1 period / week	*Semester End Exam Marks : 60*
Semester End Exam: 3 hrs	*Credits : **4***

Course Objectives:

1 To provide knowledge on solving ordinary differential equations and applications of first order ordinary differential equations.
2 To give basic knowledge on evaluation of double, triple integrals, area and volume.
3 To provide knowledge and skills in writing a periodic function in its Fourier series form and on their applications.
4 To develop skills for applying them in future on various engineering applications

Course Outcomes:

i. Understand methods of solving First order and Higher order ordinary differential equations along with some physical applications.
ii. Understand the relation between two variables by Curve fitting.
iii. Able to evaluate double, triple integrals and the area, volume by double & triple integrals respectively.
iv. Understand the concept of Fourier-series representation of periodic functions and their applications.

UNIT–I

Ordinary Differential Equations: Introduction, Linear equation, Bernoulli's equation, Exact differential equations, Equations reducible to exact equations, Orthogonal trajectories, Newton's law of cooling. Linear differential equations with constant coefficients: Definition, Theorem, Operator D, Rules for finding the complementary function, Inverse operator, Rules for finding the particular integral, working procedure to solve the equation.

UNIT–II

Method of variation of parameters, Equations reducible to linear equations with constant coefficients: Cauchy's homogeneous linear equation, Legendre's linear equation, Simultaneous linear equations with constant coefficients.

Statistics: Method of least squares, Correlation, Co-efficient of correlation (direct method), Lines of regression.

UNIT-III

Fourier series: Introduction, Euler's formulae, Conditions for a Fourier expansion, Functions having points of discontinuity, Change of interval, Even and Odd functions, half range series. Parseval's formula, Practical harmonic analysis.

UNIT–IV

Multiple Integrals: Double integrals**,** Change of order of integration, Double integrals in polar coordinates, Area enclosed by plane curves, Triple integrals, Volume by triple integral, Change of variables in a double integral.

Beta, Gamma functions, Error function

Text book:

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

Reference book:

1 Advanced Engineering Mathematics by Erwin Kreyszig, 8th edition, 2007.

ChE 112 ENGINEERING PHYSICS–I

(Common to all branches)

Lectures : 3 periods / week	*Sessional Marks : 40*
Tutorials : 1 period / week	*Semester End Exam Marks : 60*
Semester End Exam: 3 hrs	*Credits : **3***

COURSE OBJECTIVES

1 The production & detection of ultrasonics and its applications are presented to emphasize in understanding the medical ultrasound techniques. Superposition principle of light waves and its applications in thin films (wedge, convex shaped) are used to find the various parameters.

2 For the identification of various vibrational modes of atoms of molecules in materials by laser Raman spectroscopy and in the study of mechanical strains and in the studies of crystals, polarized light and diffraction phenomena can effectively be used.

3 The basics of laser light, its properties with applications in various fields and its important role played in the preparation of holograms, in analyzing the optical spectra and in optical communication are presented.

4 An overview of Maxwell's E-M equations to understand all the problems encountered in Electromagnetism and the connection to the Optics. The free electron theory and its significance to characterize the electrical and thermal properties of solids and the concept of the Fermi-Dirac distribution function to explain the Fermi energy level in metals.

LEARNIG OUT COMES: The student will understand:

i. The ultrasonics in various fields of science, engineering & medicine, to recognize the experimental evidence for the wave nature of light and interference in thin films and its technological applications.

ii. Diffraction spectra due to single slit on changing of wavelength and slit width. Concept and various types of polarization can be signified. Nicol prism as polarizer and analyzer& its limitations.

iii. Importance of the stimulated emission in producing the lasing beam and its dependence on resonating cavity and active medium. 3D image production & construction and its application using highly monochromatic lasing beam. Guiding light through thin strands of dielectric material and classification.

iv. Propagation of electromagnetic waves through Maxwell’s equations, distinguishing the properties of electrons and Photons.

UNIT–I

Ultrasonics: production of ultrasonics by magnestriction, piezo electric oscillator methods, detection by acoustic grating method, applications in engineering and medicine, ultrasonic testing methods (pulse echo technique, ultrasonic imaging).

Interference: superposition principle, young’s double slit experiment (qualitative treatment),stoke’s principle (change of phase on reflection), interference in thin films due to reflected light (Cosine law), theory of air wedge (fringes produced by a wedge shaped thin film) and theory of newton’s rings(reflected system), non-reflecting films.

UNIT-II

Diffraction: Fraunhofer diffraction due to a single slit(quantitative), theory of plane transmission diffraction grating, Rayleigh’s criterion, resolving power & dispersive power of a grating.

Polarization: introduction, double refraction, construction and working of a nicol prism, nicol prism as a polarizer and analyser, quarter wave plate, production and detection of circular and elliptical polarizations(qualitative), optical activity, specific rotation, kerr and faraday effects.

UNIT-III

Lasers: Laser characteristics, spontaneous and stimulated emissions, population inversion, pumping, active system, gas (He-Ne) laser, Nd: YAG laser and semiconductor (GaAs) laser, applications of lasers.

Holography: basic principle, recording, reproduction and applications.

Fiber optics: structure of optical fiber, light propagation through optical fiber-numerical aperture, acceptance angle and acceptance cone, types of optical fibers, fiber optics in communication system and applications of optical fibres.

UNIT-IV

Electromagnetism: induced electric fields, displacement current and conduction current, Maxwell's equation – qualitative (differential & integral forms)-significance, LC oscillations (quantitative), velocity of electromagnetic wave equation in free space , poynting vector.

Statistical Physics: phase space, Maxwell-Boltzmann, Fermi-Dirac & Bose-Einstein's distribution functions(qualitative), photon gas & electron gas.

Text Books

1. Engineering Physics – R .K. Gaur & S. L. Gupta , Danpati Rai Publications, Delhi, 2001.
2. Engineering Physics – Hitendra K. Malik & A.K.Singh, Tata MacGraw Hill, New Delhi,2009.

Reference Books

1. Fundamentals of Physics – Resnick & Halliday, John Wiley sons ,9th Edition.
2. Engineering Physics – M.N. Avadhanulu & P.G. Kshirasagar, S.Chand & Co.Ltd , 7th Edition.
3. Engineering Physics – M.Arumugam, Anuradha Publications, Chennai ,5th Edition , 2006.
4. Engineering Physics – B. K. Pandey & S. Chaturvedi, Cengage Learning India Pvt. Ltd., Delhi.

Web References:

http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-%20Guwahati/engg_physics/index_cont.htm :

Course relevant website : www.rvrjcce.ac.in/moodle/first year/2011-12/engineeringphysics

ChE 113 INORGANIC CHEMISTRY

(Only for Chemical Engineering Branch)

Lectures	*: 3 periods / week*	*Sessional Marks*	*: 40*
Tutorials	*: 1 period / week*	*Semester End Exam Marks*	*: 60*
Semester End Exam: 3 hrs		*Credits*	*: 3*

Course Objectives:

1 The student should acquire skill in solving problems.
2 To develop the ability of predicting from a given data.
3 Should adopt a planned procedure in solving a problem.
4 To understand the relationship between reactants and products in a chemical reaction.

Course Outcomes:

i. Student can establish relationship between volume, mass, moles of reactants and products using concepts of Stoichiometry (useful in – chemical technology)
ii. Student can relate various theories, using which he can have insight at structure and reactivity of compounds.
iii. Would be able to predict the type of bonding and properties like magnetic, spectral, etc. of a given substance.
iv. Shall classify the transition and inner transition elements for preparation of selected compounds.

UNIT-I

Mole Concept: Introduction**,** Stoichiometry (Mass-Mass, Mass-Volume, Volume-Volume), oxidation number, redox reactions and balancing equations.

Principles of metallurgy: Purification of metals-Physical and chemical methods, ion exchange methods in metallurgy and solvent extraction methods in metallurgy

UNIT-II

Chemical Bonding: Valence bond approach for diatomic molecules, VSEPR theory, Hybridisation and shapes of molecules, Molecular Orbital theory with respect to O_2, O_2^-, N_2 and CO molecules. Resonance, Dipole moment, Bond length, Bond energy and Bond angle.

UNIT-III

d-block elements: Electronicconfiguration , General Characteristics, Oxidation states.

Preparation and properties of $KMnO_4$ and $K_2Cr_2O_7$

f-block elements: General Properties, Atomic Size, Oxidation states.

UNIT-IV

Transition metal Chemistry: Introduction, Co-ordination compounds-Werner theory,Bonding in transition metal complexes- Crystal field theory-Octahedral, Tetrahedral and square planar complexes, Crystal field stabilization energies, John Teller theorem, spectral and magnetic properties

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Text books:

1. Principles of Inorganic Chemistry, Puri, Sarma and Kalia, 31st edition, 2011, Milestone Publishers & Distributors
2. SelectedTopicsin InorganicChemistry, W. U. Malik, G. D. Tuli & R. D. Madan, 6th edition, 2005, S.Chand & company Ltd.

Reference Books:

1 New concise Inorganic chemistry, J.D.Lee, 5thedition, 2001, Nostrand Reinhold Co. Ltd., London.

Web references:

www.wiziq.com/tutorials/
http://www.chem1.com/acad/webtext/chembond/index.html
http://www.mhhe.com/physsci/chemistry/essentialchemistry/walkthrough.pdf
https://www.ionicviper.org/

ChE.114 TECHNICAL ENGLISH AND COMMUNICATION SKILS

(Common to BT/ChE/CE/CSE/IT Branches)

Lectures : 4 periods / week	*Sessional Marks : 40*
Tutorials : 1 period / week	*Semester :End Exam Marks : 60*
Semester End Exam: 3 hrs	*Credits : **4***

Course objectives:

1 To make the student have better awareness on interpersonal skills and case studies
2 To establish the importance of the meaning of new vocabulary as well as the form and of showing how words are used in context.
3 To help the student to develop their overall knowledge and understanding of advanced grammar.
4 To develop their abilities of written communication related to office communication and also to use foreign expressions situationally.

Course outcomes:

i. The student is able to have better inter and intra personal skills and also have good understanding on case studies.
ii. Able to use vocabulary contextually.
iii. Able to learn and applying the knowledge of advanced grammar in the day-to-day life.
iv. Able to develop all kinds of written communication including office communication and also foreign expressions.

Unit – I

1. Kinesis
2. Interpersonal Skills
3. Intrapersonal Skills
4. Case Studies

Unit – II Lexis

1. Vocabulary
2. Analogies
3. Homonymys, Eponyms, Acronyms
4. Confusable words
5. One word substitute

Unit – III Syntax And Advanced Grammar

1. Correction of sentences
2. Advanced grammar
    1. Parallelism
    2. Dangling modifiers
    3. Tantology
    4. Ambiguity
    5. Word order
    6. Shift in tense, mood, voice

Unit – IV Office Communication

1. Letter writing
2. Memos
3. E-mail
4. Note taking, Note making
5. Routing slips
6. Foreign Expressions
    a. French -20
    b. Spanish – 10
    c. Italian/Latin – 20
    d. Japanese – 10
    e. German – 10
    f. Russian – 10
    g. Chinese – 10

Text Books :

1. Communication Skills – Sanjay Kumar & Pushpa Latha (OUP)- 2nd Impression, 2012

Reference Books :

1. Technical Communication – Meenakshi Raman & Sangeeta Sharma, Oxford Semester Press, 6th Impression, 2012
2. Oxford Dictionary of English Idioms – John Ayto, OUP Oxford, 08-Jul-2010
3. Dictionary of word origins – John Ayto, Bloomsbury, 2001
4. Harbrace Hand book of English
5. Mc Graw Hill's Hand Book of English Grammar and Usage – Markm Lysstar, Larry Beason, 2005
6. College Hand book

ChE 115 PHYSICAL CHEMISTRY

(Only for Chemical Engineering Branch)

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam :3 hrs — *Credits : **4***

Course Objectives:

1 To develop scientific concepts, principles, problem solving skills, attitudes, appreciations and interests.
2 Defines terms associated with thermodynamics, phase rule and chemical equilibrium.
3 Understanding the mechanisms of catalysis.
4 Calculation related to conductance, reduction potentials, cell e.m.f., concentrations and rate constants.

Course Outcomes:

i. ♦ Knowledge acquired by students on thermodynamics useful in applications related to chemical engineering.
ii. ♦ Student can establish relationship between
   a) pH-concentration
   b) concentration- rate constants
   c) concentration-equilibrium constants
   d) temperature-equilibrium constant
   e) temperature-electrode potentials-concentration
iii. ♦ Able to understand the effect of catalysts on chemical reactions.

UNIT-I

Thermodynamics: Internal energy, Work, Heat energy, First law, reversible and irreversible processes, Second law, Spontaneous process, entropy, entropy change for an ideal gas, entropy change accompanying phase change (simple problems), Physical significance of entropy. Free energy, work function, Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change-Equilibrium constant, Trouton's rule, third law of thermodynamics.

UNIT-II

Electrochemistry: Electrical conductance, Specific conductance, Equivalentconductance, variation with dilution, Kohlrausch's law and its applications, Half cell potentials, electrochemical series and its significance, Nernst equation, emf of cells, (simple problems)thermodynamics of cell

Chemical Energy Systems Electrochemistry of primary batteries (Lechlanche/dry cell), Secondary cells(Lead-acid cell, Ni-Cd cell), Lithium batteries and their advantages.

UNIT-III

Phase rule: Definition, explanation of the terms, Phase diagram of water system, Two component system Pb-Ag, Thermal analysis curves, construction of phase diagram, Application of eutectics.

Chemical equilibria: Reversible reactions, Law of mass action, Equilibrium constants-K_p, K_c, K_x for homogenous reactions. Effect of temperature on Equlibria-Van'tHoff equation, LeChateliar principle and applications.

UNIT-IV

Chemical Kinetics: Order, Molecularity, activation energy, Specific reaction rate, first order and second order reactions. Half-life period, Effect of temperature on reaction rate
(simple problems on 1^{st},2^{nd} order reactions and half-life periods)

Catalysis: Homogeneous and Heterogeneous catalysis, Characteristics of Catalyst, promoter, negative catalyst, catalytic poison, Theory of catalysis-intermediate compound formation and adsorption theory, Mechanism of acid-base and enzyme catalysis. Michelis and Menton enzyme kinetics.Industrial applications of catalysis.

Text Books:

1. Essentials of Physical Chemistry, Bahl.B.S and Tuli, 18^{th} edition, 2010, S.Chand & Co., Delhi.
2. Engineering chemistry by Jain and Jain, 15^{th} edition, 2008, Dhanpat Rai Publishing Company, Delhi.

Reference Books:

1. Physical Chemistry, K.L Kapoor, Vol. 1, 3^{rd} edition 2001, Macmillan Pub India Ltd.
2. Physical Chemistry, K.L Kapoor, Vol. 2, 3^{rd} edition 2002, Macmillan Pub India Ltd.
3. Physical Chemistry, K.L Kapoor, Vol. 3, 2^{nd} edition 2001, Macmillan Pub India Ltd.

Web references:

http://www.chem.arizona.edu/~salzmanr/103a004/nts004/nts004.html

http://www.cdeep.iitb.ac.in/nptel/Core%20Science/

http://www.wiziq.com/tutorial/

http://www.powerstream.com/BatteryFAQ.html#lec

ChE 151 PHYSICS LABORATORY

(Common to BT/ChE/CE/CSE/IT Branches)

Practicals : 3 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam :3 hrs *Credits : 2*

COURSE OBJECTIVE

Each experiment described in the lab manual issued to the students, designed to incorporate a new application of measurement, data, error, or graphical analysis to illustrating a physical principle and helps to learn how to identifyand the conclusions from data. An adequate preparation before each lab class is required to study the experimental description in the lab manual and the relevant sections in the course textbook.

LEARNIG OUT COMES: The students will be able to understand:

i. Know, understand, and use a broad range of basic physical principles.
ii. a working capability with mathematics, numerical methods, and application of solutions.
iii. Will have a wide idea on various components & instruments.
iv. Additional problem –solving skills and practical experience are through design projects and laboratory assignments, which also provide opportunities for developing team- building and technical communication skills.
v. Have an ability to learn independently.

(Any 10 out of the following experiments)

1. Interference fringes – measurement of thickness of a foil using wedge method.
2. Newton's rings - measurement of radius of curvature of Plano- convex lens.
3. Lissajous' figures – calibration of an audio oscillator.
4. Photo cell – characteristic curves and determination of stopping potential.
5. Diffrraction grating - measurement of wavelengths.
6. Torsional pendulum – determination of Rigidity modulus of a wire.
7. Photo-Voltaic cell – determination of fill factor.
8. Series LCR resonance circuit –determination of Q factor.
9. Sonometer – determination of A.C. frequency.
10. Laser – determination of single slit diffraction.
11. B – H Curve
12. Optical Fiber – Determination of Numerical Aperture and Acceptance Angle

Reference Book:

PhysicsLab Manual

ChE 152 ENGLISH LANGUAGE LABORATORY

(Common to BT/ChE/CE/CSE/IT Branches)

Practicals : 3 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam :3 hrs *Credits : 2*

Course Objectives:

1 To identify various reasons for incorrect pronunciation and make the student understand and learn Standard Pronunciation, i.e., R.P.
2 To develop skills to describe something, participate and present various presentations interesting and captivating.
3 To provide sufficient understanding on the importance of reading and get to know the basic hurdles in efficient reading.
4 To give a comprehensive understanding of having good vocabulary and learn large number of words.
5 To make the student learn within a context by working out some situations using phrasal verbs and idioms.

Course Outcomes:

i. The student is able to speak with Standard Pronunciation.
ii. Able to participate in activities and make better presentations.
iii. Able to develop good and efficient reading skills.
iv. Able to acquire sufficient knowledge on vocabulary and also use them in day-to-day life.
v. Able to use phrasal verbs and idiomatic expressions situationally.

1. **Phonetics**
   - Clear pronunciation – listening practice.
   - Distinctive sounds of English (s,t – b, p etc.,)
2. **Interactions :** 10 – 12 Activities
3. **Reading comprehension**
   - Sentence completion
   - Cloze lists
   - Two minute talk (TMT)
4. **Word origins**
5. **Idioms and phrases**

Books:

1. Keep talking – Mary spratt
2. At the chalk face – Mary spratt
3. Interactive classroom activities (10 titles – Cambridge Publication)

Software:

1. Author plus – clarity
2. Call centre communication – clarity

ChE 153ENGINEERING GRAPHICS LABORATORY

(Common to BT//ChE/CSE/IT Branches)

Lectures :2 periods / week	*Sessional Marks : 40*
Drawing : 4 periods /week	*Semester End Exam Marks : 60*
Semester End Exam : 3 hrs	*Credits : 4*

Course Objectives

1 Comprehend general projection theory with emphasis on orthographic projection to represent three dimensional objects in two dimensional views.
2 Construct letters & Numerals in a legible freehand form
3 To be able to plan and prepare neat orthographic drawings of points, Straight lines, Regular planes and solids
4 Draw and identify various types of section and Auxiliary views
5 To enable the students the aspects of development of surfaces in sheet metal working
6 Introduce Auto CAD software for the creation of basic entities and usage of different tool bars.

Course Outcomes

i. Acquire basic skills in Technical graphic communication
ii. The students will be able to visualize and communicate with 2D as well as three dimensional shapes.
iii. Understands the application of Industry standards and best practices applied in Engineering Graphics
iv. The student is able to apply the knowledge of development of surfaces in real life situations
v. Student is introduced to modern CAD system using Auto CAD.
vi. The students will be able to draw simple 2D Engineering Drawings using Auto CAD.

(To be taught & examined in First angle projection)

UNIT-I

General: Use of Drawing instruments, Lettering .-Single stroke letters, Dimensioning- Representation of various type lines. Geometrical Constructions. Representative fraction

Curves : Curves used in Engineering practice - conic sections - general construction and special methods for ellipse, parabola and hyperbola. cycloidal curves - cycloid, epicycloid and hypocycloid; involute of circle and Archemedian spiral

UNIT-II

Method of Projections: Principles of projection - First angle and third angle projection of points. Projection of straight lines. Traces of lines.

P**rojections of Planes :** Projections of planes, projections on auxiliary planes.

UNIT-III

Projections of Solids : Projections of Cubes, Prisms, Pyramids, Cylinders and Cones with varying positions.

Sections Of Solids: Sections of Cubes, Prisms, Pyramids, cylinders and Cones.true shapes of sections. (Limited to the Section Planes perpendicular to one of the Principal Planes).

UNIT-IV

Development of Surfaces: Lateral development of cut sections of Cubes, Prisms, Pyramids, Cylinders and Cones.

Isometric Projections: Isometric Projection and conversion of Orthographic Projections into isometric views. (Treatment is limited to simple objects only).

UNIT-V

Orthographic projections: Conversion of pictorial views into Orthographic views. (Treatment is limited to simple castings).

UNIT-I (Demonstration only)

Computer aided drafting (Using any standard package): Setting up a drawing: starting , main menu (New, Open, Save, Save As etc.), Opening screen, error correction on screen, units, co-ordinate system, limits, grid, snap, ortho.

Tool bars: Draw tool bar, object snap tool bar, modify tool bar, dimension tool Bar

Practice of 2D drawings: Exercises of Orthographic views for simple solids using all commands in various tool bars.

Text book

1. Engineering Drawing by N.D. Bhatt & V.M. Panchal, 50th Edition, Charotar publishing house, Anand(2010)

Reference book

1. Engineering Drawing by Prof.K.L.Narayana & Prof. R.K.Kannaiah, Scitech Publications , 2010.
2. Engineering Graphics with AutoCAD 2002 by James D. Bethune , PHI , 2011

I/IV Year B.Tech. - Second Semester

ChE 121 ENGINEERING MATHEMATICS – II

(Common to all branches)

Lectures	*: 4 periods / week*	*Sessional Marks*	*: 40*
Tutorials	*: 1 period / week*	*Semester end Exam Marks*	*: 60*
Semester end Exam 3 hrs		*Credits*	*: **4***

Course Objectives:

1 To apply rank concept of matrices in solving linear system of equations, finding the eigen values and eigen vectors and inverse of a matrix and getting familiarity with diagonalization and quadratic forms
2 To get knowledge of mean value theorems, writing series expansion of functions and finding extreme values or stationary values of functions of two (or) three variables.
3 To provide sufficient theoretical and analytical background of differentiation and integration of vector functions.
4 To make the student to learn Laplace and inverse transforms of a function and able to solve differential equation using Laplace transforms.

Course Outcomes :

i. Understand the basic linear algebraic concepts.
ii. Assess the importance of derivative in mean value theorems and extreme values.
iii. Able to solve gradient, divergence, curl and integration of vector function problems.
iv. Obtain the solution of differential equation using Laplace transform.
v. Ability of applying mathematical concepts in relevant engineering applications.

UNIT–I

Matrices: Rank of a matrix, vectors, Consistency of linear system of equations, Linear transformations, Characteristic equation, Properties of Eigen values (without proofs), Cayley-Hamilton theorem (without proof), Reduction to diagonal form.

UNIT-II

Reduction of quadratic form to canonical form, Nature of a quadratic form, Complex matrices.

Differential Calculus: Rolle's Theorem (without proof), Lagrange's Mean value Theorem (without proof), Taylor's and Maclaurin's Series for single variable (without proof). Maxima and minima of two variables, Lagrange's method of undetermined multipliers.

UNIT–III

Vector Calculus: Scalar and vector point functions, Del applied to scalar point functions, Gradient, Del applied to vector point functions, Physical interpretation of divergence and curl, Del applied twice to point functions, Del applied to products of point functions. Integration of vectors, Line integral, Surface integral, Green's theorem in the plane (without proof), Stoke's theorem (without proof), Volume integral, Gauss divergence theorem (without proof).

UNIT–IV

Laplace Transforms: Introduction, Transforms of elementary functions, properties of Laplace Transforms, Existence conditions, Transforms of derivatives, Transforms of integrals, multiplication by tn, division by t. Evaluation of integrals by Laplace Transforms, Periodic function, Inverse Transforms, Convolution theorem(without proof), Application to Differential equations with constant coefficients.

Text Book:

Higher Engineering Mathematics by B.S. Grewal,Khanna publishers, 40th edition, 2007**.**

Reference Book:

Advanced Engineering Mathematics by Kreyszig, 8th edition, 2007.

ChE122 ENGINEERING PHYSICS – II

(Common to all branches)

Lectures	*: 3 periods / week*	*Sessional Marks*	*: 40*
Tutorials	*: 1 period / week*	*Semester End Exam Marks*	*: 60*
Semester End Exam	*: 3 hrs*	*Credits*	*: **3***

COURSE OBJECTIVES

1 To explain the microscopic phenomena occurred in nature through quantum physics and the formation of the band structure and distinction of solids was explained by introducing the famous Kronig-penny model its salient features.
2 Semiconductor concepts such as Energy band formation and classification of solids, intrinsic & extrinsic semiconductors, Hall effect & photo diode, LED and LCD are presented.
3 Various magnetic materials and their characterization are presented to enable the student with materials science and to acquaint the student with the super conductivity property etc.
4 Understanding of dielectric properties and the usage of materials in engineering applications. Introduced the basics of nano world and the various applications that are presently marketed are discussed with XRD and Transmission electron microscope (TEM).

LEARNIG OUT COMES: The students will understand:

i. The principles of quantum mechanics and the electron theory of metals and their band theory.
ii. Energy band formation and classification of solids & devices based on interaction of light junction diodes.
iii. Classification of Magnetic materials, characterization and their properties. Critical parameters of superconducting materials and applications.
iv. Various types of polarizations; Nano scale materials, properties & applications.

UNIT-I

Principles of Quantum Mechanics: de Broglie's concept of matter waves, Davisson and Germer experiment, Heisenberg's uncertainty principle-experimental verification, time independent Schrodinger's wave equation, physical significance of the wave function, particle in a box (one dimensional).

Electron Theory of metals: Failures of Classical free electron theory and quantum free electron theory(qualitative).

Band theory of Solids: Bloch theorem (Qualitative), Kronig-Penney model (Qualitative treatment), effective mass of electron.

UNIT-II

Semiconductor Physics: Energy band formation in solids, Classification of solids into metals, semiconductors and insulators, intrinsic & extrinsic semiconductors, density of states, intrinsic semiconductor carrier concentration, Hall effect and its uses.

Optoelectronic devices: Photo diode, LED,LCD and solar cell (qualitative treatment).

UNIT-III

Magnetic Materials: Introduction,orbital magnetic moment of an electron, Bohr magneton, classification of dia, para and ferro magnetic materials on the basis of magnetic moment, Hysteresis curve, soft and hard magnetic materials, Ferrites and their applications.

Superconductivity: Introduction, critical parameters (T_c, H_c, I_c), Meissner effect, types of superconductors, entropy, specific heat, energy gap and isotope effect, BCS Theory(in brief), applications of superconductors, high T_c superconductors(qualitative).

UNIT–IV

Dielectric Materials: Fundamental definitions: Electric dipole moment, polarization vector, polarizability, electric displacement, dielectric constant and electric susceptibility. Types of polarizations - Electric and ionic polarizations, internal fields in solids(Lorentz method), Clausius-Mossotti equation, Frequency dependence of polarization, Ferroelectrics and their applications.

Nano Technology : Basic Concepts of Nanotechnology, nano scale, introduction to nano materials, surface to volume ratio, fabrication of nano materials (sol-gel and chemical vapour deposition methods), applications of nano materials. XRD, Transmission Electron Microscope(TEM).

Text Books

1. Applied Physics- P. K. Palanisamy, Scitech Publications.
2. Materials Science - M.Arumugam, Anuradha Publications, Chennai, 5th Edition , 2006.

Reference Books

1. Materials science – M. Vijaya and G. Rangarajan, TMH, New Delhi
2. Solid state physics by A. J. Dekkar
3. Physics of atom – Wehr and Richards.
4. Engineering Physics – B. K. Pandey & S. Chaturvedi, Cengage Learning India Pvt. Ltd., Delhi.

Web References:

http://nptel.iitm.ac.in/courses/115104043/1
http://people.seas.harvard.edu/~jones/ap216/lectures/lectures.html
http://galileo.phys.virginia.edu/classes/252/home.html

Course relevant website : www.rvrjcce.ac.in/moodle/first year/2011-12/engineeringphysics

ChE 123 ANALYTICAL CHEMISTRY

(Only for Chemical Engineering Branch)

Lectures : 3 periods / week — *Sessional Marks : 40*
Tutorials : 1 period / week — *Semester End Exam Marks : 60*
Semester End Exam: 3 hrs — *Credits : **3***

Course Objectives:

1 To have a basic idea in analysis both qualitatively and quantitatively.
2 To acquire knowledge regarding errors, various expression methods and conventional analytical methods.
3 Preliminary understanding of various analytical methods like Spectroscopy and chromatography.
4 Understanding and practical application of Atomic absorption spectroscopy, Flame photometry and Thermal analysis.

Course Outcomes:

i. Able to understand the basics of qualitative and quantitative analysis
ii. Student will have the knowledge relating Errors, Mean, Median, Mean deviation, Standard deviation etc
iii. Concepts learned by Students on various Instrumental analytical methods like UV-Visible, IR, NMR, Atomic absorption, Flame photometry are useful for their future studies and research
iv. Student can acquire the knowledge on Chromatography and its various types, including modern method like HPLC.

UNIT-I

Introduction to Analytical Chemistry

Types of Analytical Methods-Chemical and Instrumental Methods-Importance in Qualitative and Quantitative Analysis -Advantages and Limitations.

Evaluation of Analytical Data

Significant Figures and its importance, Errors-Types and minimizing methods, Accuracy and Precision-Expressing methods- Mean, Median, Mean Deviation, Standard Deviation and Confidence Limit, Method of Least Squares.

Chemical Methods

Conductometric titrations (Acid-base titrations), Potentiometric titrations (Redox titrations- Fe(II)vs$K_2Cr_2O_7$)

UNIT-II

Instrumental Methods

Beer-Lambert's law: UV-Visible, IR, NMR and Mass spectroscopy-Principle and Instrumentation (block diagram only), General Applications.

UNIT-III

Atomic absorption spectroscopy-Principle and Instrumentation (block diagram only)-Estimation of Nickel by atomic absorption spectroscopy.

Estimation of iron by colorimetric analysis - Flame photometry - Principle and Instrumentation (block diagram only) - Estimation of sodium by flame photometry

Thermogravimetric analysis and Differential Thermal analysis: Principle, Instrumentation and application ($CuSO_4.5H_2O$ and $CaC_2O_4.H_2O$), Differential Scanning Calorimetery (DSC)-Technique and application to Phenacitin.

UNIT-IV

Chromatographic Methods

Various Chromatographic methods-Column, Thin Layer, Paper, Gas, High Performance Liquid Chromatography (Principle, Stationary phase, eluting solvent, mobile phase, pumps and detectors), Separation of Cu, Co and Ni by paper chromatography- Separation of amino acids.

Text Books

1 B. K. Sharma, Instrumental methods of chemical analysis, 25th Edition, 2006, Goel Publishing house, Meerut.

2 H. Kaur, Instrumental methods of chemical analysis, 6th edition, 2009, Pragathi Prakashan, Meerut

Reference books:

1. Douglas A. Skoog and Donald M. West, F.J. Holler, Fundamentals of Analytical Chemistry, 7th edition, Harcourt College Publishers.

Web references:

http://teaching.shu.ac.uk/hwb/chemistry/tutorials/

http://bheem.hubpages.com/hub/HPLC-theory-tutorial

www.dur.ac.uk/n.r.cameron/Assets/.../DSC%20presentation.ppt

http://www.nitk.ac.in/assets/files/MetMat/Dr.AS/DTA.pdf

ChE 124C- PROGRAMMING

(Common to BT/ChE/CE/CSE/IT Branches)

Lectures : 4 periods / week	*Sessional Marks : 40*
Tutorials : 1 period / week	*Semester end Exam Marks : 60*
Semester end Exam 3 hrs	*Credits : **4***

Course Objectives:

1 Be familiar with computer software and hardware components, how they interact and its block diagram.
2 Understand the basic problem-solving process using algorithm, Flow Charts and pseudo-code development.
3 Understand the phases of compilation, from pre-processing through linking and loading. Learn how to customize compilation to produce intermediate files, etc
4 Be well-versed with various conditional and iterative structures and should be able to use them effectively for efficient programming.
5 Able to recognize the need for arrays and develop thorough knowledge on the concept of numerical and character arrays and get a better handle on multi-dimensional arrays, pointers, Learn to effectively use pointers for Dynamic memory allocation.
6 Learn to use structures and unions to create custom data types in C.
7 Have basics in File Operations
8 Have sound theoretical and practical knowledge in C .

Course Outcomes:

i. Thorough understanding of basic components of a computer and their operations.
ii. The ability to be equipped with the basic problem-solving skills using algorithm, flow charts and pseudo-code.
iii. Thorough knowledge about various phases of compilation, from preprocessing through linking and loading. Learn how to customize compilation to produce intermediate files, etc.
iv. The ability to use the control structures effectively to write efficient programs.
v. Sound knowledge regarding the numerical and character arrays
vi. Profound skills to develop various user-defined string handling functions which mimic the built-in string manipulation functions.
vii. Skills to control program's memory consumption by dynamically allocating and freeing memory as needed.
viii. The ability to use structures and unions and develop various user-defined data types in C.
ix. The basic knowledge to work with File I/O and perform various operations on sequential and random access files, including reading and writing text and binary data.
x. Have sound theoretical and practical knowledge in C and could effectively use their skills to develop programs for complex applications.

UNIT–I

Introduction: Computer Fundamentals: Computer & it's Components, Hardware / Software**,** Algorithm, Characterstics of algorithm, Flowchart, Symbols are used in flowchart, history of C, Basic structure of C, C language features.

C Tokens: Character set, Variables, Keywords, Data types and sizes, Type qualifiers, Numeric Constants and their forms of representation, Character Constants, String Constants, Declarations and Initialization of variables.

Operators & Expressions: Arithmetic operators, and expressions, Type-conversion rules, Coercion, Assignment operators and expressions, Increment and decrement operator, Conditional operator, Statements, Preprocessor directives, Input/ Output functions and other library functions. Relational operators and expressions. Boolean operators and expressions.

Programming Exercises for UNIT-I

C-Expressions for algebraic expressions, Evaluation of arithmetic and boolean expressions. Syntactic errors in a given program, Output of a given program, Values of variables at the end of execution of a program fragment, Filling the blanks in *a* given program, Computation of values using scientific and Engineering formulae, Finding the largest of three given numbers.

UNIT–II

Conditional Statements: Blocks, If-Else statement, Else-lf statement and Switch statement.
Iterative Statements: While loop, For loop, Do-While loop, Break, and continue.
Arrays: One - dimensional and character arrays, Two-dimensional numeric arrays.

Programming Exercises for UNIT-II

S numbers in a given range, and Amicable numbers.

UNIT–III

Functions: Function Definition, types of User Defined Functions, Parameter passing mechanisms, and simple recursion.
Scope & extent: Scope rules, Storage Classes, Multi-file compilation.
Pointers: Pointers Arithmetic, Character array of pointers, Dynamic memory allocation, array of Pointer, Pointer to arrays.

Programming Exercises for UNIT-III

Recursive Functions: factorial, GCD(Greatest Common Divisior),Fibonacci; To evaluate the pointer arithmetic expressions; An interactive program to perform Pointers & Functions - Insertion sort, Bubble sort, Linear search Binary search, Computation of Statistical parameters of a given list of numbers, Counting the number of characters, words and lines in a given text, Table of values of f (x,y) varying x and y; Using Storage Classes to implement the multifile compilation; implement the string operations using Dynamic memory allocation functions;

UNIT–IV

Structures: Structures, Array of structures, structures within structures, Pointer to structures, self referential structures, Unions.
Files: File Handling functions, File error handling functions, Command-line arguments.

Programming Exercises for UNIT-IV

Operations on complex numbers, operations on rational number (p/q form), Matrix operations with size of the matrix as a structure; Frequency count of keywords in an input program, Sorting a list of birth records on name and date of birth using File handling functions, Student marks processing, Library records processing - sorting on name, author, Copy one file to another.

Textbook

1. Programming with C (Schaum's Outlines) by Byron Gottfried, Tata Mcgraw-Hill, 2010.
2. Programming with C by K R Venugopal & Sudeep R Prasad, TMH., 1997

Reference books

1. Programming in C by Pradip Dey and Manas Ghosh ,Second Edition,OXFORD
2. 'C' Programming by K.Balaguruswamy, BPB.
3. C Complete Reference, Herbert Sheildt, TMH., 2000

Web references

1. http://lectures-c.blogspot.com/
2. http://www.coronadoenterprises.com/tutorials/c/c_intro.htm
3. http://www.cprogramming.com/tutorial/c/lesson1.html
4. http://vfu.bg/en/e-Learning/Computer-Basics--computer_basics2.pdf
5. http://cprogramminglanguage.net/

ChE 125 INTRODUCTION TO CHEMICAL ENGINEERING

(Only for Chemical Engineering Branch)

Lectures : 4 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs *Credits : **4***

Course Objectives

1. To provide chemical engineering career opportunities and process principles.
2. To provide Basic principles and calculations of chemical engineering; material balances and their applications.
3. To provide basic principles of momentum, heat and mass transfer and equipment.
4. Provide the foundation for Chemical reaction engineering and all subsequent chemical engineering courses

Course Outcomes

i. Understand what chemical engineering is and what careers are possible with a degree in Chemical Engineering

ii. Acquire basic principles of momentum and heat transfer & heat transfer equipment.

iii. Acquire basic principles of mass transfer and equipment.

iv. Understand the reaction kinetics and various types of industrial reactors.

UNIT – I

Introduction:

Definition of Chemical Engineering, unit operations and basic laws

Momentum Transfer:

Nature of a Fluid, viscosity, flow field, conservation of mass and energy, Friction loses in laminar flow through a circular tube, Hagen-Poiseuille equation, Friction losses in turbulent flow, Fanning equation.

UNIT – II

Heat Transfer:

Conduction: Fourier's law, mean area of heat transfer, conduction through a composite plain wall.

Convection: Newton's law of cooling, individual heat transfer coefficients, correlations for calculation of heat transfer coefficients, overall heat transfer coefficients, and logarithmic mean temperature difference.

Radiation: Stefan-Boltzmann law, radiation from the sun.

Heat transfer equipment: Double pipe, shell & tube heat exchangers(description with diagrams).

UNIT – III

Mass Transfer:

Diffusion: Diffusion in different phases, diffusivity, role of concentration difference in diffusion, resistance to diffusion, diffusion in liquids.

Distillation: Relative volatility, flash distillation, differential distillation, steam distillation, fractional distillation, McCabe-Thiele method.

Mass Transfer Equipment: Equipment for Gas-Liquid operations (plate and packed columns: description with diagrams).

UNIT – IV

Chemical kinetics:

Introduction, thermodynamics of reactions, determination of the rate equation, effect of temperature on reaction rate and reactors (description with diagrams)

Text Book:

1. Introduction to Chemical Engineering, S. K. Ghosal, S. K. Sanyal& S. Datta, Tata-McGraw-Hill, New Delhi (2006).

Reference Books:

1. Introduction to Chemical Engineering, S.Pushpavanam, PHI Learning Private Limited,. New Delhi (2012)
2. Unit Operations of Chemical Engineering, Warren L.McCabe, Julian C.Smith, Peter Harriot, 7^{th} edition, McGraw Hill, New Delhi (2008).

ChE 161 CHEMISTRY LABORATORY

(Common to BT/ChE/CE/CSE/IT Branches)

Practicals : 3 periods / week *Sessional Marks : 40*

Semester end Exam Marks : 60

Semesterend Exam : 3 hrs *Credits : **2***

Course Objectives

1 To learn concepts of equivalent weight, molecular weight, normality, molarity, weight and volume percent and to prepare molar solutions of different compounds.

2 To know the methods of determining alkalinity, hardness and chloride ion content of water sample.

3 To know the methods to determine purity of washing soda, percentage of available chlorine in bleaching powder.

4 To know principles and methods involved in using instruments like conductivity bridge, spectrophotometer, pH meter and potentiometer.

Course Outcomes :

i. Students acquire knowledge on equivalent weight, molecular weight, normality, molarity, oxidants and reductants.
ii. Students can prepare solutions of different concentrations.
iii. Students can analyze water for its hardness, alkalinity, chloride ion and iron content.
iv. Student understands the principles behind the development of the instruments suitable for chemical analysis. Later he can use the knowledge in modifying the instruments.

List of Experiments:

1. Estimation of total alkalinity of water sample.
2. Determination of purity of washing soda.
3. Estimation of Chlorides in water sample.
4. Determination of Total Hardness of water sample by EDTA method.
5. Estimation of Mohr's salt-Permanganometry.
6. Estimation of Mohr's salt –Dichrometry.
7. Determination of available chlorine in bleaching powder-Iodometry.
8. Estimation of magnesium using EDTA.
9. Conductometric titration of a strong acid vs strong base.
10. Potentiometric titrations: Ferrous vs. Dichromate.

Demonstration Experiments:

11. pH metric titrations of an acid vs base.
12. Spectrophotometry: Estimation of Mn/Fe.

ChE 162 WORKSHOP

(Common to BT/ChE/CE/CSE/IT Branches)

Practicals : 3 periods / week — *Sessional Marks : 40*

Semester end Exam Marks : 60

Semester end Exam : 3 hrs — *Credits : **2***

Course Objectives:

1 To provide the students hands on experience to make different joints in carpentry with hand tools like jack plane, various chisels & hand saws
2 To provide the students hands on experience to make different joints in welding with tools & equipment like electric arc welding machine, TIG Welding Machine, MIG Welding Machine, hack saws, chipping tools etc.
3 To provide the students hands on experience to make different joints in Sheet metal work with hand tools like snips, stacks, nylon mallets etc.
4 To provide the students hands on experience to make different connections in house wiring with hand tools like cutting pliers ,tester ,lamps& lamp holders etc .

Course outcomes

To familiarize with

i. The Basics of tools and equipment used in Carpentry, Tin Smithy, Welding and House Wiring.
ii. The production of simple models in the above four trades

List of experiments

Minimum four experiments should be conducted from each trade

1. Carpentry

To make the following jobs with hand tools

a) Lap joint
b) Lap Tee joint
c) Dove tail joint
d) Mortise & Tenon joint
e) Cross-Lap joint

2. Welding using electric arc welding process / gas welding.

The following joints to be welded.

a) Lap joint
b) Tee joint
c) Edge joint
d) Butt joint
e) Corner joint

3. Sheet metal operations with hand tools.

a) Rectangular Scoop
b) Rectangular Tray
c) Traingular Tray
d) Pipe Joint
e) Funnel

4. House wiring

a) To connect one lamp with one switch
b) To connect two lamps with one switch
c) To connect a fluorescent tube
d) Stair case wiring
e) Go down wiring

Reference books

1 Kannaiah P. & Narayana K. C., "Manual on Work Shop Practice", SciTech Publications, Chennai, 1999.
2 WorkshopLab Manual , R.V.R. & J.C. College of Engineering , Guntur.

ChE 163 C – PROGRAMMING LABORATORY

(Common to BT/ChE/CE/CSE/IT Branches)

Practicals : 3 periods / week *Sessional Marks : 40*

Semester end Exam Marks : 60

Semester end Exam : 3 hrs *Credits : **2***

Course Objectives:

1 Understand the ANSI C/Turbo C compilers.
2 Be able to develop various menu driven programs using conditional and control flow statements.
3 Be able to effectively use the arrays, strings and pointers in programming.
4 Develop programs using structures, unions and files.
5 Develop 'C' programs for various applications.
6 Be able to participate and succeed in competitive examinations.

Course Outcomes:

i. The understanding ANSI C/ Turbo C compilers.
ii. The ability to develop various menu driven programs like generation of electricity bill, evaluation of series etc.
iii. The ability to develop menu driven for displaying various statistical parameters.
iv. The practical knowledge to write C programs using 1D, 2D and Multi Dimensional arrays.
v. Skills to develop various programs on strings and pointers.
vi. Able to write C programs to develop various applications using structures, unions and Files.
vii. Thorough practical knowledge to develop 'C' programs for various applications.
viii. The capability to participate and succeed in competitive examinations.

List of programs (to be recorded)

1. A program for electricity bill taking different categories of users, different slabs in each category. (Using nested if else statement or Switch statement).

Domestic level Consumption As follows:	
Consumption Units	**Rate of Charges(Rs.)**
0 – 200	0.50 per unit
201 – 400	100 plus 0.65 per unit
401 – 600	230 plus 0.80 per unit
601 and above	390 plus 1.00 per unit
Street level Consumption As follows:	
Consumption Units	**Rate of Charges(Rs.)**
0 – 50	0.50 per unit
100 – 200	50 plus 0.6 per unit
201 – 300	100 plus 0.70 per unit
301 and above	200 plus 1.00 per unit

2. Write a C program to evaluate the following (using loops):
   a. $1 + x^2/2! + x^4 / 4!+$ upto ten terms
   b. $x + x^3/3! + x^5/5!+$ upto 7 digit accuracy
   c. $1+x+x^2/2! +x^3/3!+$……upto n terms
   d. Sum of 1 + 2+ 3 +……..+n

3. A menu driven program to check the number is (using Loops):
   i) Prime or not
   ii) Perfect or Abundant or deficient
   iii) Armstrong or not
   iv) Strong or not

4. A menu driven program to display statistical parameters (using one – dimensional array)
   i) Mean ii) Median iii) Variance iv) Standard deviation

5. A menu driven program with options (**using one -Dimensional array)**
   (i) To insert an element into array
   (ii) To delete an element
   (iii) To print elements
   (iv) To remove duplicates

6. A menu driven program with options (using two dimensional array)
   (i) To compute A+B
   (ii) To compute A x B
   (iii) To find transpose of matrix A
   Where A and B are matrices. Conditions related to size to be tested

7. A menu driven program with options (using Two-dimensional Character arrays)
   (i) To insert a student name
   (ii) To delete a name
   (iii) To sort names in alphabetical order
   (iv) To print list of names

8. A menu driven program (using pointers)
   a. Linear search b. Binary search

9. A menu driven program with options (**using Dynamic memory allocation**)
   a. Bubble sort b. Insertion sort

10. A menu driven program with options (**using Character array of pointers**)
    (i) To insert a student name
    (ii) To delete a name
    (iii) To sort names in alphabetical order
    (iv) To print list of names

11. Write a program to perform the following operations on Complex numbers (**using Structures & pointers):**
    i) Read a Complex number
    ii) Addition of two Rational numbers
    iii) Subtraction of two Complex numbers
    iv) Multiplication of two Complex numbers
    v) Display a Complex number

12. a) Write a C program To copy the one file contents to the another file (**using command line arguments).**
    b) Write a C Program to count the frequencies of words in a given file.

Text book

1. Programming with C (Schaum's Outlines) by Byron Gottfried, Tata Mcgraw-Hill, 2010.
2. Programming with C by K R Venugopal & Sudeep R Prasad, TMH., 1997

Reference books

1. Programming in C by Pradip Dey and Manas Ghosh ,Second Edition,OXFORD
2. 'C' Programming by K.Balaguruswamy, BPB.
3. C Complete Reference, Herbert Sheildt, TMH., 2000

Web references

a. http://cprogramminglanguage.net/
b. http://lectures-c.blogspot.com/
c. http://www.coronadoenterprises.com/tutorials/c/c_intro.htm
d. http://www.cprogramming.com/tutorial/c/lesson1.html
e. http://vfu.bg/en/e-Learning/Computer-Basics--computer_basics2.pdf

ChE 211 COMPUTATIONAL TECHNIQUES

(Common to ChE & ME)

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs — *Credits : **4***

Course Objectives:

1. Focused in partial differential equations and their applications.
2. Chemical Engineering applications are emphasized.
3. Focused on numerical methods for Chemical Engineering.
4. Numerical solution of ordinary differential equations and partial differential equations.

Course Outcomes: After completion of the course, student's possess:

i. Solve first order linear and nonlinear; higher order linear partial differential equations.
ii. Solve the Laplace's equation and Wave equation for a variety of boundary conditions.
iii. Solve nonlinear equations and interpolating the values for the given data of equal and
iv. unequal intervals.
v. Find the numerical solution of ordinary differential equations and partial differential equations.

UNIT–I

Partial Differential Equations: Introduction, Formation of Partial Differential Equations, Solutions of a Partial Differential Equations, Equations solvable by direct integration, Linear equations of the first order, Non-Linear equations of the first order using Charpit's Method, Homogeneous Linear Equations with Constant Coefficients, Rules for finding the Complementary Function, Rules for finding the Particular Integral, Non-Homogeneous Linear Equations.

UNIT–II

Applications of Partial Differential Equations: Introduction, Method of separation of variables, One dimensional wave equation, One dimensional heat equation- steady and unsteady states, Two dimensional heat flow equation- Steady state heat flow –Laplace's equation in Cartesian coordinates.

UNIT–III

Numerical Methods: Solution of Algebraic and Transcendental Equations: Introduction, Newton-Raphson Method, Solution of Linear Simultaneous Equations: Gauss Seidel Iterative Method.

Finite Differences & Interpolation: Introduction, Finite difference operators, Symbolic relations, Differences of a polynomial, Newton's forward and backward interpolation formulae, Interpolation with Unequal intervals: Lagrange's Interpolation, inverse interpolation.

Numerical Differentiation: Finding first and second order Differentials using Newton's formulae.

UNIT–IV

Numerical Integration: Trapezoidal rule, Simpson's one-third rule.

Numerical Solutions of Ordinary Differential Equations (first order): Picard's Method, Euler's Method, Runge-Kutta Method of fourth order, Simultaneous equations (R K method).

Numerical Solutions of Partial Differential Equations: Classification of Partial Differential Equation of second order, Solutions of Laplace's and Poisson's Equations by iteration methods.

Text book:

1. Higher Engineering Mathematics, B.S.Grewal, 40th edition, Khanna publishers, New Delhi, 2007.

Reference books:

1. Advanced Engineering Mathematics by Erwin Kreyszig, Johnwiley & Sons, 8th edition, 2007.
2. A text book of Engineering Mathematics by N.P. Bali, Lakshmi publications, 6th edition, 2003.

ChE 212 ENVIRONMENTAL STUDIES

(Common to all Branches)

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To Create an awareness on various environmental pollution aspects and issues
2. To give a comprehensive insight into natural resources , eco system and bio diversity
3. To educate the ways and means to protect the environment from various types of pollution
4. To impart some fundamental knowledge on human welfare measures and environmental acts
5. To demonstrate the environmental problems like global warming, ozone layer depletion and acid rains.

Course Outcomes

The students are able

i. To define and explain the basic issues concerning the ability of the human community to interact in a sustainable way with the environment.
ii. To describe and discuss the environmental implications of the cycles of biologically important materials through the eco system.
iii. To discuss the benefits of sustaining each of the following resources ; food, health , habitats, energy , water ,air , soil and minerals
iv. To understand the causes, effects and controlling measures of different types of environmental pollutions with some case studies

UNIT-I

Introduction:

Definition, Scope and Importance.

Natural Resources:

Forest Resources: Use and over-exploitation, Deforestation, Mining, dams and their effects on forests and tribal people.

Water Resources: Use and over-utilization of surface and ground water, floods and droughts, Water logging and salinity, Dams – benefits and problems, Conflicts over water.

Energy resources: Energy needs, Renewable and non-renewable energy sources.

Land resources: Land as a resource, land degradation, soil erosion & desertification, Effects of modern agriculture on land resources.

Ecosystems:

Definition, Structure and functions of an Ecosystems, Biogeochemical cycles-water, carbon, nitrogen and water cycles, Types-Forest, Greenland, Desert, Aquaticecosystem.

UNIT-II

Biodiversity and its Conservation:

Definition, Value of biodiversity. Bio-geographical classification of India, India as a mega-diversity nation, Hot-spots of biodiversity, Threats to bio-diversity, Endemic and endangered species of India, Conservation of biodiversity.

.**Environmental Pollution:** Causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, nuclear pollution, Solid waste management.

UNIT-III

Social Issues and Environment:

From unsustainable to sustainable development, Population growth and environment, Green revolution, Rain water harvesting, watershed management, cloud seeding, Resettlement and rehabilitation of people - problems and concerns, Environmental Impact Assessment.

Climate Changes:

Global warming & Green house effect, Acid rain, Ozone layer depletion.

UNIT-IV

Environmental acts:

Prevention and Control of Water pollution & Air Pollution act, Environmental protection act, Wild life protection act, Forest Conservation act.

International Conventions:

Stockholm Conference 1972, Earth Summit 1992. Copenhagen Summit 2009.

Case Studies:

Chipko movement, Narmada Bachao Andolan, Silent Valley Project, Madhura Refinery and Taj Mahal, Chernobyl Nuclear Disaster, Ralegaon Siddhi, Florosis and Bhopal Tragedy.

Field work:

Visit to a local area to document environmental assets – river/ forest/ grassland / hill /mountain.
Study of local environment-common plants, insects, birds.
Study of simple ecosystems – pond, river, hill, slopes etc.
Visits to industries, water treatment plants, effluent treatment plants.

Text Books

1. Environmental Studies, by Dr. Suresh K. Dhameja,1st edition, S.K. Kataria & Sons, Ludhiana.(2010)

Reference Books

1. Environmental studies by Anubha Kaushik and C.P.Kaushik., New Age International Publishers, New Delhi.,3rd Edition (2012)
2. Environmental Studies by T Benny Joseph, 2nd edition Tata McGraw-Hill Publishing Company Limited, New Delhi., (2008)

ChE 213 ELECTRICAL & ELECTRONICS ENGINEERING

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To explain how voltages and currents will be in each and every elements in the circuits for DC as well as AC excitations.
2. To explain basic concepts of electrical machines with operation, control, testing and application.
3. To understand the principle of operation and characterstics of all electronic devices and small signal analysis of transistors.
4. To study the working of various oscillators and electronic devices

Course Outcomes

i. To understand the concept of DC/AC circuits and analyze.
ii. Able to analyze performance of electrical machines in terms of efficiency and their utilizations in different applications.
iii. To know various electronic devices and their operations with their characteristics.
iv. To know the principles of operation of oscillator and electronic measuring devices.

UNIT- I

Basic concept components and Electrical Circuits: The unit of charge, voltage, current, power and energy. Circuit elements, circuit concept, Kirchhoff's voltage law and Kirchhoff's current law applied to simple series and parallel circuits.

Alternating currents: Definition of Peak value, Rms value, Average value, Peak factor and Form factor of Alternate current, Behavior of Resistance, Inductance and Capacitance to Sinusoidal voltage.

Vector and J-notation as applied to the resolution of AC circuit, Vector diagrams, Single-phase series, and Parallel and Series-parallel circuits to sinusoidal excitation. Calculation of Active, Reactive and Complex power and Power factor.

Polyphase circuits: 3-phase supply, star-delta connections, Voltage, Current and Power relationships.

UNIT- II

DC generators and Motors: Constructional features of Dc machines and functions of component parts, Calculation of induced E.M.F, Methods of excitation, Characteristics of shunt, series and compound generators and motors and applications, Torque developed in a motor, Dc 3 point Starter, losses and efficiency calculations, Testing of Dc machines: O.C.C. on Dc shunt generator, Swinburnes test and Brake test on Dc motor.

Transformers: Construction, Principle of Operation, EMF equation, efficiency, O.C. and S.C. test of single phase transformers.

Three-phase induction motors: Construction, Principle of Operation, Production of rotating magnetic field, Theory of slip-ring and squirrel cage induction motors, Torque-slip characteristics.

UNIT- III

Electronic devices: Characteristics of Semiconductor junction Diode Zener diode transistor, JFET, UJT, SCR and their applications.

Power supplies: Half-wave, full-wave rectifiers and Bridge rectifier, with (L and LC) and with out filters, Zener Voltage Regulator and their applications.

Oscillators: Classification, RC phase shift, wien-bridge, Hartley and Colpitts oscillators

UNIT- IV

Electrical and Electronic Measurements: Classification of instruments, construction and Principle of operation of permanent magnetic moving coil, moving iron dynamo meter type wattmeter. Principle of operation of DVMs and CROs.

Transducers: Introduction to transducers principle of operation of LVDT, Thermister Thermo Couple and their applications.

Text Books:

1. Basic Electrical Engineering, B.L.Theraja & A.K.Theraja, Volume – I & II (Unit-I,II,IV)
2. Electronic Devices and Circuits, S Salivahanan, N Suresh Kumar and A Vallavaraj (unit-III), 4thEdition(2012)

References Books:

1. Principles Electrical Engineering, V.K.Mehta & Rohit Mehta, 2ndEdition, S.Chand & Co., New Delhi(2010)
2. Basic Electronics, N.N.Bhargava & Kulasresta, Tata McGraw Hills, New Delhi

ChE214 ORGANIC CHEMISTRY

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives:

1 To study the various factors involved in reactivity of organic compounds and an ability to study the reaction mechanisms and basics of isomerism phenomenon.
2 An ability to explain the stabilities of organic compounds by aromatic character and some substitutions of groups in aromatic compounds.
3 To provide an experience in the study of various organic compounds containing different functional groups and the study of products obtained by the reactants and reagents.
4 To study the acidic and basic nature of various organic compounds and also different types of bio-molecules and their importance in human life.

Course Outcomes:

i. The graduate acquires the knowledge of stability of organic compounds based on their chemical reactivity according to rules.
ii. The graduate can understand the mechanism of different named reactions and able to predict products formed.
iii. The graduate acquires knowledge about the acidic and basis strength of different organic compounds.

UNIT-I

Electron displacements in a molecule: Inductive, mesomeric and electromeric effects, resonance, hyperconjugation. Reaction mechanisms of SN^1, SN^2, E_1 and E_2 reactions. Generation, stability and structure of carbocation, carbanion, carbenes and free radicals. Hydrogen bonding in organic molecules and its effects.

Stereo chemistry: Basics of optical and geometrical isomerisms – Enantiomers, Diastereomers, Meso compounds, Sequence rules- R and S ,E and Z configuration, Keto-enol tautomerism, Conformations of ethane and n- butane.

UNIT-II

Cyclo alkanes: Stability of cycloalkanes, Bayer's Strain theory, Conformation analysis of cyclohexane and di-substituted cyclohexanes.

Alkenes: Preparation by dehydration of alcohols, dehydrohalogenation of alkyl halides (Saytzeff's rule), Addition reactions –Markownikoff's rule and anti-Markownikoff's rule, 1,2-and 1,4-additions in dienes(Diels-Alder reaction).

Benzene: Resonance, aromaticity, Huckel's rule, Molecular Orbital description of aromaticity, Electrophilic aromatic substitution, Mechanism of nitration, Friedal–Crafts alkylation and acylation, Orientation in disubstituted benzenes, activating and de-activating groups, aryl halides and aralkyl halides, anti-aromaticity.

Heterocyclic Compounds: Furan, Thiophene, Pyrrole, Pyridine and Indole, their important derivatives.

UNIT-III

Hydroxy Compounds: Manufacture of alcohol from molasses,phenols–acidity comparison with alcohols–differences between phenols and alcohols.Reactions of phenols–Reimer-Tiemann reaction, Kolbe's reaction and Fries rearrangement.

Carbonyl compounds: Aldehydes and Ketones–Preparation–Grignard reagents, Gattermann reaction. Nucleophilic addition reactions of carbonyl compounds-Cannizaro reaction, Aldol condensation, Perkin reaction, Claisen condensation, Clemmensen reduction, Wolf-Kishner reduction, Pinacol-Pinacolone rearrangement, Deckmann condensation and Haloform reaction.

Carboxylic acids: Acidity, Influence of substituents on acidity, Functional derivatives of carboxylic acids-acid halides, amides, anhydrides and esters.

UNIT-IV

Aliphatic and Aromatic amines: 1^0, 2^0, 3^0 amines-Distinguishing tests, Preparation by Hofmann's degradation of amides, basicity of amines, Diazonium salts-preparation and synthetic importance-Sand Mayer reaction.

Biomolecules: Nomenclature, Classification of Carbohydrates-Amino acids and their classification-Structure and general reactions of Glucose and Fructose and their inter conversions, muta rotation.

Synthesis of anti-bacterial drugs: Sulphanilamide, Sulphapyridine

Synthesis of anti-malarial drugs: Isopentaquine, Chloroquine

Text Books:

1. Text Book of Organic Chemistry, B.S.Bahl and Arun Bahl, 20th Edition (Unit-I,II,and III)(2011)S.Chand & Co., Delhi.
2. Text Book of Organic Chemistry, Vol.2, I.L. Finar, 5th Edition, Pearson education(Unit-IV)(2007).

Reference Books:

1. Text Book of Organic Chemistry, R.T.Morrison and R.N.Boyd, 6th edition, PHI, Delhi.(2008)
2. Principles of Organic Chemistry, M.K. Jain, 9th edition. S. Nagin & Co.
3. Fundamentals of Biochemistry, J.L. Jain.

Web references:

www.chemguide.co.uk/
www.adichemistry.com/
www.research.cm.utexas.edu/nbauld/
www.chem.ucla.edu/harding/tutorials/

ChE 215 CHEMICAL PROCESS CALCULATIONS

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. Understands the stoichiometric approach to chemical reactions.
2. Designs the humidification and dehumidification operations.
3. Comprehends and solves the material balances in a simple flow sheet.
4. Solves the energy balance in simple mixing and with reactions.

Course Outcomes

i. Ability to troubleshoot problems in material flow rate handling in chemical production
ii. Ability to design air flow rates in drying and humidification processes.
iii. Ability to improve yield in chemical production processes.
iv. Ability to accurately calculate requirement of energy inputs.

UNIT-I

Introduction to Chemical Engineering Calculations:

Units and dimensions, density, specific gravity, concepts of mole, mole fraction, weight fraction, basis, stoichiometry, limiting reactant, excess reactant, selectivity, yield.

UNIT-II

Vapour Pressures & Humidity :

Ideal gas law, partial pressure, vapour pressure, Antonie equation, Henry's law, Raoult's law, Binary vapour – liquid equilibrium calculations. Relative humidity, percentage humidity, absolute humidity, dew point, material balances involving condensation and vaporization, humidity charts and their use.

UNIT-III

Material Balances:

Material balances without chemical reaction, material balances with chemical reaction, recycle, bypass, purge, inert, tie component.

UNIT-IV

Energy Balances:

Calculation of enthalpy changes, specific heat capacity, energy balances without chemical reaction, heat of a reaction, energy balances that account for chemical reaction, flame temperature.

Text Book:

1. Basic Principles and Calculations in Chemical Engineering by David M.Himmelblau and James B. Riqqs,7thedition, Prentice Hall India(2003).

Reference Books:

1. Chemical process Principles Part–1, Material and Energy Balances by O.A.Hougen,K.M. Watson, and R.A.Ragatz, 2nd Edition, John Wiley & Sons(2004)
2. Stoichiometry by B. Bhatt and S.Vora, 4th edition, Tata McGraw Hill(2004)
3. Stoichiometry and Process Calculations by K. V. Narayanan and B. Lakshmikutty, Prentice-Hall of India Private Limited, New Delhi.

ChE 216 MOMENTUM TRANSFER

Lectures : 4 periods / week — *Sessional Marks : 40*
Tutorials : 1 period / week — *Semester End Exam Marks : 60*
Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To introduce basis and models for fluids.
2. To provide basis for formulating conservative principles.
3. To provide an understanding about compressible fluids and flow past immersed bodies.
4. To study methods for transporting and measuring of flow in various conduits.

Course Outcomes

i. To apply the concept of hydrostatic equilibrium and to have a knowledge on fluid flow phenomena.
ii. To determine engineering design quantities for laminar and turbulent flows.
iii. To work with compressible fluids, packed bed and fluidized bed columns.
iv. To work with variety of pumps and to estimate pressure losses due to various flow measuring apparatus.

UNIT – I

Basic Concepts:
Units and dimensions, dimensional analysis, similarity, equations of state, material and energy balances.
Fluid Statics:
Nature of fluids, pressure concept, hydrostatic equilibrium, manometers and decanters.
Fluid Flow Phenomena:
Concept of stream lines, stream tubes, velocity field, viscosity, types of fluids, turbulence and its nature, flow in boundary layers, its formation and growth in tubes and on plates.

UNIT – II

Basic Equations of Fluid Flow:
Continuity, momentum and Bernoulli's equations.
Flow of Incompressible Fluids:
Relation between skin friction and wall shear, laminar flow in pipes, Hagen-Poiseuille equation, turbulent flow in pipes, velocity distribution equations, friction factor, flow through channels of non-circular cross section, friction from changes in velocity or direction, flow of liquids in thin layers.

UNIT – III

Flow of Compressible Fluids:
Continuity equation, total energy balance, processes of compressible flow, isentropic flow, adiabatic frictional flow.
Flow Past Immersed Bodies:
Friction in flow through beds of solids, motion of particles through fluids, fluidization, mechanism of fluidization, pressure drop in fluidization, applications of fluidization.

UNIT – IV

Transportation of Fluids:

Pipes, fittings, valves, pumps, fans, blowers, compressors, vacuum pumps, jet ejectors.

Metering of Fluids:

Venturi meter, Orifice meter, Rotameter, Pitot tube, Brief introduction to target meters, Turbine meters, Magnetic meters, Ultrosonic meters, Thermal meters.

Text Book:

1. Unit Operations of Chemical Engineering, Warren L.McCabe, Julian C.Smith, Peter Harriot, 7th Edition, McGraw Hill (2008)

Reference Books:

1. Perry's Chemical Engineers Hand Book, Robert H. Perry, 8th edition, McGraw Hill(2007)
2. Coulson & Richardson's Chemical Engineering, Volume-1, J.F. Richardson, J. H. Harker and J. R. Backhurst, 6th edition, Elsevier(2006)

CHE 251 ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY

Practicals : 3 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs *Credits : 2*

Course Objectives

1. To know different types of power supplies, protecting devices, different types of meters used for AC and DC supplies.
2. How to connect the elements in series and parallel or to connect a network and give supply.
3. How to connect the different meters to measure the different electrical quantities.
4. How to conduct different test on the electrical and electronics equipment.

Course Outcomes

i. Student is able to detect elements, functional groups and structure of unknown organic compound.
ii. Student acquires knowledge which is useful in preparation of different organic compounds.
iii. Student is able to determine physical parameters.
iv. Student is able to purify a given organic compound.

1. Verification of KVL and KCL.
2. Parameters of choke coil.
3. OC and SC Tests on transformer.
4. O.C.C Test on D.C. Shunt Generator
5. Load test on D C Shunt Generator
6. Brake test on D.C. Shunt motor.
7. Swinburnes test on D. C. Shunt machine
8. Load test on Three Phase squirrel - cage induction motor
9. VI Characteristics of Junction diode.
10. VI Characteristics of Zener diode.
11. Zener Diode as Voltage Regulator.
12. Half wave Rectifier and Full wave rectifier.
13. Common Emitter configuration of a Transistor.
14. Characteristics of FET.
15. Characteristics of UJT.

ChE 252 ORGANIC CHEMISTRY LABORATORY

Practicals : 3 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs *Credits : 2*

Course Objectives :

1 To know how various types of reactions can be applied in organic compound preparations.

2 To acquire knowledge about the qualitative analysis of organic compounds.

3 To learn how the yield of an organic compound can be determined.

4 To describe the preparation of suitable derivatives of organic compounds selected for analysis.

5 To apply the basic knowledge about functional groups in identifying the given organic compound.

Course Outcomes :

i. Students would be able to identify the nature and type of the given organic compound.
ii. Students can prepare the required organic compound or derivative and confirm its identity by suitable methods.
iii. Students can prepare solutions of different concentrations.
iv. Student understands the principles behind the development of the instruments suitable for chemical analysis. Later he can use the knowledge in modifying the instruments.

Syllabus:

1) Preparation of Aspirin
2) Preparation of Benzanilide
3) Preparation of m-dinitrobenzene
4) Preparation of Benzoic acid
5) Preparation of Dibromo aniline
6) Preparation of Methyl Orange
7) Preparation of Parabenzoquinone
8) Preparation of Nerolin
9) Detection of Extra elements
10) Analysis of compound - 1
11) Analysis of compound - 2
12) Analysis of compound - 3
13) Analysis of compound - 4
14) Analysis of compound - 5
15) Analysis of compound - 6

16) **Note:** Analysis of organic compound with single functional groups containing phenol, aldehyde, ketone, carboxylic acid, amides, amines, monosaccharides with two derivatives.

ChE 253 MOMENTUM TRANSFER LABORATORY

Practicals : 3 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs — *Credits : 2*

Course Objectives

1. Experimentation, observation and analysis of physical phenomena in Fluid Mechanics.
2. Training students in measurement of the physical properties of fluids
3. Provide experience in collection, analysis, interpretation and presentation of experimental data. Precision analysis and equipment limitations.
4. To measure the frictional losses in laminar and turbulent pipe flows

Course Outcomes

i. Students should be able to collect quality raw data from an operation
ii. Students should be able to compare observed with predicted performance
iii. Students should be able to communicate the results of their analysis effectively in written and oral reports
iv. Students should be able to function effectively in a lab team

1. Determination of Friction factor
2. Determination of Minor losses
3. Orifice meter
4. Venturimeter
5. Open Orifice
6. V-Notch
7. Rectangular Notch
8. Centrifugal Pump Characteristics
9. Reciprocating Pump Characteristics
10. Reynolds Apparatus
11. Bernoulli’s Apparatus
12. Packed Bed
13. Fluidized Bed
14. Pitot Tube
15. Rota meter

ChE 221 PROBABILITY AND COMPLEX ANALYSIS

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives:

1 To develop and implement a prototype of a mathematical assignment to connect Fourier transforms and special functions to real world applications.

2 To introduce the undergraduate students to complex analysis because technology we rely on requires scientists and engineers to understand this topic. Complex analysis is widely used in the fields of science and technology.

3 To introduce students to the algebra and geometry of complex numbers and to the calculus of functions of a complex variable. The emphasis will be on gaining a geometric understanding of complex analysis functions, as well as developing computational skills in employing the powerful tools of complex analysis for solving theoretical and applied problems.

4 To understand the basic concepts of probability and statistical inference, including confidence interval, sampling size and hypothesis testing.

Course Outcomes:

After completion of the course, student's posses:

i. Understand and apply basic concepts of probability including calculating conditionaland un-conditional probabilities.
ii. Understand the basic concepts of statistical inference, including confidence intervals,sample size and hypothesis testing.
iii. Determine analytic function and can find the harmonic conjugate.
iv. Apply Cauchy-Riemann equations and harmonic functions to problems of fluidmechanics, thermodynamics and electromagnetic fields.
v. Integrate the given complex functions and can evaluate the real definite integrals.

UNIT – I

Integral Transforms: Introduction, Definition, Fourier Integral Theorem (without proof), Fourier sine and cosine integrals, Complex form of the Fourier Integral, Fourier Transforms, Fourier sine and cosine transforms.
Complex Analysis: Introduction, Continuity, Cauchy's Riemann equations, Analytic Functions, Harmonic functions, orthogonal system.

UNIT – II

Complex Integration: Cauchy's Integral Theorem, Cauchy's Integral Formula.
Conformal Mapping: Conformal mapping, linear fractional transformations, Special linear fractional transformations, Mapping by other functions.

UNIT – III

Series: Taylor's Series (without proof), Laurent's Series (without proof).
Calculation of residues: Zeroes and Singularities, Calculation of residues, Evaluation of real definite integrals (by applying the residue theorem).

UNIT – IV

Probability and Distributions: Probability and problems related to probability – addition theorem, multiplication theorem, Baye's theorem, Binomial distribution, Poisson distribution, Normal distribution.

Sampling and Inference: Sampling, Testing a Hypothesis, Sampling of Variables – large and small samples (Tests Concerning Means), Chi-Square test: Definition, Goodness of fit.

Text book:

1. Higher Engineering Mathematics, B.S.Grewal, 40th edition, Khanna publishers, New Delhi, 2007.

Reference books:

1. Advanced Engineering Mathematics by Erwin Kreyszig, Johnwiley & Sons, 8th edition, 2007.

ChE 222 APPLIED MECHANICS & MECHANICAL ENGINEERING

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To understand the variations in different type of axial forces & coplanar forces and their reactions support,identify the difference between centriod, centre of mass& gravity to determine them
2. To estimate the thermal stress in a circular bar in normal & tapering diameters and their variations with temperature, determine poisons ratio, bulk modulus& elastic modulus on thick& thon cylinders.
3. To understand about the properties of steam and its behaviour at different pressures and specific volumes, the knowledge regarding the steam generators like boilers, their classification with accessories and mountings.
4. The object is to impact about the drive systems, their classification according to their applications, maximum power transmitted by the belt drives, gears and bearings.

Course Outcomes

i. To understand the variations in different type of axial forces & coplanar forces and their reactions support
ii. To identify the difference between centriod, center of mass& gravity to determine them
iii. To estimate the thermal stress in a circular bar in normal & tapering diameters and their variations with temperature
iv. To determine poisons ratio, bulk modulus& elastic modulus on thick& thon cylinders

UNIT- I

Forces:

Concurrent Forces, Composition and Resolution of coplanar Forces, Equilibrium of Coplaner forces.

Section Properties:

Centre of gravity and Moment of Inertia of simple and composite elements.

UNIT- II

Stress and Strain:

Simple stress and strain, Hooke's Law, factor of safety, thermal stresses, Lateral strain, modules of rigidity, bulk modules, strain energy.

Thin and Thick Cylinders:

Thin and thick circular cylinders subjected to internal and external pressure. Thin and thick cylinders with spherical ends. Lame's theorem and application to thick cylinders.

UNIT- III

Steam:

Generation of steam, Properties of steam, use of steam tables and Mollier chart.

Steam Generators:

Classification – Cochran and Babcock-Wilcox boilers - accessories and mountings, Fluidized Beds.

UNIT- IV

Drives:

Belts, expression for the ratios of tensions on the slack and tight side, power transmitted, V-belts, chain drives.

Gears:

Spur, helical, Bevel gear trains – simple and compound.

Bearings:
Purpose of bearings, slipper bearing, thrust bearing, ball and roller bearings.
Couplings:
Flange, flexible couplings, hooks joint, universal coupling.

Text Books:

1. Strength of Materials, S. Ramamrutham, 17th Edition, Dhanpath Rai Publishers, Delhi (Unit – I, II)(2011)
2. Elements of Mechanical Engineering, Mathur, and Mehta Jain Brothers, Delhi (Unit – III, IV), (2005)

Reference Books:

1. Applied Mechanics & Strength of Materials, R. S. Khurmi, 13th Edition, S. Chand & Co.(1977)
2. Basic Mechanical Engineering, T.J.Prabhu & Others, 1st Edition, Scitech Publishers(2010)

ChE 223 PROFESSIONAL ETHICS AND HUMAN VALUES

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. Be able to demonstrate adeptness of object oriented programming in developing solutions to problems, demonstrating usage of data abstraction, encapsulation and inheritance and skills to become a proficient programmer.
2. Have sound knowledge on objects, their behaviors, relationships and modeled these objects into a functional application that the student will compile, modify, enhance and run.
3. Be able to implement one or more patterns involving realization of an abstract interface and utilization of polymorphism in the solution of problems which can take advantage of dynamic dispatching.
4. Learn other features of the C++ language including templates, exceptions, forms of casting, conversions, covering all features of the language.

Course Outcomes

i. Ability to demonstrate mastery of C++ syntax and semantics.
ii. Ability to demonstrate mastery of fundamental object-oriented programming techniques such as data abstraction, information hiding, encapsulation, inheritance and polymorphism.
iii. Ability to read and modify substantial well-written C++ programs.
iv. Ability to create classes and programs in C++ that are correct, robust and capable of being understood, reused and modified by others.

UNIT-I

Human Values:

Morals, Values and Ethics, Integrity, Work Ethic, Service Learning, Civic Virtue, Respect for Others, Living Peacefully, caring, Sharing, Honesty, Courage, Valuing Time, Co-operation, Commitment, Empathy, Self-Confidence, Character, Spirituality.

UNIT-II

Engineering Ethics:

Senses of Engineering Ethics, Variety of moral issues, Types of inquiry, Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Professions and Professionalism, Professional Ideals and Virtues, Theories about right action, Self-interest, Customs and Religion, Uses of Ethical Theories.

UNIT-III

Engineering as Social Experimentation:

Engineering as Experimentation, Engineers as responsible Experimenters, Codes of Ethics, A Balanced Outlook on Law.

Safety, Responsibility and Rights:

Safety and Risk, Assessment of Safety and Risk, Risk Benefit Analysis and reducing risk.

Workplace rights and responsibilities:

Collegiality and Loyalty, Respect for Authority, Collective Bargaining, Confidentiality, Conflicts of Interest, Occupational Crime, Professional Rights, Employee Rights, Intellectual Property Rights (IPR), Discrimination, Limits on acceptable behavior in large corporation, Organizational responses to offensive behavior & harassment, Industrial Integrity.

UNIT-IV

Global Issues:

Multinational Corporations, Environmental Ethics, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and Advisors, Moral Leadership, Sample Code of Ethics like Indian Institute of Chemical Engineers(IIChE), ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers, India, etc.

Text Book:

1. Professional Ethics & Human Values, K.R. Govindan & S.Senthil Kumar, Anuradha Publications.

Reference Books:

1. Ethics in Engineering Practice & Research by Caroline Whitbeck,2nd edition Elsevier(2011).
2. Ethics in Engineering by Mike Martin and Roland Schinzinger,3rd edition, McGraw Hill. New York (2012).
3. Professional Ethics& Human Values by R.S. Naagarazan, 1st edition,New Age International Publishers(2006)

ChE 224 PROCESS HEAT TRANSFER

Lectures : 4 periods / week — *Sessional Marks : 40*
Tutorials : 1 period / week — *Semester End Exam Marks : 60*
Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. Solve analytically using basic laws and semi-empirical correlations one dimensional steady heat transfer problems for a variety of geometries.
2. Solve transient heat transfer problems using the lumped capacitance method.
3. Solve problems involving heat transfer by convection and acquire a basic understanding of heat transfer operations.
4. Develop the students ability to design or predict the performance of heat exchangers.

Course Outcomes

i. Describe the three modes of heat transfer mathematically and physically..
ii. Estimate the thermal conductivity, convective heat transfer coefficient and emissivity for any application.
iii. Calculate convective heat transfer coefficients for forced, free, phase change problems.
iv. Design or predict the performance of different types of heat exchangers.

UNIT – I

Introduction: Modes of heat transfer, basic laws of heat transfer.
Conduction: Fourier law of heat conduction, steady state one dimensional heat conduction through plane wall, cylindrical wall, spherical wall, composite structures. Critical insulation thickness. Unsteady state heat conduction through infinite slab, infinite long solid cylinder, sphere.

UNIT – II

Convection: Heat exchange equipment, heat flux and heat transfer coefficients, thermal boundary layer, dimensionless numbers in heat transfer and their significance.
Forced Convection: Heat transfer by forced convection inside tubes and ducts in laminar, transition & turbulent flow. Analogy between heat and momentum transfer, Reynold's, Prandtl and Colburn analogies.
Natural convection: Grashoff number, natural convection from vertical and horizontal surfaces.
Heat transfer to liquid metals: Forced convection over exterior surfaces. Heat transfer for tubes in cross flow.

UNIT – III

Heat transfer to fluids with phase change: Heat transfer from condensing vapours; film wise and drop wise condensation, derivation and practical use of Nusselt equation, condensation of super heated vapours, Effect of non-condensable gases on rate of condensation. Heat transfer to boiling liquids; Boiling of saturated liquid, maximum flux and critical temperature drop, minimum flux and film boiling, sub-cooled boiling.
Radiation: Thermal radiation, emission of radiation, absorption of radiation by opaque solids, radiation between surfaces, radiation to semitransparent materials, combined heat transfer by conduction, convection and radiation.

UNIT – IV

Heat-Exchange Equipment: Shell & tube heat exchangers, plate – type exchangers, extended surface equipment, scraped - surface exchangers, condensers and vaporizers, heat transfer in agitated vessels and packed beds.

Evaporation: Types of evaporators. Performance of evaporators; capacity and economy of evaporators, boiling point elevation and Duhring's rule, material and energy balances in single effect evaporator. Multi effect evaporators; methods of feeding, capacity and economy.

Text Book:

1. Unit Operations of Chemical Engineering, Warren L.McCabe, Julian C.Smith, Peter Harriot, 7th edition, McGraw Hill, New Delhi (2008)

Reference Books:

1. Heat Transmission by H. William and Mc Adams, McGraw Hill(1954)
2. Process Heat Transfer by Donald, Q.Kern, McGraw Hill(2001)
3. Process Heat Transfer–Principles and Applications by Robert W Serth, 7th edition, Elsevier Science & Technology Books(2007)

ChE 225 MECHANICAL OPERATIONS

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To provide the students with the terminology of thermodynamics like system, properties, processes, reversibility, equilibrium, phases, components; the relationship between heat and work by understanding the significance of the first law of thermodynamics;
2. To learn how to obtain or to estimate the thermal and volumetric properties of real fluids, the limitations imposed by the second law of thermodynamics on the conversion of heat towork.
3. To learn chemical reaction thermodynamics and its application to homogenous and heterogeneous chemical reactions with multiple components.
4. To learn the applications of energy balances in the analysis of batch, flow, and cyclical processes, including power cycles, refrigeration.

Course Outcomes

i. Students will be able to understand the role and relevance of Chemical Engineering Thermodynamics
ii. Students will be able to Understand and analyze processes such as isothermal
iii. Students will be able to explain the property relation of homogeneous phases
iv. Students will be able to understand and Analyze steam power cycles; refrigeration cycles

UNIT – I

Properties and Handling of Particulate Solids:

Characterization of solid particles: shape and size, mixed particle size analysis, specific surface of mixtures, average particle size, number of particles in mixture, screen analysis and standard screen series, size measurements with fine paticles. Properties of masses of particulate, storage and conveying of solids.

Size Reduction:

Characteristics of comminuted products, energy and power requirements in comminution, crushing laws and work index. Equipment for size reduction; crushers, grinders, ultra fine grinders and cutting machines. Equipment operation; Open circuit and closed circuit operation, energy consumption, size enlargement.

UNIT – II

Mechanical Separations:

Screening, screening equipment; stationary, grizzlying, gyratory, vibrating, revolving screens. Comparison of ideal and actual screens, material balances over screen, Capacity and effectiveness of screens.

Materials Separation:

Magnetic separators, Electro- static separators and froth flotation.

UNIT – III

Filtration:

General consideration, cake filters, centrifugal filters, filter media, filter aids. Principles of Cake filtration: Pressure drop calculations, constant rate filtration, constant pressure filtration. Clarifying filters; liquid clarification, gas cleaning, principle of clarification.

UNIT – IV

Gravity Sedimentation Processes:

Gravity classifiers, sorting classifier; sink and float methods, differential settling methods, clarifiers and thickeners. Centrifugal sedimentation processes; cyclones, hydroclones, centrifugal decanters, jigging and tabling.

Agitation and Mixing Liquids:

Purpose of agitation, agitation vessels, power consumption in agitated vessels. Blending and mixing.

Mixing of Solids:

Measures of mixer performance, mixers for noncohesive solids, mixers of cohesive solids.

Text Book:

1. Unit Operations of Chemical Engineering, Warren,L., McCabe, Julian C.Smith, Peter Harriot, 7th Edition, McGraw Hill(2008).

Reference Books:

1. Chemical Engineering, vol.-II, J.H.Coulson and Richardson,5th edition,Elsevier India (2006).
2. Mechanical Operations for Chemical Engineers, C. M. Narayana and B.C.Bhattacharyya, Khanna Publishers (1992).
3. Perry's Chemical Engineers Hand Book, Perry Rober H, 8th edition, McGraw Hill(2007)

ChE 226 CHEMICAL ENGINEERING THERMODYNAMICS–I

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To provide knowledge on properties of solids, handling, size reduction techniques and screen analysis.
2. To provide the fundamentals of the screening and screening effectiveness.
3. To provide the necessary tools to obtain quantitative solutions for filtration and learn the different types of filteration equipment.
4. To provide knowledge on mixers and agitators required in chemical process industries.

Course Outcomes

i. Understand the properties of solids and different types of size reduction principles.

ii. Analyse the best screening equipment necessary in chemical industries.

iii. Identify the best suitable filteration equipment and design of the filter equipment

iv. Identify the best mixers and agitators in a chemical industry depending on their specific requirements.

UNIT – I

The First Law and other Basic Concepts:

Relevance and scope of chemical engineering thermodynamics, internal energy, first law of thermodynamics, energy balance for closed systems, thermodynamic state and state functions, equilibrium, the phase rule, the reversible process, constant volume and constant pressure processes, enthalpy, heat capacity, mass and energy balances for open systems.

UNIT – II

Volumetric Properties of Pure Fluids:

PVT behavior of pure substances, Virial equations of state, the ideal gas, applications of Virial equations, cubic equations of state, generalized correlations for gases and liquids.

The Second Law of Thermodynamics:

Statements of Second law, heat engines, thermodynamic temperature scales, entropy, entropy and probability, entropy changes of an ideal gas, mathematical statement of second law, entropy balance for open systems, calculation of ideal work and lost work, third law of thermodynamics.

UNIT – III

Thermodynamic Properties of Fluids:

Property relations for homogeneous phases, Maxwell's equations, residual properties, two phase systems, thermodynamic diagrams, generalized property correlations for gases.

Applications of Thermodynamics to Flow Processes:

Thermodynamics of flow processes –duct flow of compressible fluids, Turbines, compression processes**.**

UNIT – IV

Refrigeration and Liquefaction:

Refrigeration, Carnot refrigeration, vapor – compression cycle, choice of refrigerant, absorption, refrigeration, heat pump, liquefaction process.

Text Book:

1. Introduction to Chemical Engineering Thermodynamics by J.M.Smith, H.C.Vannessand M.M. Abbott7th Edition (In SI units), Tata McGraw Hill(2009).

Reference Books:

1. Chemical Engineering Thermodynamics by T.E. Daubert, McGraw Hill(1985).
2. Chemical Engineering Thermodynamics by Y.V.C.Rao, University Press(1997).
3. A textbook of Chemical Engineering Thermodynamics by K.V. Narayana, PHI(2009)

ChE 261 MECHANICAL OPERATIONS LABORATORY

Practicals : 3 periods / week — *Sessional Marks : 40*

University Exam Marks : 60

University Exam : 3 hrs — *Credits : **2***

Course Objectives

1. Have sound knowledge on objects, their behaviors, relationships and modeled these objects into a functional application that the student will compile, modify, enhance and run.
2. Be able to implement one or more patterns involving realization of an abstract interface and utilization of polymorphism in the solution of problems which can take advantage of dynamic dispatching.
3. Learn other features of the C++ language including templates, exceptions, forms of casting, conversions, covering all features of the language.
4. Exploit their awareness to understand interrelated subjects and be able to effectively utilize current platforms and tools.

Course Outcomes

i. Understand the properties of solids and different types of size reduction principles
ii. Able to Use the best screening and settling methods in chemical industries.
iii. Able to decide the best separation operation needed in chemical process industries
iv. Able to design a liquid solid separation equipments

1. Sampling by Riffle, Cone & Quartering and Bulk method
2. Grindability index (G.I.) of coal.
3. Ball Mill
4. Sink and float.
5. Optimum time of sieving.
6. Verify the laws of crushing.
7. Effectiveness of a given screen by hand sieving
8. Effectiveness of a given screen using vibrating/Rotap sieving
9. Magnetic separator
10. Terminal settling velocity in viscous medium.
11. Plate & Frame filter press
12. Centrifugal separator.
13. Mixing Index
14. Cyclone separator.

ChE 262 COMPUTATIONAL PROGRAMMING LABORATORY

Practicals : 3 periods / week — *Sessional Marks : 40*

University Exam Marks : 60

University Exam : 3 hrs — *Credits : **2***

Course Objectives

1 To Learn basics in EXCEL/MATLAB skills
2 To solve linear/polynomial regression problems
3 To solve problems involving iterative solutions
4 To successfully employ programming both In EXCEL and MATLAB

Out Comes

Students shall be able to:

i. Successfully employ EXCEL/MATLAB skills
ii. Solve linear/polynomial regression problems
iii. Solve problems involving iterative solutions
iv. Successfully employ programming both In EXCEL and MATLAB

1 EXCEL AND MATLAB BASICS: Introduction, Plotting Graphs, Using Built in Functions to Solve Regression and Iterative Solutions, Using Macros, Programming in Excel and MATLAB.

2 Numerical Methods:Roots of algebraic equation; Solution of simultaneous equations; Regression analysis; Interpolation, Extrapolation and Numerical Differentiation; Numerical Integration; Solution of ordinary differential equations.

3 Application of Numerical Methods to SolveChemical Engineering Problems: Material and Energy Balances-Fluid flow operations-Heat transfer and Evaporation-Mass transfer operations-Thermodynamics-Mechanical Operations-Prediction of Properties.

4 Introduction to Aspen Plus

ChE 263 COMMUNICATION SKILLS LABORATORY

Practicals : 3 periods / week *Sessional Marks : 40*

University Exam Marks : 60

University Exam : 3 hrs *Credits : **2***

Course Objectives-

1. To incorporate creativity and innovative thinking in problem solving.
2. Students will be trained to acquire conclusions using well structured and logical reasoning.
3. To select and apply appropriate qualitative and/or quantitative analytical methods and to identify reasonable alternatives.
4. To develop a reasonable line of argument by using valid and reliable evidence, avoiding appeals to the emotions.
5. To bring about an understanding of the importance of interpersonal skills in both professional and personal lives.
6. To extend their abilities to listen effectively in a variety of situations for a variety of purposes.
7. To extend their abilities to: read fluently and confidently a variety of texts for a variety of purposes.
8. Train the students to make inferences from information in a sentence or paragraph, cause and effect logic, functional concepts and context clues.

Course Outcomes-

i. Arrive at objective, well-reasoned decisions in reasonable time.
ii. Understand creativity and blocks to creativity.
iii. The student holds a particular value or belief that now exerts influence on his/her behaviour so that it becomes a characteristic.
iv. Comprehend and use language with accuracy, clarity, and discernment.
v. Students focus on assignments using processes that apply content rather than on lectures and simply acquiring content.
vi. Students express ideas in a non-judgmental environment which encourages synthesis and creative applications.
vii. Problem-solving exercises nurture students' cognitive abilities.
viii. Students will understand and measure the impact deriving from their analyses by knowing their limitations.

1. Analytical Thinking
    - Emotional intelligence, emotional quotient, cognitive skills, analysis and logical thinking, creative thinking and lateral thinking
    - Managing anger, failures, disappointments
    - Positive approach

    <u>Interpersonal Skills / People Skills</u>

2. Behavioral skills - Attitude, self esteem, time management, punctuality, confidence, integrity
    - Case studies
    - Role play
    - Mock press
3. Listening skills – Effective listening
4. News paper reading – Reading aloud

5. Group discussion – Do's and Don'ts, modulation of voice

Text books

1. Listening skills - Shrinky Slicy
2. Call centre Stories – Case Studies.

Reference books

1. Kevin Gallagher, Skills Development for Business and Management Students.1st edition, Oxford university press. 2010.
2. Daniel Goleman, Working with Emotional Intelligence (1998) Bantam Books
3. Hari Mohan Prasad &Rajnish Mohan, How to prepare for Group Discussions and Interview, 2nd edition, TMT

ChE 311 MATERIAL TECHNOLOGY

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To provide the background knowledge about the structure and properties of various metallic and nonmetallic materials of construction starting from fundamentals.
2. To develop the understanding of present-day materials demand a thorough knowledge of basic engineering and scientific principles, including crystal structure, crystal imperfections, heat treatment techniques, elastic and plastic behavior.
3. To understand the various types of materials with an emphasis on structure-property relationships and materials selection: metals, polymers and ceramics.
4. To graduate the students who contribute to their profession and society through engineering practice, research and development.

Course Outcomes

i. An ability to apply knowledge of mathematics, physics, chemistry, materials and statistics to identify, formulate and solve the problems encountered in the production or application of a material.
ii. Apply and integrate knowledge from the major elements of the field (structure, properties, processing, and performance) to solve materials selection and design problems.
iii. Use the techniques, skills and modern engineering tools necessary engineering practice.
iv. Apply advanced science (such as chemistry and physics) and engineering principles to materials systems.

UNIT – I

Atomic structure and chemical bonding: Structure of an atom, quantum states, periodic table, Ionization potential, electron affinity and Electro negativity.

Chemical bonding: Types of bonds, Ionic covalent, metallic and secondary bonding, properties and bond characteristics.

Crystal geometry and structure determination geometry of crystals: space lattices, crystal structures, miller indices of crystallographic phases and directions, structure determination by x-ray diffraction, Bragg law, powder method.

Structures of solids and crystal imperfections: crystalline and non-crystalline solids, inorganic solids, ionic solids, cubic systems packing efficiency and co-ordination number.

Crystal imperfections: point, line and surface imperfections.

UNIT – II

Phase diagrams and phase transformations: Constitution of alloys, phase rule, single component systems, two component systems, binary phase diagrams – tie line rule, lever rule, isomorphus, eutectic, eutectoid, peritectic and peritectoid systems with simple examples.

Metal shaping processes and their brief study: Rolling, forging, drawing, extrusion.

Strengthening of metals and alloys: Grain refinement, solid solution strengthening, dispersion strengthening, strain hardening and precipitation hardening.

Heat treatment of steels applied to the materials used in chemical industry: Annealing, normalising, hardening and tempering.

UNIT – III

Elastic behavior of materials Plastic deformation: Mechanism of slip and twinning.
Creep: Mechanism and methods to reduce Creep in materials.
Fracture: Fracture in ductile and brittle materials, Fatigue-Mechanism and preventive methods
Oxidation and corrosion: Basic principle, types of corrosion, various combating methods.

UNIT – IV

Metals and alloys: Types of metals and alloys used in chemical process industry, Criteria of selection of materials of construction in process industry. Brief study of composite materials

Text Book:

1. Material Science and Engineering by V.Raghavan,5th edition, Prentice Hall of India Pvt.Ltd., ,New Delhi (2009)

Reference Books:

1. Material Science and Engineering by R.K.Rajput,3rd edition S.K.Kataria & Sons,, Delhi(2005).
2. Material Science for Engineering by D.Callisters Jr,Weily & Sons, New Delhi (2006)
3. Elements of Material Science and Engineering by Van Vlock, L.H,6th edition., PHI,New Delhi (1989)

ChE 312 MASS TRANSFER OPERATIONS – I

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To impart knowledge on how certain substances undergo the change in composition, change in phases and exhibit the properties according to the changed environment.
2. To learn given a physical description of a system, be able to compute or determine the applicable diffusion and mass transfer coefficients from mathematical models, engineering data, or correlations.
3. To explain the students with the basic principles of mass transfer operations and other separation processes with examples.
4. To describe and illustrate to the students the equipment used in operations involving mass transfer and other separation processes with their advantages and disadvantages.

Course Outcomes

i. An ability to define the basic principles of mass transfer operations and other separation processes.
ii. An ability to apply knowledge of maths and science to problems in mass transfer
iii. An ability to identify the major parts of various mass transfer equipment , conduct experiments and prepare tables and graphs that effectively present experimental results.
iv. An ability to identify the basic techniques for measurement of diffusivity, mass transfer coefficient, evaporation rate, absorption, Sizing of packed and plate columns, humidification and dehumidification, drying rate, Time of drying.

UNIT- I

Molecular Diffusion:

Steady state diffusion into fluids at rest and in laminar flow, continuity equation, Fick's law, diffusion coefficient, diffusion in binary gas mixtures–one component stagnant, equimolar counter diffusion, non-equimolar counter diffusion, estimation of diffusivities in liquids and gases, diffusion in solids.

UNIT- II

Mass transfer coefficient:

Mass transfer into a single phase: notation for mass transfer coefficients for liquids and gases, mass transfer from gas into a flat falling liquid film, Sherwood number, Peclet number, Schmidt number, Reynolds number, mass transfer coefficient correlations for laminar and turbulent flow in circular pipes, film theory, penetration theory, surface renewal theory, analogy between mass, heat and momentum transfer.

Mass transfer between phases: Diffusion on both sides of an interface, relationship of overall mass transfer coefficient with either side mass transfer coefficient

UNIT-III

Equipment for Gas-Liquid Operations:

Gas dispersed: Sparged vessels – diameter of gas bubbles, gas hold up, specific interfacial area, mass transfer coefficient, Tray towers – bubble cap trays

Liquid dispersed: Venturi scrubbers, wetted wall tower, spray tower, packed tower, types of packing, mass transfer coefficient in packed tower.

Humidification:
Vapor-gas mixtures, absolute humidity, dry bulb temperature, relative saturation, percentage saturation, dew point, enthalpy, psychrometric charts, air-water system, wet bulb temperature, Lewis relation, Adiabatic operation – design of water cooling with air, Non-adiabatic operation – evaporative cooling.

UNIT- IV

Drying: Batch drying, rate of batch drying, time of drying, mechanism of batch drying, equipment for batch and continuous drying operations.
Crystallization: Crystal geometry, nucleation, crystal growth, equipment– vacuum crystallizer & draft tube crystallizer.
Ion Exchange: Types of ion exchange, mechanism for rate of ion exchange
Membrane Separations: Mechanism, Membrane modules, dialysis, pervaporation

Text Book:

1. Mass Transfer Operations, Robert E. Treybal, 3rd edition, International Edition, McGraw Hill (1981).

Reference Books:

1. Unit Operations of Chemical Engineering, Warren,L., McCabe, Julian C.Smith, Peter Harriot, 7th Edition, McGraw Hill(2008).
2. Transport process and separation process principles, Christie John Geankoplis, 4th edition, PHI (2009)
3. Separation Process Principles, J D Seader and E J Henly, 2nd Edition, John Wiley & sons (2006).

ChE 313 INORGANIC CHEMICAL TECHNOLOGY

Lectures	*: 3 periods / week*	*Sessional Marks*	*: 40*
Tutorials	*: 1 periods*	*Semester End Exam Marks*	*: 60*
Semester End Exam	*: 3 hrs*	*Credits*	*: **4***

Course Objectives

1. Know various inorganic chemical manufacturing processes.
2. Know the important unit operations of some major inorganic chemical processes.
3. Understand problem solving in chemical processes.
4. Learn how to analyze and evaluate complex industrial processes.

Course Outcomes

i. Demonstrate basic knowledge of chemical concepts & skills in handling chemical materials & equipment.
ii. Demonstrate conceptual knowledge & laboratory proficiency in the area of chemical analysis.
iii. Demonstrate proficiency in the use of analytical instrumentation generally found in the chemical industry.
iv. Exercise safety in the laboratory & adhere to safety, health &environmental regulation.

UNIT – I

Introduction:
Objectives, unit processes and unit operations. General Fundamentals
Water:
Water conditioning and waste water treatment.
Alkali Industries:
Soda ash, caustic soda and chlorine.

UNIT – II

Ceramic industries:
Raw materials and manufacturing process's, refractories.
Cement:
manufacture, special cements
Glass:
Raw materials, manufacture, special glasses
Industrial gases:
Nitrogen, Carbon dioxide, hydrogen and oxygen

UNIT – III

Nitrogen industries:
Synthetic ammonia, urea, other nitrogenous fertilizers, nitric acid.
Phosphate Industries:
Phosphoric Acid, calcium phosphate and super phosphate
Potassium Industries:
Potassium chloride and potassium sulphate.

UNIT – IV

Sulfur and sulfuric acid:
manufacture of sulfur and sulfuric acid.
Hydrochloric acid:
Manufacture of Hydrochloric acid

Aluminum Industries:
Aluminum sulfate and alum
Nuclear industries: Uranium and thorium fission, nuclear fuels

Text Book:

1. Dryden's Outlines of Chemical Technology for 21st Century by M.Gopal Rao and M.Sittig,3rd edition, East West Press(2010).

Reference Books:

1. Shreve's Chemical Process Industries byG.T. Austin, McGraw Hill, 5th edition (1984)
2. A Text Book of Chemical Technology (Volume II), G.N.Panday, Vikas Publishers
3. Chemical Process Technology by Jacob A.Moulijin, MIchie**l** Makkee and Annelies Van Diepen, John Wiley & Sons(2001)

ChE 314 CHEMICAL REACTION ENGINEERING – I

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To provide knowledge on different types of reactions, reaction rate, collection and analysis of reaction rate data to derive rate expressions.
2. To provide knowledge on different kinetic models to analyze the batch reactor data
3. To provide knowledge of different types of reactors (Batch, semi batch, CSTR, PFR) and to derive the design equations of ideal reactors from mole balance.
4. To provide a foundation on deriving rate expressions for series, parallel, reversible reactions and the knowledge about product distribution in multiple reactions, recycle reactors and auto catalytic reactions.

Course Outcomes

i. Analyze kinetic data and determine the rate expressions (reaction order and specific reaction rate) for a reaction.

ii. Derive and solve design equations for batch, semi batch and steady state flow reactors.

iii. Solve appropriate rate expressions for series, parallel and reversible reactions. Understand the performance characteristics and the advantages and disadvantages of major reactor types

iv. Analyze multiple reactions to determine selectivity and yield.

UNIT – I

Overview of Chemical Reaction Engineering:

Thermodynamics, chemical kinetics, classification of reactions, variables affecting the rate of reaction, definition of reaction rate.

Kinetics of homogeneous reactions: Concentration dependent term of rate equation, temperature dependent term for rate equation, searching for a mechanism, predictability of reaction rate from theory.

UNIT – II

Interpretation of Batch Reactor Data:

Constant volume batch reactor, variable volume batch reactor, temperature and reaction rate, search for a rate equation.

UNIT – III

Introduction to Reactor design:

Single ideal Reactor: Ideal batch reactor, space time and space velocity, steady state mixed flow reactor, steady state plug flow reactor, holding time and space time for flow systems.

UNIT – IV

Design for Single Reactions:

Size comparison of single reactors, multiple reactor systems, recycle reactor, autocatalytic reactions.

Design for multiple reactions:

Reactions in parallel, reactions in series, contacting patterns, product distribution.

Text Book:

1. Chemical Reaction Engineering, Octave Levenspiel, 3rd edition, John Wiley & Sons(1998)

Reference Books:

1. Elements of chemical reaction engineering, H.S.Fogler, 4th edition, PHI(2009)
2. Chemical Engineering Kinetics, J.M.Smith, 3rd edition, McGraw Hill (1981).

ChE 315 CHEMICAL ENGINEERING THERMODYNAMICS–II

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course objectives

1. To understand the concept of adiabatic and theoretical flame temperatures and to explain the effect of temperature on the enthalpy change of a chemical reaction.
2. To introduce the concepts of chemical potential , partial properties ,property relations for ideal gases, fugacity excess properties and to develop the theoretical foundation for applications of thermodynamics to gas mixtures and liquid solutions .
3. To perform the phase equilibrium calculations using simple models for VLE, Gamma/Phi approach and equation of state approach.
4. To determine the effect of temperature, pressure and initial composition on the equilibrium conversion of chemical reactions.

Course Outcomes

i. Students will be able to perceive the principles of heat effects of industrial reactions and temperature dependency of heat of reaction.
ii. Students will be able to understand the procedures for estimating the thermodynamic properties and perform thermodynamic calculations oriented to the analysis and design of chemical processes
iii. Students will be able to understand how to choose a reasonable model to estimate the physical properties of a substance or a mixture of substances
iv. Students will be able to estimate the equilibrium compositions of mixtures under phase and chemical-reaction equilibria.

UNIT – I

Heat effects:

Sensible heat effects, temperature dependence of heat capacity, heat effects accompanying the phase changes, the standard heat of reaction, formation and combustion, temperature dependence of ΔH^0, heat effects of industrial reactions.

UNIT – II

Solution thermodynamics:

Fundamental property relation, chemical potential, criterion for phase equilibria, partial properties, ideal gas mixtures, fugacity and fugacity coefficients, generalized correlations for fugacity coefficients, the ideal solution, excess properties.

Solution Thermodynamics Applications:

Liquid phase properties from VLE data, activity coefficient, excess Gibb's energy, Gibb's Duhem equation, data reduction, thermodynamic consistency, models for excess Gibb's energy, property changes of mixing, heat effects of mixing processes.

UNIT – III

Vapor-Liquid Equilibrium:

Nature of equilibrium, Phase rule, Duhem's Theorem, VLE: Qualitative behavior, simple models for VLE, VLE, modified Raoult's Law, VLE from k – values correlations.

Phase Equilibrium:

The Gamma / Phi formulation of VLE, VLE from cubic equations of state, equilibrium and stability, LLE, VLLE, SLE, SVE.

UNIT – IV

Chemical Reaction Equilibrium:

The reaction coordinate, application of equilibrium criteria to chemical reactions, the standard Gibbs-Energy change and the equilibrium constant, effect of temperature on the equilibrium constant, evaluation of equilibrium constants, relation of equilibrium constants to composition, equilibrium conversions for single reactions, phase rule and Duhem's theorem for reacting systems, multireaction equilibria.

Text Book:

1. Introduction to Chemical Engineering Thermodynamics by J.M.Smith, H.C.Vannessand M.M. Abbott7thEdition (In SI units), Tata McGraw Hill(2009).

Reference Books:

1. Chemical Engineering Thermodynamics by T.E. Daubert, McGraw Hill(1985).
2. Chemical Engineering Thermodynamics by Y.V.C.Rao, University Press(1997).
3. A textbook of Chemical Engineering Thermodynamics by K.V. Narayana, PHI(2009)

ChE 316 PROCESS INSTRUMENTATION

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To provide the basic principles of primary sensing elements, transducers, transmitters, indicators and recorders in process industries.
2. To provide knowledge on types of instruments used for measurement of temperature
3. To provide knowledge on the choice of measuring instruments and statistical background of the methods and limitations of measurement techniques for pressure and vacuum.
4. To provide an understanding on instrumental methods for composition analysis

Course Outcomes

i. Understand the basic measurement principles of the physical quantities of interest.
ii. Understand principles involved in the measurement and control of industrial processes
iii. Familiar with instruments and devices available for designing process control system
iv. Learn various sensors used for measurement of process parameters such as temperature, flow, pressure, level etc. covering principle of operation, specifications etc.

UNIT – I

Qualities of Measurement:

Elements of instruments, static characteristics, dynamic characteristics, dynamic response of 1^{st} order, and 2^{nd} order systems.

Process Instrumentation:

Recording instruments, indicating and signaling instruments, transmission of instrument readings, the control center, instrumentation diagram, diagrammatic control center layout, process analysis.

UNIT – II

Temperature measurement:

Expansion thermometers, thermo- electric temperature measurement, Resistance thermometers, radiation temperature measurement.

UNIT – III

Pressure, Level and flow measuring instruments:

Measurement of pressure and vacuum, measurement of head and level, Flow metering.

UNIT – IV

Methods for composition analysis:

Absorption spectroscopy, Atomic Absorption Spectroscopy, emission spectroscopy, mass spectroscopy, color measurement by spectrometers, gas analysis by thermal conductivity, refractometer, Gas chromatography, High Performance Liquid Chromatography.

Text Book:

1. Industrial Instrumentation by Donald P. Eckman, 1^{st} edition, Wiley Eastern Ltd.(2004)

Reference Books:

1. Principles of Industrial Instruments by Patrenabis, 3^{rd} edition,Tata McGraw Hill(2010)
2. Instrumental Methods of Chemical Analysis by R. Gurudeep, Chatwal andSham K. Anand, Himalaya Publishing house(2007).
3. Introduction to Chemical Analysis by Robert D. Braun, 2^{nd} edition, McGraw Hill(2012).

ChE351 PROCESS HEAT TRANSFER LABORATORY

Practicals : 3 periods / week *Sessional Marks : 40*

University Exam Marks : 60

University Exam : 3 hrs *Credits : **2***

Course Objectives

1. To apply the concepts of heat transfer, fluid dynamics and thermodynamics to the design and operation of heat transfer experiments.
2. To develop practical understanding of common heat transfer equipments.
3. To develop skills in experimental design and troubleshooting.
4. To develop skills in data collection, analysis and interpretation.

Course Outcomes

i. Students should be able to collect quality raw data from an operation
ii. Students should be able to compare observed with predicted performance
iii. Students should be able to communicate the results of their analysis effectively in written and oral reports
iv. Students should be able to function effectively in a lab team

1. Thermal conductivity of a metal rod
2. Natural convective heat transfer coefficient on a vertical surface
3. Temperature distribution along a pin fin under natural convection and forced convection
4. Heat transfer coefficient in forced convection.
5. Overall heat transfer coefficient for a fluid in parallel and counter flow in double pipe heat exchanger.
6. Stefan- Boltzmann constant.
7. Emissivity of a metal rod.
8. Heat transfer coefficient for a fluid through a lagged pipe.
9. Temperature distribution through composite walls.
10. Boiling heat transfer
11. Overall heat transfer coefficient for a fluid flow in a shell and tube heat exchanger.
12. Unsteady state heat transfer in a rod.
13. Overall Heat transfer coefficient for a fluid flow in agitated vessels.
14. Overall Heat transfer coefficient for a fluid flow in a jacketed kettle.
15. Rate of evaporation in single effect evaporator.
16. Heat flux for a fluid flow through heat pipe.
17. Heat transfer coefficient in drop wise & film type condensation (Demonstration).

ChE 352 MASS TRANSFER OPERATIONS LABORATORY-I

Practicals : 3 periods / week — *Sessional Marks : 40*

University Exam Marks : 60

University Exam : 3 hrs — *Credits : **2***

Course Objectives

1. Determines experimentally the diffusion coefficient in binary systems of liquids and gases
2. Understands surface evaporation in stationary and moving surfaces
3. Studies dynamics of single drop hydrodynamics and perforated plate tower.
4. Determines the kinetic and equilibrium parameters of drying of wet solids

Course Outcomes

i. Ability to design experiments to obtain mass transfer coefficients like diffusion coefficient in liquids and gases.
ii. Ability to troubleshoot problems in liquid – liquid extraction perforated towers or spray towers.
iii. Ability to calculate drying rates of wet solids and volatile chemical spills.
iv. Ability to design gas – liquid absorbtion columns.

1. Diffusivity coefficient for liquid-liquid system.
2. Diffusivity coefficient for given vapor-Gas system
3. Mass transfer coefficient for Surface evaporation of a liquid
4. Hydrodynamics of single drop extraction
5. Hydrodynamics of perforated plate tower
6. Hydrodynamics in a spray column
7. Mass transfer coefficient in a perforated plate tower
8. Mass transfer coefficient in a wetted wall tower
9. Mass transfer coefficient in a Packed bed absorption
10. Batch drying.
11. Humidification
12. Dehumidification
13. Solid dissolution
14. Venturi scrubbers.

CHE 353 ADVANCED COMMUNICATION SKILLS LABORATORY

Practicals : 3 periods / week — *Sessional Marks : 40*

University Exam Marks : 60

University Exam : 3 hrs — *Credits : **2***

Course objectives:

1 To expose the students to a variety of learner-friendly methods of language learning
2 To train the students to use language effectively to face interviews, group discussion and public speaking
3 To initiate the students to speak better
4 To expose the students to corporate etiquette
5 To develop proficiency in presentation
6 To train the students in speech writing
7 To develop employability skills
8 To develop civic sense and concern to the society

Course outcomes:

i. The student develops a variety of learner –friendly methods of language learning
ii. The students are capable of using language effectively to face interviews, group discussion and public speaking
iii. The students develop confidence level to speak better
iv. The students learn the corporate etiquettes
v. They are proficient in presentations
vi. The students develop felicity of expression
vii. The students develop employability skills
viii. The students turn out to be responsible and become service minded.

1. Employability skills – Interview skills
2. Critical appreciation
    - Poems
    - Short stories
    - Life stories
    - Excerpts of great personalities
3. Film clippings
4. Briefing and explaining
5. Board room discussions
6. Presentations
7. Mini Projects

    Assignment on – Visiting orphanages, old age homes, hospitals, bank, traffic etc.

    ,

8. Speech writing

- Acceptance speech
- Hosting
- Vote of thanks
- Introducing people on the stage
- Farewell speech
- Compeering
- Commentary
- Thank you speech

Books

1. Soft skills for Everyone – Jeff Butterfield
   Cengage learning ,First print 2010, Third Indian Reprint 2012
2. Personality Development and Soft Skills - Barun K.Mitra.Oxford University Press , First published 2011.

ChE 321 INDUSTRIAL POLLUTION CONTROL

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To provide the student knowledge on environmental impacts of human activities and understanding of the factors which determine how emission legislation is approached and of relevant legislation.
2. To provide knowledge of the unit operations and unit processes which can be used for emission abatement
3. To provide knowledge on the sources, affects and control measures of air pollution.
4. To provide knowledge of the concepts of waste minimization, clean technology and green chemistry.

Course Outcomes

i. Describe and quantify health risks due to toxic chemicals.
ii. Perform basic mass balances, formulate flow sheets and carry out preliminary sizing for biological unit operations for pollutant removal including activated sludge and trickling filters.
iii. Describe mobile and stationary sources of air pollutants and their removal processes from the environment
iv. Define hierarchies for pollution prevention. Discuss concepts and examples of clean technology, waste minimization

UNIT – I

Introduction:

Man & Environment, Types of Pollution, Pollution control aspects.

Industrial Pollution emissions & Indian Standards:

Industrial emissions-Liquids, Gases, Environmental Legislation, Water quality management in India, Air Act -1981.

UNIT – II

Water Pollution:

Removal of BOD, Biological oxidation, Biological oxidation units, Anaerobic treatment, Removal of Chromium, Removal of Mercury, Removal of Ammonia, Urea, Treatment of Phenallic effluents.

UNIT – III

Air Pollution:

Removal of Particulate matter, Removal of Sulfur dioxide, Removal of Oxides of Nitrogen, Removal of Organic vapors from Effluent.

UNIT – IV

Pollution control in selected process Industries:

General considerations, pollution control aspects of Fertilizer industries, Pollution control in Petroleum Refineries and Petrochemical units, Pollution control in Pulp and Paper Industries.

Text Book:

1. Pollution control in Process Industries by S.P .Mahajan, Tata McGraw Hill Publishing Company Ltd, New Delhi(1985)

Reference Books:

1. Environmental Pollution Control Engineering byC.S.Rao, 2nd edition, New Age International Ltd(2006).
2. Air pollution by M.N.Rao and H.V.N.Rao, Tata McGrawhill(1989).
3. Industrial Water Pollution control by W.Wesley Eckenfelder Jr.,3rd edition,Tata McGrawHill(1999).

ChE 322 MASS TRANSFER OPERATIONS–II

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. Understand the concept of vapor liquid equilibrium
2. Given specifications for a feed and desired product streams, select a separation method and design a process utilizing that method to achieve the desired products.
3. For a proposed separation process, apply the fundamentals of mass transfer and engineering correlations to unit-level design of process equipment.
4. To choose an appropriate separation technology for a particular application

Course Outcomes

i. An ability to understand the basic concepts of different mass transfer operations, its governing laws.
ii. An ability to understand the importance of mass transfer phenomena in the design of Process equipment.
iii. An ability to apply mass transfer fundamentals to calculate rates of mass transfer for practical situations and to identify rate-limiting processes
iv. An ability to use Excel, Polymath and ASPEN software packages to design and analyze separation equipment and transfer phenomena.

UNIT-I

Distillation:

Principles of Vapor-Liquid Equilibrium for binary system, relative volatility, flash distillation, differential distillation, continuous rectification, McCabe-Thiele method, Tray efficiency, Ponchon Savarit method, azeotropes, azeotropic distillation, extractive distillation and steam distillation

UNIT-II

Liquid-Liquid Extraction:

Choice of Solvent, Ternary equilibrium, tie line, calculations for insoluble liquids – single stage, multi stage cross current and counter current operations, equipment – mixer-settler, perforated plate tower, rotating disk contactor, pulsed columns

UNIT-III

Gas Absorption:

Solubility of gases in liquids, ideal liquid solutions, non-ideal liquid solutions, choice of solvent for absorption, single component absorption material balance – counter current multi stage operations in plate tower, absorption of one component in packed tower, HETP concept.

UNIT-IV

Leaching:

Preparation of solids, percolation tanks, Shanks system, filter press leaching, agitated vessels, Rotocel, Kennedy extractor, Bollman extractor, single stage leaching calculation

Adsorption:

Types of adsorption – physical adsorption and chemisorption, nature of adsorbents, types of industrial adsorbents, types of adsorption isotherms for vapors, Freundlich isotherm for dilute solutions, calculations for single stage, multi stage cross current and multi stage counter current operation.

Text Book:

1. Mass Transfer Operations, Robert E. Treybal, 3rdEdition, International Edition, McGraw Hill (1981).

Reference Books:

1. Transport process and separation process principles, Christie John Geankoplis, 4th edition, PHI (2009)
2. Separation Process Principles, J D Seader and E J Henly, 2nd Edition, John Wiley & sons (2006).
3. Principles of Mass Transfer and Separation Process, Binay K. Dutta, PHI, New Delhi(2007).

ChE 323 ORGANIC CHEMICAL TECHNOLOGY

Lectures	*: 3 periods / week*	*Sessional Marks*	*: 40*
Tutorials	*: 1 period*	*Semester End Exam Marks*	*: 60*
Semester End Exam	*: 3 hrs*	*Credits*	*: **4***

Course Objectives

1. To instill students with an appreciation of the fundamental principles and concepts of chemistry to solve practical problems.
2. To provide students with the fundamental aspects of chemical process technology and professional knowledge in selected areas of chemical technology.
3. To develop students' appreciation of the environmental, techno-economics and management problems associated with the chemical industry.
4. To induce the development of students' independent, analytical and creative thinking.

Course Outcomes

i. Be able to demonstrate knowledge and understanding on fundamental principles of chemistry and chemical technology and on contemporary applications;
ii. Be able to design and conduct experiments, as well as critically analyze and interpret experiment results;
iii. Be able to identify, formulate and solve problems in chemical technology and related fields;
iv. Be able to specify, modify and design a component, process or system to meet the needs of trade;

UNIT – I

Rubbers:
Classification, natural rubber, monomers of synthetic rubber, manufacture of SBR.
Synthetic Fibers:
Classification, manufacture of nylon 6,6, polyester fiber, viscose rayon fiber.
Petroleum Refining:
Constituents of petroleum, Products of Refining, petroleum refining process- Cracking, reforming, polymerization, alkylation, isomerization, hydro-cracking, esterification and hydration.

UNIT – II

Plastic industry:
Classification of plastics, outlines and manufacture of phenols, formaldehyde, vinyl chloride and vinyl acetate, manufacture of phenol-formaldehyde resin and polyvinyl resins.
Paints and Varnishes:
Constituents of paints and varnishes and their manufacturing procedures.

UNIT – III

Sugar and starch industry:
Manufacture of cane sugar, production of starch from maize.
Fermentation industry:
manufacture of alcohol from molasses, manufacture of penicillin.
Pulp and paper industry:
Methods of pulping, production of sulphate and sulphite pulp, production of paper–wet process. Cellulose and its derivatives.

UNIT – IV

Oils, soaps and detergents:
Definitions, constitution of oils, extraction and expression of vegetable oils, refining and hydrogenation of oils, continuous process for the production of fatty acids and soap, production of detergents.

Text Book:

1. Dryden's Outlines of Chemical Technology for 21st Century by M.Gopal Rao and M.Sittig,3rd edition, East West Press (2010).

Reference Books:

1. Shreve's Chemical Process Industries byG.T. Austin, McGraw Hill, 5th edition (1984)
2. Text Book of Chemical Technology (Volume II), G.N.Panday, Vikas Publishers(2000)
3. Chemical Process Technology by Jacob A.Moulijin, MIchiel Makkee and Annelies Van Diepen, John Wiley & Sons(2001)

ChE 324 CHEMICAL REACTION ENGINEERING – II

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To provide the knowledge on thermal characteristics of various reactions.
2. To accomplish knowledge on non-ideal reactors.
3. To provide the knowledge on kinetics of fluid particle reacting systems along with describing the different kinetic models for non catalytic fluid particle reactions.
4. To Emphasis on heterogeneous reacting system design with its catalysis.

Course Outcomes

i. Able to explain the thermal characteristics and design of adiabatic reactors for single and multiple reactions.
ii. Able to apply the non-ideality concepts in the reacting system for better understanding the deviations from ideality and to use the tanks-in-series model and the dispersion model for a first-order reaction, to solve
iii. Able to develop the progressive conversion model and shrinking core model for explaining the fluid particle reaction
iv. Able to understand the principles and mechanism involved in heterogeneous catalysis and analyze the data of heterogeneous catalytic reactions.

UNIT – I

Temperature and pressure effects:

Single reaction and multiple reactions

Thermal characteristics and design of reactors:

Batch reactor, PFR, CSTR under adiabatic conditions for first order irreversible reactions

UNIT – II

Non-ideal reactors:

Residence time distribution of fluid in vessel, measurement of the RTD (Tracer Techniques), Characteristics of the RTD, RTD in ideal reactors, Reactor modeling with the RTD: Segregation model, the Tanks in series model, the Dispersion (plug flow) model for closed vessel. Concept of micro and macro mixing

UNIT – III

Introduction to design for heterogeneous reacting systems:

Rate equations for heterogeneous reactions, contacting patterns for two phase systems.

Fluid particle reactions: Selection of a model, un-reacted core model for spherical particles, rate of reaction for shrinking spherical particles, determination of rate controlling steps.

UNIT – IV

Heterogeneous catalysis:

Catalyst properties, Estimation of surface area, pore volume, physical adsorption and chemisorptions, adsorption isotherms-Derivations of rate equations for various mechanisms with rate limiting steps(Adsorption, surface reactions, desorption controlling etc.,) Data analysis for heterogeneous catalytic reactors, isothermal packed bed (PFR) reactor design, Diffusion and reaction within porous solids: effectiveness factor and internal pore diffusing criteria for internal pore diffusing limitation. Deactivation of catalysts: types, mechanism of catalyst deactivation, rate equation using experimental data.

Text Book:

1 Chemical Reaction Engineering, Octave Levenspiel, 3rd edition, John Wiley & Sons(1998)

2 Chemical Engineering Kinetics, J.M.Smith, 3rd edition, McGraw Hill(1981).

Reference Books:

1 Elements of chemical reaction engineering, H.S.Fogler, 4th edition, PHI(2009)

ChE 325 PROCESS DYNAMICS AND CONTROL

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To provide the students the working knowledge of Laplace transforms to express the dynamics of linear control system in terms of transfer functions, a method which allows the categorization of a range of dynamic responses commonly encounter in practice.
2. To provide the students with fundamental background of process control theory and working knowledge of automatic control systems for chemical process.
3. To provide the students the knowledge of stability analysis, frequency response analysis and control system design approaches.
4. To provide the students working knowledge in analysis, design and turning of feedback / feed forward controllers in the context of various control strategies used to control chemical processes.

Course Outcomes

i. Analyze typical process dynamics with and without feedback control using both time domain and Laplace domain approaches.
ii. Be able to analyze open loop and closed coop system properties such as stability and performance.
iii. Apply frequency response based analysis for control system stability and performance.
iv. Be able to perform model based and testing of PID controllers and other types of single variable controllers.

UNIT – I

Basic Principles and problems of process control:

Laplace transform, inversion by partial fractions and properties of transforms.

Linear open loop systems:

Response of first order systems, physical examples, response of first order systems in series, second order systems and transportation lag.

UNIT – II

Linear closed loop systems:

Control systems, controllers and final control elements, block diagram of a chemical reactor control system, closed loop transfer function, transient response of simple control systems, stability and root locus.

UNIT – III

Frequency response:

Introduction, substitution rule, Bode diagrams.

Control system design by frequency response:

Temperature control systems, stability criteria, Ziegler–Nichols control settings, transient responses.

UNIT – IV

Advanced control strategies:

Cascade control, feed forward control, ratio control, internal model control

Controller tuning and process identification:

Tuning, tuning rules, process identification.

Control Valves:

Valve construction, sizing, characteristics, positioner.

Text Book:

1. Process systems analysis and control, D.R.Coughanour& L.B. Koppel, .2nd edition, McGraw Hill.(1991)

Reference Books:

1. Chemical Process Control: An introduction to Theory and Practice, George Stephanopoulos, PHI(1983).
2. Process Control, Peter Harriot, Tata-McGraw-Hill, New Delhi(1972).
3. Process Control Modeling, Design and Simulation, B.W.Bequette, PHI(2003)

ELECTIVE–I:

ChE 326 (A) ELECTRO - CHEMICAL ENGINEERING

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To apply chemical engineering principles to develop mathematical models for electro chemical processes
2. The course objective is to explain the principles and describe the design and operation of electrochemical reactors and processes, fuel cells and batteries;
3. Concept of electrode potentials and their use in predicting spontaneous and anti-spontaneous paired redox reactions; diffusion and migration processes to overall transport rates in electrochemical systems
4. To provide knowledge on electrodes used in different electro chemical industries.

Course Outcomes

i. Students will be able to understand balanced electrochemical reactions; analyze the open-circuit potentials of electrochemical cells, including liquid-junction potentials and understand the structure of the electric double layer, based partly on surface-tension data.
ii. Students will be able to understand the reaction mechanisms and kinetics to obtain electrode over potentials and mass-transfer phenomena, including the estimation of limiting currents.
iii. Students will be able to explain the principles and working conditions of the different types of primary and secondary batteries.
iv. Students will be able to understand the uses of electrodes in used in various electrochemical; industries like metal finishing, electroplating and electro polishing, etc.

UNIT – I

Review of basics of Electro - Chemistry:

Faraday's law, Nernst potential, galvanic cells, polarography.

The electrical double layer: Its role in Electro-chemical process, Electro-capillary curve, Helmota layer, Gucy, Steven's layer, fields at the interface.

UNIT – II

Mass transfer in Electro-Chemical systems:

Diffusion controlled Electro-chemical reaction, the importance of convection and the concept of limiting current, mass transfer over potential or concentration polarization. Primary current distribution, Secondary current distribution, the rotating disc electrode.

UNIT – III

Primary and Secondary Batteries:

Lechlanche dry cell, Alkaline manganese cell, mercury cell, Reverse electrolyte cells like Mg-$CuCl_2$, Mg-Pbo_2, Zn-PbO_2. Secondary cells like lead and Ni-Cd, Ni-Fe, AgC-Zn, AgC-Cd, sodium-sulphur, Li-S, fuel cells.

UNIT – IV

Electrodes used in different Electrochemical Industries:

Metals, graphite, lead dioxide, titanium substrate insoluble electrodes, iron oxide, semi conducting type etc., Metal finishing: Electro deposition, Electro refining, Electro forming, Electro polishing, anodizing, selective solar coatings, cell design.

Text Book:

1. An Introduction to Electrochemistry by Samuel Glasstone , Maurice Press(2007)
2. Electro Chemical Engineering by David J.Picket, Prentice Hall Inc., Publications (1979)

Reference Books:

1. Electrochemical Power sources Primary and Secondary Batteries by M.Barak (ed.) and L.K.Steverge, Publisher : The Institution Of Engineering And Technology(1980)
2. Electro Chemical Engineering Science and Technology in Chemical and other industries by H.Wendt and G.Kreysa, Springer links publications(1999)

ChE 326 (B) TEXTILE ENGINEERING

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To make the graduate a creative problem-solver using latest tools of engineering to design novel, functional textiles and processes.
2. To make the graduates to be able to analyze structure property relationships of textile materials, and develop and characterize novel textiles including woven, knitted and non-woven structures.
3. To provide the students the strong knowledge in the areas of Yarn manufacturing, cotton processing and finishing
4. To provide the students the string knowledge in the areas of wool processing, printing and finishing processes.

Course Outcomes

i. Student will be able to demonstrate the ability to design and develop useful textile-related products, processes, and/or other systems;
ii. Student will be able to demonstrate the ability to design and conduct experiments and analyze and interpret data related to problem solving in the areas encompassed by textile engineering;
iii. Student will have a broad-based educational background enabling them to pursue careers within or outside of textile engineering.
iv. Student will be able to explain and apply the manufacturing processes and finishing of text tile products like Yarn and wool.

UNIT – I
Raw Materials:
Natural Fibres:
Cotton : ginning, grading, baling.
Silk: Horticulture, sericulture and pre and post cocoon operation.
Wool: Sheep rearing, wool shearing, grading, baling.
Jute: Rretting, scotching.
Manmade fibres: Viscose, polyester, polyamide, acrylic, polypropylene, elastomeric fibres.
Auxiliary raw materials: Dyes, finishes and auxiliaries

UNIT – II
Yarn manufacture:
Mixing, Opening and Cleaning, Carding, Drafting, Combing, Speed frame, Ring frame, Doubling and Winding, Warping, Pirn Winding, Sizing, Drawing.

UNIT – III
Cotton processing:
Preparatory Processes :
Introduction to various preparatory processes for cotton, wool, silk, nylon, polyester, acrylic and blends including optical whitening.
Dyeing:
Introduction to dyeing of natural and synthetic fibre fabrics and blend fabric with various dye classes.
Printing :
Printing methods and styles of printing, natural and synthetic fibre fabrics and blends.
Finishing:
Finishing of natural and synthetic fibre fabrics and their blends including heat setting of synthetic fibre/fabrics. Softeners and stiffening finishes and their applications. Mechanical finishing stenters and mangles. Easy care finishing of cotton and polyester/cotton blends.

UNIT – IV

Wool Processing:

Wool setting and milling, Mildew, rot and moth proofing.

Silk Processing:

Degumming, Silk Dyeing, Silk Printing, Silk Finishing, Weighting of silk and scroop finish.

Printing:

Printing with kerosene and transfer printing.

Finishing:

Emerising biopolishing, water proofing and water repellency, flame proofing.

Text Book

1. Encyclopedia Of Textile Science Technology And Engineering, L. Lam, Asia Pacific BusinessPress Inc.(2009)

Reference Book:

1. The Complete Book on Textile Processing and Silk Reeling Technology, H. Panda, Asia PacificBusiness Press Inc.(2010)

ChE 326(C) MEMBRANE TECHNOLOGY

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To provide the fundamentals of the different membrane processes.
2. To provide the suitable range of operating conditions for every process and separation problem
3. To provide suitable type of module with the application and membrane material.
4. To provide membrane characteristics from experimental data.

Course Outcomes

i. An ability to understand the membrane technology to use according to the characteristics of the species to be separated.
ii. An ability to select the right material and membrane structure according to the properties of the involved compounds.
iii. An ability to evaluate the flux of water and solute through a membrane, under fixed operating conditions, from transport equations or supplier information
iv. An ability to identify and understand the membrane technology applications for energy efficient and environmental friendly operations.

UNIT – I

Introduction:

Introduction to barrier separation processes, definitions and principles membrane separation process, classification of membrane process, modules and modes of operation. Process configuration, requirements for ideal membrane, comparison with conventional separation processes.

UNIT – II

Membranes:

Synthetic membranes, characteristics of membrane materials, classification, methods of preparation, membrane characterization, structural properties.

UNIT – III

Processes:

Microfiltration, ultrafiltration, nanofiltration, reverse osmosis, dialysis, electrodialysis, gas permeation, liquid membrane separations and their Industrial applications.

UNIT – IV

Pervaporation, Transport, Polarization, Fouling:

Pervaporation, Transport in porous and non-porous membranes, concentration polarization, Fouling, factors affecting fouling, methods to reduce fouling and flux enhancement, cleaning of membranes.

Text Book:

1. Basic principles of membrane technology, Marcal Mulder, 2nd Edition, Springer India(1996).

Reference Books:

1. Ultrafiltration and Microfiltration, Munir Cheryan, 2nd Edition, Technomic Publishing Co(1998).
2. Synthetic Polymeric membranes, R. E. Kesting, 2nd Edition, McGraw Hill (1985)
3. Membrane separation processes, Kaushik Nath, PHI, New Delhi(2008).

ChE 326 (D) CORROSION ENGINEERING

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To provide the fundamentals of the different types of corrosion.
2. To provide the strong knowledge about polarization and Corrosion potentials.
3. To provide the knowledge about electro-chemical principles and aspects of corrosion
4. To provide the suitable methods of prevention and control of corrosion.

Course Outcomes

i. An ability to identify the electrochemical reactions occurring at cathodes andanodes.
ii. An ability to identify the type of corrosion occurring on a material.
iii. An ability to construct and interpret Fourbaix Diagram.
iv. An ability to predict the corrosion rate from available data and to prevent or initiate corrosion.

UNIT – I

Introduction and Scope:

Corrosion, definition, Wet and dry corrosion, mechanisms, Electro-chemical principles and aspects of corrosion, Faradays laws, specific conduction, specific resistance, transport no. mobility etc., various forms of corrosion, a brief review, corrosion rate expression, thermodynamic aspects of corrosion, equilibrium potential, Nernst equation for electrode potential, EMF series, over voltage, application of Nernst equation to corrosion reactions, calculation of Corrosion Rates.

UNIT – II

Polarization and Corrosion potentials:

Polarization & Corrosion potentials, reference electrodes for corrosion measurements, types of polarization, concentration, activation and resistance polarizations, Tafel equation, Tafel constant, Evans diagrams, anodic control, cathodic control. Mixed control: Fourbaix diagram for Fe-H_2O system, galvanic corrosion, uniform attack, pitting corrosion, dezincification, cavitation erosion. Fretting corrosion, inter-granular and stress corrosion cracking, some remedial measures for the above.

UNIT – III

Oxidation:

High temperature oxidation, pilling bedworth ratio, mechanisms of oxidation, corrosion testing procedures & evaluation. Corrosion of iron and steel in aqueous media, effect of velocity, temperature and composition of media.

UNIT – IV

Control:

Prevention techniques, modification of the material, alloying, appropriate surface or core treatment, chemical and mechanical methods of surface treatment. Coatings, metallic, non-metallic linings, cathodic protection, passivity and anodic protection.

Text Book:

1. Corrosion & Corrosion Control, H.H.Uhlig, Springer India

Reference Books:

1. An Introduction to Electrochemistry, Samuel Glasstone, Maurice Press(2008)
2. Corrosion engineering, Fontana and Greene, 2nd Edition,Mc Grawhill higher education(1978)

ChE 326(E) NUCLEAR CHEMICAL ENGINEERING

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To provide the knowledge about fundamentals of nuclear forces and nuclear reactors.
2. To provide the strong knowledge about types of nuclear reactions.
3. To provide the knowledge about nuclear reactor components, fuels and moderators.
4. To provide the knowledge of different of types homogeneous and heterogeneous nuclear reactors.

Course Outcomes

i. An ability to understand the mechanisms of nuclear binding and nuclear reaction.
ii. An ability to identify the type of nuclear reactors.
iii. An ability to explain the concepts of elementary treatment of research reactors, breeder reactors, power reactors and thermal reactors.
iv. An ability to explain about the nuclear reactor components.

UNIT – I

Introduction:

The atomic nucleus, Nuclear forces and Nuclear binding. The compound nucleus and nuclear reactions.

UNIT – II

Types of Reactions: Neutron reactions, Nuclear fission, thermal Neutrons.

UNIT – III

Nuclear Reactions: The nuclear chain reaction, Neutron diffusion, the critical equation.

UNIT – IV

Nuclear reactor classification:

Elementary treatment of research reactors, Breeder reactors, power reactors, thermal reactors, fast reactors, homogeneous and heterogeneous reactors, nuclear reactor components, fuels, moderators, coolants, reflectors, control rod and shielding.

Text Book:

1. Elementary Introduction to Nuclear Reactor Physics, S.E.Liverhaul, John Wiley and Sons, New York, (Unit I – III).
2. Nuclear Chemical Engineering, Benedict and Pigford, 2nd edition, McGraw Hill, (Unit - IV).

Reference Book:

1. Perry's Chemical Engineers Hand Book, Perry Rober H, 8th edition, McGraw Hill(2007)

ChE 326 (F) FLUIDIZATION ENGINEERING

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To provide the knowledge about fundamentals of fluidized beds.
2. To provide the strong knowledge about types and industrial applications of fluidization.
3. To provide the students various techniques such as terminal velocity, entrainment for infinite free board and a small free board.
4. To provide strong knowledge about fluidized bed reactors.

Course Outcomes

i. An ability to explain the difference between fixed and fluidized beds
ii. An ability to explain about various types of fluidized beds and their use in industries..
iii. An ability to derive minimum fluidization mass velocity and pressure drop equation for minimum fluidization.
iv. An ability to predict the Pressure drop in stick-slip flow, aerated flow, beds, cyclones and fluidized bed reactors.

UNIT – I

Introduction:

Phenomena of fluidization, liquid like behaviour of fluidized beds, advantages and disadvantages of fluidized beds, different types of fluidized beds, application of fluidization techniques in process industries.

Fixed beds:

Derivation of fixed bed pressure drop equations from fundamental characteristics, Kozeny Carman equation and Ergun's equation. Effect of particle size, sphericity, vesicularity, wall effect, surface roughness and voidage on fixed bed pressure drop.

UNIT – II

Minimum fluidization:

Derivation for minimum fluidization mass velocity, pressure drop equation for minimum fluidization.

Fluidization:

Types of fluidization, batch, continuous and semi fluidizations, pressure drop flow diagrams, slugging, channeling, effect of L/D, fluid distributors, mode of fluidization, power consumption and pumping requirements.

UNIT – III

Bubble phenomena:

Single rising bubble, two dimensional Davidson model, maximum stable bubble size, criteria for the stability of the bubble, rise velocity of a gas bubble, bubbling bed model for the bubble phase.

Terminal Velocity:

Derivation for terminal velocity.

Entrainment and Elutriation:

Transport disengaging height (TDH), entrainment at or above TDH, single size of solids, entrainment below TDH, elutriation rate equation, elutriation of fines, entrainment for an infinite Free Board and small Free Board.

UNIT – IV

Flow of High Bulk Density and Low Bulk Density Mixtures:

Pressure drop in stick-slip flow, pressure drop in aerated flow, downward discharge from a vertical pipe, flow in a horizontal pipe. Saltation velocity (horizontal flow), choking velocity (vertical flow), pressure drop in beds, cyclones in fluidized bed reactors.

Spouted bed:

Pressure drop flow diagram, minimum spouting correlation, spouting requirements.

Text Book:

1. Fluidization Engineering, Kunii, Diazo and Octave Levenspiel, Wiley Eastern

Reference Book:

1. Fluidization, Max Leva, McGraw Hill
2. Perry's Chemical Engineers Hand Book, Perry Rober H, 8^{th} edition, McGraw Hill(2007)

ChE 361 INSTRUMENTATION & PROCESS CONTROL LABORATORY

Practicals : 3 periods / week — *Sessional Marks : 40*

University Exam Marks : 60

University Exam : 3 hrs — *Credits : **2***

Course Objectives

1. To provide the fundamental background in understanding the dynamic behavior of physical systems.
2. To provide knowledge in calibrating the instruments.
3. To provide knowledge in understanding the role and operation of the main components in a feedback loop.
4. To evaluate the tuning of a Pneumatic P+I controller through manual tuning

Course Outcomes

i. To obtain and analyze the dynamic responses of the physical systems.
ii. To calibrate and use the measuring instruments.
iii. To obtain the transfer function of the unknown processes.
iv. To obtain tuning parameters of Pneumatic P+I controller, to control a particular process.

1 Response of Hg –Glass bare thermometer

2 Two tank non interacting system

3 Two tank interacting system

4 Control valve characteristics

5 Response of thermocouples

6 Response of thermometers

7 Response of U-Tube manometer

8 Response of temperature control trainer for step input forcing function

9 Response of level control trainer for step input forcing function

10 Response of flow control trainer for step input forcing function

11 Response of pressure control trainer for step input forcing function

12 Response of temperature control trainer for sinusoidal input forcing function

13 Response of level control trainer for sinusoidal input forcing function

14 Response of flow control trainer for sinusoidal input forcing function

15 Response of pressure control trainer for sinusoidal input forcing function

16 Pneumatic P+I controller

ChE 362 MASS TRANSFER OPERATIONS LABORATORY – II

Practicals : 3 periods / week | *Sessional Marks : 40*

University Exam Marks : 60

University Exam : 3 hrs | *Credits : **2***

Course Objectives

1. Determines experimentally the Vapor-Liquid Equilibrium data for binary systems.
2. Compares theory with experiment for simple distillation and continuous rectification.
3. Determines the equilibrium data for Liquid-Liquid Equilibrium in ideal and ternary systems.
4. Compares efficiency of liquid-liquid extraction in single and multi stage operations.

Course Outcomes

i. Ability to obtain experimentally the data relevant to different types of distillation.
ii. Ability to determine experimentally the data relevant for liquid-liquid extraction.
iii. Ability to identify solvents for leaching.
iv. Ability to evaluate single versus multi stage operations.

1. To verify the Steam law and determine of vaporization efficiency for a given system using steam distillation.
2. To verify Rayleigh's equation for differential distillation
3. To determine the H.E.T.P of a given packed bed tower for two component distillation.
4. To determine the Vapor - Liquid Equilibrium data for a given binary system.
5. To determine the binodal solubility curve in the case of ternary liquid equilibrium.
6. To determine the liquid – liquid equilibrium data for a given insoluble liquids and a solute.
7. To perform leaching and determine the oil percentage in the given seeds.
8. To compare single stage efficiency with multi stage efficiency in liquid – liquid extraction.
9. Mass transfer coefficient in a single drop extraction
10. Freundlich's isotherm for a given system.
11. Multi stage distillation
12. Raoult's Law verification
13. Bubble temperature verification
14. Dew temperature verification
15. Bubble pressure verification
16. Dew pressure verification

ChE 363 CHEMICAL TECHNOLOGY LABORATORY

Practicals : 3 periods / week — *Sessional Marks : 40*

University Exam Marks : 60

University Exam : 3 hrs — *Credits : **2***

Course Objectives

1 To instill students with an appreciation of the fundamental principles and concepts of Inorganic Chemical Technology to solve practical problems.
2 To provide students with the fundamental aspects of chemical process technology and professional knowledge in selected areas of Inorganic chemical technology.
3 To provide knowledge in soap manufacturing, analysis and estimation
4 To provide knowledge in oil (testing), analysis and estimation of glucose and sugar

Course Outcomes

i. Ability to demonstrate knowledge and understanding on fundamental principles of chemistry and Inorganic chemical technology and on contemporary applications.
ii. Ability to design and conduct experiments, as well as critically analyze and interpret experiment results
iii. Ability to demonstrate and understand the principles of organic chemical technology and other applications
iv. Ability to identify, modify and design a component process or system to meet the required product quality

1. Determination of suspended, dissolved, total solids and pH of water
2. Determination of chloride in tap water
3. Determination of copper in brass
4. Determination of Calorific value of solid, liquid and gaseous fuels
5. Determination of acid insoluble and available lime
6. Preparation of copper pigment
7. Preparation of chrome yellow
8. Preparation table salt
9. Estimation of metals by spectrophotometric method.
10. Proximate analysis.
11. Carbon residue in liquid fuels.
12. Treatment of water by lime-soda process.
13. Treatment of water by ion-exchange process.
14. Estimation Sulphate
15. Ferrous content in the iron ore
16. Beer's law
17. Estimation of λ_{max}
18. Active matter in detergents
19. Total fatty matter in soaps
20. Determination of adulteration in edible oils

21. Analysis of glucose-Estimation of total reducing sugars
22. Analysis of sawdust-Estimation of total cellulose
23. Preparation of soap by semi boiled process
24. Preparation of phenol formaldehyde resin
25. ASTM distillation of crude
26. Estimation of Urea
27. Preparation of ester
28. Preparation of Linear Alkyl Benzene Sulfonate
29. Preparation of Metallic salts
30. Iodine value
31. Acid value
32. Saponification value

ChE 411 COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. The students are able to apply knowledge of mathematics, science and engineering to solve numerical problems in Chemical Engineering.
2. The course gives the student the opportunity to analyze and interpret data, to identify, formulate and solve engineering problems
3. To provide the numerical methods for the approximate solution of mathematical equations encountered in chemical engineering.
4. The students are able to solve the Chemical Engineering problems by using ASPEN PLUS, widely used in the chemical process industry.

Course Outcomes

i. An ability to apply basic knowledge of mathematics, science and engineering.
ii. An ability to identify, formulate and solve chemical engineering problems.
iii. An ability to use the Numerical techniques, skills and modern engineering tools necessary for engineering practice.
iv. An ability to solve process design problems, based on economic analysis and using mathematical models of chemical processes

UNIT – I

Treatment and interpretation of engineering data:

Roots of algebraic and transcendental equations

Iteration methods:

Bisection method, Regula–Falsi method ,Newton–Raphson method. Roots of simultaneous sets of transcendental and algebraic equations. System of linear equations and their solutions by different techniques.

UNIT – II

Ordinary differential equations:

Analytical and numerical solutions, Interpolation, Numerical differentiation and integration.

UNIT – III

Regression Analysis:

Least squares and orthogonal polynomial approximations. Partial differential equations, formulation and solution. Numerical solutions of partial differential equations (Simple case studies).

UNIT – IV

Application of law of conservation of mass:

Salt accumulation in a stirred tank, Starting and equilibrium still, Solvent extraction in two stages, Diffusion with chemical reaction.

Application of law of conservation of energy:

Radial heat transfer though a cylindrical conductor, Heating in a closed kettle.

Application of finite difference method:

a) Calculation of the number of theoretical plates required for an absorption column.
b) Calculation of the number of theoretical plates required for a distillation column.
c) Number of steps required for a countercurrent extraction and leaching operations.

Text Books:

1. Numerical methods in Engineering &Science by B.S.Grewal,7th edition Khanna Publishers,(2005) (Unit I - III)
2. Mathematical methods in Chemical Engineering, by Jenson, V.J., and Jeffreys, G.V., Academic Press, London, Newyork, 1977 (Unit- IV)

Reference Books:

1. Applied Mathematical methods for Chemical Engineersby Norman W Loney, 2nd edition, CRC Press(2007).
2. Numerical methods for Engineers, by Chapra.S,6th edition McGraw Hill (2006).
3. Applied Mathematics in Chemical Engineering by Mickley, H.S., Sherwood, T.S., and Reed, C.E.,2nd edition, Tata McGraw Hill(1977)

ChE 412 CHEMICAL PROCESS EQUIPMENT DESIGN

Lectures : 5 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs *Credits : 5*

Course Objectives

1. To introduce the basic principles of process design
2. To Understand principle criteria involved in the design of process heat transfer equipment
3. To develop working knowledge on Mass transfer, chemical reaction kinetics and design various types of columns/reactors.
4. Learn the fundamentals of Mechanical design of process equipment

Course Outcomes

i. synthesize and analyze process flow sheets, draw flow charts, layout and specification of equipment
ii. Effectively design chemical engineering projects.
iii. Be able to perform process selection, material Energy balances, Waste minimization, Pollution & its abatement and Safety &health considerations.
iv. Analyse and design mass and heat transfer equipment, reactors including Packed and fluidized bed columns for separation and reactors.

UNIT – I

Introduction to Design : Nature of Design, Anatomy of a Chemical Manufacturing Process, organization of a Chemical Engineering Project, Project Documentation, Codes & Standards and Design Factors.

Safety and Loss Prevention: Introduction, Materials Hazards, Process Hazards, Analysis of Product and Process Safety, Failure–Mode Effect Analysis, Hazard and Operability Studies and Quantitative Hazard Analysis

General Site Considerations: Introduction, Plant Location and Site Selection, Site Layout, Plant Layout, Utilities and Environmental Considerations.

Flow Sheeting: Introduction, Flow Sheet Presentation: block diagrams, pictorial representation, presentation of stream flow rates. Flow sheets with recycle:tearing the flow sheet

UNIT – II

.**Heat Transfer Equipment:** Introduction, Basic Design Procedure and Theory, Overall Heat Transfer Coefficient, Fouling Factors, Double Pipe Heat Exchangers, Shell and Tube Heat Exchangers-Construction Details and General Design Considerations, Tube side and Shell side heat coefficients and pressure drops, Plate Heat Exchangers, Finned Tubes,.

Equipment Selection, Specification and Design: Introduction, Gas-Gas Separations, Liquid-Solid Separators-filtration, Gas-Solids Separations. Reactors:Types of reactors and design procedure

UNIT – III

Separation Columns: Introduction, Continuous Distillation-Process description and Basic principles, Design Variables in distillation, Design Methods for Binary System, Plate and Packed Columns.

UNIT – IV

Mechanical Design of Process Equipment: Design of Cylindrical and Spherical Vessels under internal pressure, design of heads and closures, design of tall vessels

Text Books:

1. Chemical Engineering Design, by Ray Sinnott and Gavin Towler, 5th edition Elsevier Publications (UNIT I-III),2010
2. Introduction to Chemical Equipment Design, Mechanical aspects by B.C.Battacharyya, 1st edition, CBS Publishers and Distributors, New Delhi(UNIT- IV),2003.

Reference Books:

1. Plant Design and Economics for Chemical Engineers, Max. S. Peters, K.D.Timmerhaus and Ronald E.West, 6th edition , McGraw Hill (2012)
2. Process Equipment Design M.V.Joshi. and V.V.Mahajani, 4th edition Macmilan India Ltd(2009).

ChE 413 TRANSPORT PHENOMENA

Lectures	*: 4 periods / week*	*Sessional Marks*	*: 40*
Tutorials	*: 1 period*	*Semester End Exam Marks*	*: 60*
Semester End Exam	*: 3 hrs*	*Credits*	*: **4***

Course Objectives

1. Understands the co-existance of flow, heat and mass transfer.
2. Solves for velocity profiles in flow inside tubes.
3. Determines the utility of heat transfer coefficients in flow systems
4. Develops equations for mass transfer in stationary and moving fluids using diffusion concepts.

Course Outcomes

i. Ability to analyse processes involving simultaneous flow, heat and mass transfer.
ii. Ability to design packed bed flows and fluidization processes.
iii. Ability to calculate coefficients for equipment such as Shell & tube heat exchanger.
iv. Ability to decipher the mechanism of mass transfer in stationary and flow systems.

UNIT – I

Momentum Transport:

Introduction to momentum transport, viscosity and the mechanism of momentum transport, Newton's law of viscosity, non-Newtonian fluids, pressure and temperature dependence of viscosity of liquids and gases, velocity distribution in laminar flow, shell momentum balances and boundary conditions, flow of falling film, flow through circular tubes and annulus.

Equations of continuity and motion:

Application of Navier strokes equation and Euler equation for laminar, steady flow problems: tangential annular flow of a Newtonian fluid, shape of the surface of a rotating liquid.

UNIT – II

Turbulent Flow:

Velocity distribution in turbulent flow, fluctuations and time smoothed quantities, time smoothing of equations of change for an incompressible fluid, logarithmic distribution law for tube (far from wall) velocity distribution for tube flow (near wall)

Friction Factors & Macroscopic Balance:

Friction factors for flow in tube-pressure drop calculations, friction factors for flow around spheres, packed columns, macroscopic mass, momentum and mechanical energy balances, pressure rise and friction loss in a sudden expansion.

UNIT – III

Energy Transport:

Steady state conduction, thermal conductivity mechanism of energy transport, Fourier's law, effect of temperature and pressure on thermal conductivity. Temperature distribution in solids and in laminar flow, shell energy balances, boundary conditions, heat conduction with electrical heat source, viscous heat source, heat conduction through composite wall, addition of resistances, forced convection and free convection, heat transfer coefficients–forced convection in tubes & around submerged objects, free convection on a vertical plate and horizontal pipe.

UNIT – IV

Mass Transport:

Diffusivity and mechanism of mass transport, definition of concentration, velocities and mass fluxes, Fick's law of diffusion, temperature and pressure dependence of mass diffusivity, shell mass balances, boundary conditions and applications, diffusion through a stagnant gas film, diffusion with heterogeneous and homogeneous chemical reactions, Diffusion into falling liquid film, Equation of continuity for binary mixtures.

Text Book:

1. Transport Phenomena by R.B.Bird, Warrin.E, Stewat and Edwin N. Light Foot, 2nd edition, John Wiley & Sons(2007).

Reference Book:

1. Transport process and separation process principles by Christie John Geankoplis, 4th edition, PHI(2003)
2. Transport Phenomena, A Unified approach by Roberts, Broadkey and Harry C. Hershey, McGraw Hill.

ChE 414 BIO-CHEMICAL ENGINEERING

Lectures : 3 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester End Exam : 3 hrs — *Credits : **4***

Course Objectives

1. To provide the fundamental background of the principles of biology and biochemistry in order to understand, design and operation of biochemical processes.
2. To determine the rates of enzyme catalyzed reactions and to provide knowledge on the immobilization of enzymes.
3. To provide knowledge regarding cell growth patterns and design of various bioreactors.
4. To expose the students to the various unit operations and unit processes involved in the down stream processing.

Course Outcomes

i. To understand and use the basic principles of biology and biochemistry to successfully design and operate a biochemical process.

ii. To derive the kinetic expression for the rates of enzyme catalyzed reactions.

iii. To understand the factors effecting cell growth and to design and operate various bioreactors.

iv. To apply various unit operations and unit processes for carrying out down stream processing.

UNIT – I

Introduction:

An overview of industrial bio chemical processes, comparing with chemical processes.

A little Microbiology:

Biophysics and cell doctrine, Structure of cells, types of cells.

Chemicals of life:

Lipids, proteins, building blocks of DNA and RNA.

UNIT – II

The kinetics of enzyme–catalyzed reactions:

The enzyme-substrate complex & enzyme action, simple enzyme kinetics with one and two substrates, substrate activation & inhibition, modulation & regulation of enzyme activity, other influences on enzyme activity.

Applied enzyme catalysis:

Applications of enzymes, enzyme immobilization, medical & analytical applications of immobilized enzymes, effect of external mass transfer resistances, analysis of intra particle diffusion & reaction.

UNIT – III

The kinetics of cell growth:

Ideal reactors for kinetics measurements, Monod growth kinetics, growth cycle phases for batch cultivation.

Biological reactors:

Fed batch reactors, enzyme–catalyzed reactions in CSTRs, CSTR reactors with recycle and wall growth, the ideal plug flow tubular reactor, sterilization reactors, packed bed reactors, fluidized bed reactors and trickle-bed reactors.

UNIT – IV

Product recovery operations:

Recovery of particulates - Filtration, centrifugation, sedimentation.

Production Isolation:

Extraction, precipitation, Chromatographic techniques, membrane separations, drying and crystallization.

Text Book:

1. Biochemical Engineering fundamentals by J.E..Bailey and D.F.Ollis, 2nd edition,McGraw Hill(1986)

Reference Books:

1. Bio process Engineering Basic Concepts, Michel L. Shuler and Fikeet Kargi, 2nd edition, PHI(2002)
2. Biochemical Engineering, James M Lee, PHI(1992).

Elective-II

ChE 415(A) ENERGY ENGINEERING

(Open to other branches)

Lectures	*: 3 periods / week*	*Sessional Marks*	*: 40*
Tutorials	*: 1 period*	*Semester End Exam Marks*	*: 60*
Semester End Exam	*: 3 hrs*	*Credits*	*: 3*

Course Objectives

1. To provide the knowledge about formation, classification, ranking, analysis, testing, carbonization, gasification and liquification of coal, manufacture of cock.
2. To provide the knowledge about design, occurrence, composition, classification, exploration and production of petroleum, refining, testing and analysis of petroleum products.
3. To provide knowledge about the non conventional energy courses and its storage
4. To provide knowledge about the energy related problems in the world and its solutions.

Course Outcomes

i. An ability to understand the importance of environment and conservation of natural resources.
ii. An ability to succeed in the competitive exams of energy industry.
iii. An ability to utilize the non conventional energies in place of conventional energies and its manufacture.
iv. An ability to maintain the sustainability in the environment.

UNIT – I

Conventional energy resources, the present scenario, scope for future development.

Coal: Origin, occurrence and reserves, classification, ranking, analysis and testing, coal carbonization, manufacture of coke, coal gasification, coal liquefaction.

UNIT – II

Petroleum: Origin, occurrence and reserves, composition, classification, characteristics, exploration and production.

Petroleum Refining: Refinery processes, petroleum products, testing and analysis of petroleum products.

UNIT – III

Non conventional energy sources: Solar energy, solar radiation, principles of heating and cooling, photo voltaic cells.

Bio gas products, bio-mass, wind energy, hydrogen energy, geothermal and ocean thermal energy, fuel cells.

UNIT – IV

Energy storage, mechanical energy storage, water storage, solar pond, phase change storage, chemical storage.

Energy Conservation: Conservation methods in process industries, Theoretical analysis, practical limitations, equipment for energy saving / recovery.

Text Books:

1. Conventional Energy technology by S.B.Pandy, Tata McGraw Hill (1987)
2. Fuel Science by Harker and Allen,Ist edition , Oliver & Boyd (1972).
3. Principles of Energy conversion by Culp, Mc Graw Hill(1991)

Reference Books:

1. Hand book of Energy Technology by Considine D. M,McGraw Hill(1977).
2. Fuels and energy by Harker and Backhusst, Academic press (1981)
3. Solar Energy Thermal Process by John A Duffie, John Wiley & Sons Inc (1975).

ChE 415 (B) BIOFUELS

(Open to other branches)

Lectures	*: 3 periods / week*	*Sessional Marks*	*: 40*
Tutorials	*: 1 period*	*Semester End Exam Marks*	*: 60*
Semester End Exam	*: 3 hrs*	*Credits*	*: 3*

Course Objectives

1. To provide the knowledge about properties, composition, features of biofuels and uses of biomass and their environmental impacts.
2. To provide the students a substantial knowledge of biofuel production technologies.
3. To provide knowledge about the process of biogas production and methods of production of biodiesel and comparison of the standards to the conventional diesel.
4. To provide knowledge about the production of lipids, bio hydrogen from different bacteria and algae.

Course Outcomes

i. An ability to describe the functional principle of biofuel technologies in small and large scale.
ii. An ability to describe the main steps and components in bioethanol, biodiesel and biogas production.
iii. An ability to Participate actively in teamwork and work with case related problem solving.
iv. An ability to work with professional problem solving in an industrial environment.

UNIT – I

Introduction:

Sources of energy, introduction of biofuels, availability of bio mass, composition of biomass, terrestrial biomass, aquatic biomass. Physical and chemical properties of biomass. useful features of biofuels, undesirable features of biofuels, energy crops, modes of utilization of biomass and their environmental impacts.

UNIT – II

Biogas:

The substrate, the digester, the microorganisms, the process of bio gas production, factors affecting bio gas yields, advantages, disadvantages.

Bioethanol:

Bioethanol vs. Petrol, production of bio ethanol, ethanol recovery. Bio butanol.

UNIT –III

Bio diesel:

Sources of lipids, production of lipids, methods of production of bio diesel, comparison of bio diesel with conventional diesel. Standards of bio diesel.

UNIT – IV

Bio hydrogen:

Production of bio hydrogen from anaerobic bacteria, photosynthetic algae, photosynthetic–hydrogenase system.

Fuel cells:

Enzymatic fuel cells, microbial fuel cells.

Text Book:

1. Bio Technology – Expanding horizons, B.D.Sing, Kalyani Publishers, Ludhiana.

Reference Books:

1. Fundamentals of Renewable Energy Systems, D.Mukherjee, S.Chakrabarti, New Age International Publishers.
2. A Text Book of Biotechnology, R.C.Dubey, S.Chand & Company Ltd., New Delhi.
3. Non-Conventional Energy Sources, G.D.Rai, Khanna Publishers.

ChE 451 MINI PROJECT

Practicals : 3 Periods / week *Sessional Marks: 100*

No. of credits : 2

Course Objectives

1. Performs literature search on the topic of their interest.
2. Develops a process flow sheet for the intended product.
3. Explains the properties of the product.
4. Presents the techno-economic demand for the product.

Course Outcomes

i. Ability to collect information on own regarding a chemical product or process.
ii. Ability to perform basic and detailed engineering for a given process.
iii. Ability to carry out economic feasibility of a given product production.
iv. Ability to present coherent data and analysis about a given process.

PURPOSE:

The Mini Project helps to supplement the final year Project Work of the B.Tech students. It helps to identify their research area / topic and complete the groundwork and preliminary research required for it comfortably. It trains the students to make use of research tools and material available both in print and digital formats.

PROCEDURE:

The topic of Mini Project is chosen from the B.Tech curriculum. Based on the topic a hypothesis is to be made by the student. The hypothesis may be a null hypothesis also. The students are then required to collect literature and support information for their Mini Project from standard reference books, journals and magazines- Both printed and online. Each student should refer a minimum of 5 reference sources outside the prescribed Text Books. The Mini Project contains:

- The Aim and Objective of the study.
- The need for Rationale behind the study.
- Identify the work already done in the field.
- Hypothesis and Discussion
- Conclusion
- Appendix with support data (Illustrations, Tables, Graphs etc.,)

ChE 452 CHEMICAL REACTION ENGINEERING LABORATORY

Practicals : 3 periods / week — *Sessional Marks : 40*

University Exam Marks : 60

University Exam : 3 hrs — *Credits : **2***

Course Objectives

1. To provide a core foundation for the analysis and design of chemical reactors
2. To provide instruction in the analysis of experimental data to obtain rate equations and kinetic and thermodynamic data
3. To provide the information of parametric study of the various chemical reactions. To gain knowledge in the design of reactors
4. To give students experience with a flexible bench scale experiment that can be used to study the processes of liquefaction.

Course Outcomes

i. Design ideal continuous reactors operating at isothermal conditions given kinetic data and conversion.
ii. Solve for conversion in a non-ideal reactor given a residence time distribution
iii. To understand how to measure reaction rates using integral and differential methods
iv. Students are aware that materials, construction, operability, safety and ethical issues must be considered in reactor

1. Determination of the order of a reaction using a Batch reactor and analyzing the data by

   (a) differential method

   (b) integral method.

2. Determination of activation energy of a reaction using a batch reactor
3. To determine the specific reaction rate constant of a reaction of known order using a batch reactor
4. To determine the specific reaction rate constant of a reaction of known order using a CSTR (Continuous Stirred Tank Reactor).
5. To determine the order of the reaction and the rate constant using tubular reactor.
6. To determine the order of the reaction and the rate constant using a plug flow reactor
7. Langmuir adsorption isotherm. To determine the surface area of activated charcoal.
8. To determine the RTD and the dispersion number in a tubular reactor using a tracer
9. To determine the RTD and the dispersion number in a CSTR
10. To determine the RTD and the dispersion number in a CSTR's in series.
11. To determine the RTD and the dispersion number in a combined reactor.
12. Mass transfer with chemical reaction (Liquid–Liquid system) to determine the mass transfer coefficient in the stirred cell
13. Mass transfer with chemical reaction (Solid-liquid system). To determine the mass transfer coefficient of stirred cell.
14. Axial mixing in a packed-bed. To determine the RTD and the dispersion number for a packed-bed using a tracer

ChE 453 COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING LABORATORY

Practicals : 3 periods / week *Sessional Marks : 40*

University Exam Marks : 60

University Exam : 3 hrs *Credits : **2***

Course Objectives

1. To analyze and interpret data, to identify and solve Chemical Engineering problems
2. To introduces a range of numerical methods for the approximate solution of mathematical equations in Chemical Engineering
3. To develop a program for the solving the roots f Algebraic and transdental equation
4. To solve the Chemical Engineering problems by using ASPEN PLUS, which is widely used in the Chemical process industry.

Course Outcomes

i. Able to analyze the Chemical Engineering problems with computed knowledge
ii. Able to develop the computer program for the real chemical engineering problems
iii. Able to solve the chemical engineering problems using ASPEN software
iv. Able to solve the numerical methods as well as the roots of various function using C language

1. **Roots of nonlinear equations iterative methods:**
   a. Bisection method
   b. False position method
   c. Newton Raphson method
   d. Secant method

2. **Direct solution for set of linear equations:**
   a. Gauss Elimination Method
   b. Gauss-Jordan method
   c. Matrix inversion method
   d. Triangular Factorization (L.U.Decomposition method)

3. **Iterative solution for set of linear equations:**
   a. Jacobi's method
   b. Gauss Seidel method

4. **Regretion analysis:**
   a. Fitting Linear equation
   b. Fitting Transdental equations
   c. Fitting a polynomial function

5. **Numerical differentiation:**
   a. Forward difference quotient
   b. Central difference quotient
   c. Backward difference quotient

6. **Numerical integration:**
   a. Trapezoidal rule
   b. Simpson's 1/3 Rule
   c. Simpson's $3/8^{th}$ rule

7. **Numerical solution of ordinary differentialequations:**
    a. Taylor series method
    b. Euler's method
    c. Heun's method
    d. Polygon method
    e. Runga-Kutta method

8. **Predictor and corrector methods:**
    a. Milne-Simpson method
    b. Adam Bash forth method
9. Rating of shell and tube heat exchanger using Aspen Plus software.
10. Rating of Distillation column using Aspen Plus software.
11. Simulation of Recycle Processes.
12. Simulation of PFR and CSTR.

ChE 454 INDUSTRIAL POLLUTION CONTROL LABORATORY

Practicals : 3 periods / week — *Sessional Marks : 40*

University Exam Marks : 60

University Exam : 3 hrs — *Credits : **2***

Course Objectives

1. To determine the oxygen levels, Biological oxygen demand, chemical oxygen demand in municipal ground sewage and industrial effluent waters.
2. To determine the dissolved suspended solids fixed and volatile solids in the give sample of water.
3. To determine the optimum amount of coagulant and alums required for municipal sewage and industrial affluent water.
4. To determine the chloride and iron contents in the given sample of water, the maximum wave length of colouring agents by using spectrophotometer

Course Outcomes

i. Ability to determine the amount of oxygen and the extent of pollution of water due to organic matter
ii. Ability to determine the extent of suspended and dissolved solid pollution in the given sample of water
iii. Ability to predict the optimum dosage of alum and coagulant required for purification of water
iv. Ability to determine the salt dyes and metallic components in a given sample of water.

1. Suspended solids in air sample using high volume sampler.
2. CO_2 and CO concentrations in a given sample.
3. SO_2 concentrations in a given sample.
4. Hardness
5. pH value
6. Dissolved oxygen content.
7. BOD
8. COD
9. Iron content in a given industrial effluent sample.
10. Determination of Fluoride content in a given sample.
11. Determination of Chloride content in a given sample.
12. Nitrates
13. Determination of optimum dose of coagulant.
14. Determination of MLSS and MLVSS in a given industrial effluent sample.
15. Noise Measurement

ChE 421 PROCESS ECONOMICS & INDUSTRIAL MANAGEMENT

Lectures : 4 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs *Credits : **4***

Course Objectives

1. To provide the student with an insight on the various principles, concepts and functions of General Management and economics with thrust on Industrial Management, to enable him/her to take up employment or pursue higher education.
2. To provide students with an ability to integrate knowledge about various production systems, functions and controlling techniques etc.
3. To enable the student to demonstrate a thorough working knowledge about Industrial Management and various functional areas of management.
4. To motivate the student for entrepreneurship activities.

Course Outcomes

i. To gain insight on contemporary issues in General and Industrial Management.
ii. Ability to identify, analyze and interpret various concepts of Finance, systems of production to enable the student to meet the needs of Industry.
iii. An understanding of the impact of various Industrial Management solutions and techniques with focus on economic, environmental and societal context.
iv. Recognition of the need and ability to engage in perpetual learning.

UNIT – I

Interest &Depreciation:
Time value of money, interest discrete and continuous, Depreciation and depletion.
Cost:
Cost concepts, capital costs for process plants, estimation of production cost, cost indices, cost accounting and process costing –profit and loss account and balance sheet. Break even analysis.
Profitability:
Profitability analysis, comparison of alternative investments and replacements: Accounting for inflation and technological advancement.

UNIT – II

Production system:
Operation Manager's activities, types of operations, classification of production system, manufacturing and service units, mass production and batch production systems.
Work:
Work study, motion study and work measurement.
Production:
Production Planning and control, forecasting, controlling and intermediate production system, functions under PPC.

UNIT – III

Management:
Principles and functions of management
Forms of Business Organizations:
Sole trader, partnership, company form of business organization.
Organization:
Organization chart, principles of organization, types of organization, line and staff functions.

UNIT – IV

Inventory control:

Reasons for inventory control, analytical treatment and Inventory control techniques

Operations Research:

Problem formulation, linear programming, simplex and graphical solutions. Introduction to Marketing Management.

Text Books:

1. Plant Design and Economics for Chemical Engineers, Peters. M. S. and Timmerhaus, K.D., 5th edition, McGraw Hill, (Unit - I)
2. Industrial Management and Operations Research, K. K. Ahuja, Khanna Publishers, New Delhi (Unit II – IV)

Reference Books:

1. Engineering Economics, Paneerselvam, PHI
2. Essentials of Management, Koontz and O'Donnel, McGraw Hill.
3. Works Organization and Management, K.C. Sahu, N.K.Dutta, Oxford publications

ChE 422 PROCESS MODELLING AND SIMULATION

Lectures : 4 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs *Credits : **4***

Course Objectives

1. To understand cause-effect relationships of processes of chemical industry.
2. To understand the fundamental relationships of mass, heat and momentum transfer interaction in processes.
3. To provide an overview of numerical methods used for continuous simulation.
4. To provide an overview of computer simulation.

Course Outcomes

i. To analyze processes in terms of their fundamental transport rates and thermodynamic equilibria.

ii. To calculate compositions of streams exiting a system for cases involving simple algebraic or ordinary or partial differential representations of the model.

iii. To use the appropriate numerical methods to solve the non linear algebraic or ordinary or partial differential equations.

iv. To understand the principles of computer simulation and create simulation model of various types.

UNIT – I

Mathematical models for chemical engineering systems:

Introduction, Use of mathematical models, Scope of coverage, Principles of formation, Fundamental laws, Continuity equation, Energy equation, Equations of motions, Transport equations, Equations of state, Equilibrium, Chemical kinetics.

UNIT – II

Examples of mathematical models of chemical engineering systems:

Introduction, Series of isothermal, constant hold up CSTRs, CSTRs with variable hold-ups, Two heated tanks, Gas phase pressurized CSTR, Non-isothermal CSTR, Single component vaporizer, Multi-component flash drum, Batch reactor, Reactor with mass transfer, Ideal binary distillation: Batch distillation with holdup.

UNIT – III

General Concepts of Simulation for Process Design:

Introduction, Process simulation models, Methods for solving non-linear equations, Simulation examples.

UNIT – IV

Computer simulation:

Simulation examples, Gravity flow tank, Three CSTRs in series, Non-isothermal CSTR, Binary distillation column, Multi-component distillation column, Batch reactor.

Text Book:

1. Process Modeling Simulation and Control for Chemical Engineers by, W.L.Luyben, 2nd edition, McGraw Hill (1990).

Reference Books:

1. Process Modelling and Simulation by R.W.Gaikwad and Dr. Dhirendra,2nd edition, Central Techno Publications(2006).
2. Chemical Process Modelling and Computer Simulation, Amiya K. Jana, 2nd edition,PHI(2011)
3. Computational methods for process simulation by W. F. Ramirez,2nd edition, Betterworthus series in Chemical Engineering(1998)

ELECTIVE – III:

ChE 423 (A) POLYMER TECHNOLOGY

Lectures : 4 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs *Credits : **4***

Course Objectives

1. To provide knowledge to understand polymerizations leading to polymer networks, including the types of monomers required and how their functionality affects gelatin.
2. To provide knowledge to compute molecular weight averages from the molecular weight distribution
3. To provide knowledge to understand the major classes of step growth and chain growth polymerization
4. To provide knowledge to understand the manufacture, properties and applications of addition and condensation polymers

Course Outcomes

i. An ability to understand the basis of the methods used most widely to measure the polymer molecular weight distribution and its averages.
ii. An ability to specify reaction conditions to control molecular weight and, to the extent possible, its distribution.
iii. An ability to understand how polymers from the same monomer can have different chain architecture and how to control it during polymerization.
iv. An ability to specify all the manufacturing processes and applications of addition and condensation polymers.

UNIT –I

Definitions: Monomer, polymer, functionality, homo and copolymers, heterochain and homochain polymers, polymer blends.
Classification of Polymers: Based on origin, applications, thermal behavior and polymerization.
Measurement of Molecular Weights: By end group analysis, colligative properties, intrinsic viscosity, Gel permeation chromatography and light scattering methods.
Chemical structure and physical states of polymers: Configuration & conformations, crystalline and amorphous states.
General properties of polymers: Mechanical, chemical, thermal, electrical and optical properties.

UNIT – II

Mechanism and kinetics: (I) step growth or condensation polymerization, (II) addition or chain growth a) free radical, b) anionic, c) cationic and d) coordination polymerizations.
Copolymerization of binary monomer system: Kinetics and relation of copolymer composition to monomer ratio.
Role of Chemicals: Initiator, catalyst, solvents, inhibitors, chain transfer agents in polymerization.
Methods of polymerization: Bulk or mass, solution, suspension and emulsion polymerization techniques.
Polymer chemical reactions: Degradation, curing or cross linking and vulcanization

UNIT – III

Compounding of polymers: Role of various additives such as fillers, reinforcing agents, stabilizers, antioxidants, lubricants, fire retardants, coupling agents.
Processing methods: a) Extrusion, b) moulding, c) injection moulding, d) calendaring, e) fibre spinning.

Manufacture, properties and applications of addition polymers:
a) polyethylene, b) polypropylene, c) polyvinyl chloride, d) polystyrene, e) polymethyl methacrylate, f) polytetra fluoroethylene and g) natural rubber.

UNIT – IV

Manufacture, properties and application of condensation polymers:
a) phenolic resins, b) polyesters c) unsaturated and saturated: PET & polycarbonate, d) Polyamides (nylon 6 & nylon 6,6) e) polyurethanes, f) epoxy resins, g) silicone resins, h) cellulose and its derivatives.

Text Book:

1. Polymer science, V. R. Gowarikar, N. V. Viswanathan, Jayadev Sreedhar, New Age International (2011).

Reference Books:

1. Polymer science and technology, Joel R. Fried, 2nd Edition, PHI publishers, (2009).
2. Polymer Science And Technology : Plastics, Rubbers, Blends And Composites**,** , Premamoy Ghosh, 3rd Edition, Tata McGraw Hills, New Delhi, (2010)

ChE 423 (B) FERTILIZER TECHNOLOGY

Lectures : 4 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs *Credits : **4***

Course Objectives

1. To become aware of the impact of fertilizer addition to crop productivity.
2. To know the basic, primary and secondary micronutrients essential for crop and plant growth and development.
3. To become aware of different fertilizer combinations and methods of application of these materials
4. To introduce the primary materials used in cropping systems to deliver nutrients to the field.

Course Outcomes

i. An ability to list primary nutrients and describe why they are primary.
ii. An ability to describe what systems the primary elements impact most within crop plants
iii. An ability to contrast fertilizer usage in the developed and developing worlds
iv. An ability to describe how do primary elements differ from secondary and micro elements

UNIT – I

Introduction:

Details about indigenous fertilizer production, raw materials, details of the various nutrients with their importance.

Raw Materials:

Source of nitrogen and hydrogen. steam reforming of hydrocarbons. Partial oxidation of Fuel oils with gas purification, CO_2 removal processes and methanation.

UNIT – II

Nitrogen Fertilizers:

Coal gasification, ammonia synthesis, thermodynamic principles associated with ammonia synthesis, ammonia reactors. Nitric acid and sulfuric acid.

Urea, total recycle and stripping processes, process details, ammonium sulfate, ammonium chloride, ammonium nitrate, calcium ammonium nitrate.

UNIT – III

Phosphorous Fertilizers:

Phosphate rock availability and benefaction methods, upgradation, bone-meal, basic slag single super phosphate, triple super phosphate, phosphoric acid by wet process and furnace process. AMI process with HCL. Complex fertilizer like Mono and Di-ammonium phosphates, urea- ammonium phosphates.

UNIT – IV

Potassium Fertilizers:

Nitrophosphates, Ores for the potassic fertilizers, potassium chlorides, potassium sulfate, potassium nitrite liquid fertilizers, pollution abatement methods, controlled release fertilizers.

Text Book:

1. Hand book on Fertilizers, published, Fertilizer Association of India, New Delhi

Reference Books:

1. Chemistry and Technology of Fertilizers, V. Sauchelli, Reinhold Publications.
2. Fertilizer manual, A UNIDO Publication from International Fertilizer Development Centre, Albania, USA.

ChE 423 (C) TECHNOLOGY OF EDIBLE FATS

Lectures : 4 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs *Credits : **4***

Course Objectives

1 To provide strong knowledge of refining and modification of oils for edible purpose.
2 To describe how to manufacture the specialty fats such as butter, ghee, vanaspathi, bakery and confectionary.
3 To provide strong knowledge about storage, stability and packing of edible fats.
4 To describe how to handle the fat products in order to overcome the pollution problems.

Course Outcomes

i. An ability to explain different techniques of modification and refining of oils.
ii. An ability to describe the manufacturing processes of specialty fats.
iii. An ability to understand the pollution problems involved and how to overcome the same.
iv. An ability to understand the handling techniques of fat products.

UNIT – I

Refining:

Processes and plants employed for refining, bleaching and deodorization.

UNIT – II

Modification:

Hydrogenation and Winterization of oils for edible purposes, manufacture and evaluation of auxiliary materials such as nickel catalysts and hydrogen.

UNIT – III

Specialty Fats:

Manufacture of butter, margarine, ghee, vanaspati, bakery and confectionery fats and fatty foods, composition and properties of products.

UNIT – IV

Storage, Stability and Packing:

Spoilage during storage of fats and fat products, storage, handling and stabilization of edible fats and oils, pollution problems in oil industry, packaging of fats and oils.

Text Book:

1. Bailey's Industrial Oil and Fat products, Fereidoon Shahidi, Alton Edward Bailey, Fereidoon Shahidi , Swern Daneil E, 6th edition, John Wiley Publishers(2005).

Reference Book:

1. Technology of Oilseeds Processing, Oils & Fats And Refining, EIRI Board, Engineers India Research Institute (2011)

ChE 423 (D) NANOTECHNOLOGY

Lectures : 4 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs *Credits : **4***

Course Objectives

1. To provide the students strong knowledge of the molecular nanotechnology.
2. To provide the strong knowledge about the concepts of nano powders, nano tubes and nanomaterials.
3. To provide the exposure to the students about the synthesis of rotaxanes and catenanes, molecular computers.
4. To provide the strong knowledge of the nano biometrics.

Course Outcomes

i. An ability to explain about molecular nanotechnology, nanolithography
ii. An ability to explain the concept of preparation of nanomaterials, sol-gels.
iii. An ability to explain the .synthesis of rotaxanes and catenanes
iv. An ability to explain about lipids, DNA strucute.

UNIT-I

Introduction to nanotechnology:
Importance of nanotechnology and nanoscale, molecular and atomic size, surface and dimensional spaces.

Molecular nanotechnology:
Atoms by inference, electron microscopes (SEM) nanomanipulator, nanotweezers, atom manipulation, nanodots, nanolithography.

UNIT-II

Nanopowders and nanomaterials:
Concepts of nanomaterials, preparation, plasma arcing, chemical vapor deposition, sol-gels, electrodeposition, ball milling, applications.

Carbon nanotubes:
Structure, Types, formation, assemblies, purification, properties and uses.

UNIT-III

Molecular mimics:
Catenanes and rotaxanes, various molecular switches, synthesis of rotaxanes and catenanes, molecular computers, chemical rotors, prodders, flippers, atom shuttles, actuators, contacts.

Optics, photomics and solar energy:
Properties of light and nanotechnology, interaction.

UNIT-IV

Nanobiometrics:
Lipids as nano-bricks and mortar, self-assembled monolayers, proteins, 3-D structures arising from amines acids, nanoscale motors, biological computing, ion channels as sensors, information in DNA structure, using DNA to build nano-cubes, hinges, smart glue, wire template.

Text Book:

1. Nanotechnology (Basic Science and EmergingTechnologies) by Mick Wilson, K.K.Geoff Smith , Michella Simmons and Burkhard Raguge, Overseas Press(2005).

Reference Book:

1. Introduction to Nanotechnology by Charles P. Poole, Jrl and Frank J Owens, 1st edition,Wiley Inter-science(2007).

ChE 423 (E) COMPUTER AIDED DESIGN

Lectures : 4 periods / week — *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs — *Credits : **4***

Course Objectives

1. To introduces the students to the available computational tools for process flow design development and general design considerations.
2. Development of system design skills for chemical processes
3. Experience solving a complex engineering design problem
4. To prepare process simulations (using Aspen, Pro II) for unit operations including Heat Exchangers, 2-phase separators, 3-phase separators, Reactors, Mixers, Pipe segments, Evaporators, Thermo siphon reboiler, Distillation and Condensers.

Course Outcomes

i. An ability to prepare process flow sheets for design showing reactors, distillation columns and other process equipment.
ii. An ability to apply knowledge of mathematics, science and engineering.
iii. An ability to design a system, component, or process to meet desired needs.
iv. An ability to use the techniques, skills and modern engineering computer tools necessary for engineering practice.

UNIT-I

Introduction:

Tracing the Historical Development, Task of the process engineer, what is mathematical modeling and simulation, Scope and structure.

Estimation of Gas and liquid properties:

Volumetric properties of gases, Volumetric properties of liquids, Fugacity of gases and liquids, Estimation of Enthalpy.

CAD of flow of fluids in Pipes:

Flow of Newtonian fluids in pipes, Sizing of pipes for Newtonian and Non-Newtonian flow, Pressure drop in compressible fluid flow, Flow of Non –Newtonian fluids in pipes, Pipe network calculations, Two-Phase flow systems.

UNIT – II

CAD of heat transfer equipment:

Introduction, Shell and Tube Exchangers without phase change, Condensers, Reboilers, Applications to furnaces.

UNIT – III

CAD of mass transfer equipment:

Introduction, Distillation, Gas Absorption, Liquid extraction

CAD of chemical reactors:

Introduction, Extent of reaction, analysis of rate data, Ideal reactor models, Temperature effects in homogeneous reactors.

UNIT – IV

Chemical Process Simulation:

Introduction, Process simulation Techniques, Partitioning and Tearing, The Flow sheet Simulator.

Text Book:

1. Chemical Process Computations by Raghu Raman, Elsevier Applied Science Publishers, the University of Michigan(1985)

Reference Books:

1. Computer Applications in chemical Engineering: Process Design & simulation by Robert G. Squires,G. V. Reklaitis, Books on Demand (1980)
2. Computer Aided Process Plant Design by M.E.Leesley , Gulf Pub. Co., Book Division(1982)
3. Chemical Engineering Design by R. K. Sinnott, Gavin Towler, 5th Edition, Elsevier Publications (2010)

ChE 423 (F) PETROLEUM REFINERY ENGINEERING

Lectures : 4 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs *Credits : **4***

Course Objectives

1. To provide the knowledge about design, reserves, composition and pretreatment of crude oil, refinery and testing methods of petroleum products.
2. To provide the knowledge about the petroleum products atmospheric and vacuum industrial distillations.
3. To provide knowledge about improving the quality and quantity of gasoline from refinery products by thermal cracking, catalytic cracking, hydro cracking and refining.
4. To provide the knowledge about converting useless products into useful forms of gasoline by alkylation, isomerization, polymerization etc.,

Course Outcomes

i. An ability to understand the extent of availability of petroleum resources for future generation.
ii. An ability to succeed in the competitive examinations of petroleum industries.
iii. An ability to use innovative methods in extracting the highly demanded petroleum products from crude oil.
iv. An ability to identify and improving the qualities of petroleum products. Determination of type of gasoline for different climatic conditions

UNIT – I

Origin and formation:

Origin and formation of petroleum, reserves and deposits of the World, Indian petroleum industry, composition of crudes. Refinery products and test methods. Evaluation of crudes. Crude pretreatment, dehydration and desalting, pipe still heater, atmospheric and vacuum distillation of crude oil.

UNIT – II

Gasoline Treatment:

Treatment of products, additives, blending of gasoline, treatment of gasoline, kerosene, lubes and lubricating oil, wax.

UNIT – III

Cracking:

Thermal and catalytic cracking, hydrocracking and hydrotreating, catalytic reforming.

UNIT – IV

Reforming and Asphalt Technology:

Coking, visbreaking, alkylation, isomerization, polymerization, asphalt and air blown asphalt.

Text Book:

1. Modern petroleum Refining Processes, B.K.B.Rao, Oxford IBH.

Reference Book:

1. Petroleum Refining Engineering, Nelson, McGraw Hill

ELECTIVE - IV

ChE 424 (A) CATALYST SCIENCE AND TECHNOLOGY

Lectures : 4 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs *Credits : **4***

Course Objectives

1. To provide the knowledge about how to deal with the adsorption process which is fundamental to catalysis.
2. To outline the utility of adsorption process for evaluating the texture and also surface properties of catalysts.
3. To provide knowledge about the mechanism of catalytic reactions and steps involved in it.
4. To provide the detailed description of catalytic deactivation.

Course Outcomes

i. An ability to understand the adsorption process and its application in catalysis.
ii. An ability to describe in detail about the adsorption isotherms.
iii. An ability to explain various steps involved in catalytic reactions and techniques such as synthesizing and reforming catalyst.
iv. An ability to understand the types and & mechanism of catalyst deactivation.

Unit-I

Introduction of catalysis: Definition, Catalyst properties, Heterogeneous & Homogeneous Catalysis, Nature of catalytic reactions, Adsorption & Chemisorptions

Unit-II

Mechanism: Steps in Catalytic reactions, Synthesizing the rate law, mechanism and rate limiting step, reforming catalyst, geometric electric factor in catalysis, adsorption isotherms.

Unit-III

Process: Production, testing & characterization of industrial catalysts

Solid Catalyst: Determination of surface area, void volume & solid density, pore volume distribution, theories of heterogeneous catalyst.

Unit-IV

Catalyst deactivation: Types & mechanism of catalyst deactivation, Decay reactions, determination of rate from experimental data from independent deactivation, effect of pore diffusion resistance on the kinetics of reaction with deactivating catalysts. Temperature-time trajectories, moving bed reactors, straight through transport reactors (STTR).

Text Books:

1. Elements of chemical reaction engineering, H. Scott Fogler, 4th edition, Pearson Prentice Hall. (Unit - I, II & IV)
2. Chemical Engineering Kinetics, J. M. Smith, 3rd edition, McGraw Hill Publishers. (Unit - III)

Reference Books:

1. Heterogeneous catalysis – Principles and applications, G. Bond, 2nd edition, Oxford University Press.
2. Catalytic processes with prover catalysis, C. C. Thomas, Academic press.

ChE 424 (B) FOOD TECHNOLOGY

Lectures : 4 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs *Credits : **4***

Course Objectives

1. To provide the knowledge about function and sources of food components such as lipids, proteins, Carbohydrates and vitamins and minerals..
2. To provide knowledge about the nutritional needs that include factors effecting nutritional needs and recommended daily intakes (RDI).
3. To provide the detailed description of deteriorative factors and their control.
4. To provide the knowledge about the techniques such as sterilization and pasteurization.

Course Outcomes

i. An ability to understand the recommended daily intakes for various life stages.
ii. An ability to describe conversion and preservation operations of the food by using suitable techniques.
iii. An ability to explain various steps involved sterilization and &pasteurization of food products.
iv. An ability to apply the knowledge of maintenance of the various products such as bakery, confectionary, soft & alcoholic beverages and dairy products.

UNIT-1

General aspects of Food Industry, Constituents of Food, Quality & nutritive aspects, Food additives, Standards.

UNIT-II

Deteriorative factors and their control, Preliminary methods, Conversion and preservation operations, Preservation by Heat and Cold, Concentration, Drying, Irradiation, Microwave heating.

UNIT-III

Sterilization & Pasteuterisation, Fermentation & Pickling, Packing methods, Cereal grains, Pulses, Vegetables, Fruits, Spices, Fats & Oils.

UNIT-IV

Bakery, Confectionery & Chocolate Products, Soft & Alcoholic beverages, Dairy products, Meat, Poultry & Fish products.

Text Book:

1. Food Science, Norman N. Potter Joseph H. Hatchkiss, 5th edition, CSB Publishers & Distributors, New Delhi

Reference Books:

1. Fundamentals of Food processing operations, J.L.Heid and K.A Joslyn, the AVL Publishing Co., Westport
2. Food Process Engineering, D.R. Heldman, The AVL Publishing Co., Westport
3. The Fundamentals of Food Engineering, S.E. Charm, The AVL Publishing Co., Westport.

ChE 424 (C) OPTIMIZATION OF CHEMICAL PROCESS

Lectures : 4 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs *Credits : **4***

Course Objectives

1. Understands the maximizing and minimizing methods for single variable functions
2. Determines the maxima using linear programming and Simplex method for linear convex functions
3. Develops objective functions for optimizing design of flow and mass transfer equipment.
4. Simplifies and solves the optimization problems in chemical processes

Course Outcomes

i. Ability to fit data to linear and nonlinear functions.
ii. Ability to formulate chemical processes as optimization problems.
iii. Ability to solve linear convex objective functions.
iv. Ability to simplify and solve complex chemical engineering processes.

UNIT – I

Fundamentals of Optimization:

Nature and Organization of optimization problems, fitting models to data, formulation of objective functions, obstacles to optimization. Basic concepts of optimization, optimization of unconstrained function – single and two variables, one dimensional search - numerical methods

UNIT – II

Optimization Techniques:

Linear programming and applications, Simplex method and applications.

UNIT – III

Chemical Engineering Examples:

Optimization of recovery of waste heat, shell and tube heat exchanger, evaporator design, liquid-liquid extraction process, optimal design of staged distillation column.

UNIT – IV

Chemical Engineering Examples:

Optimal pipe diameter, optimal residence time for maximum yield in an ideal isothermal batch reactor, chemostat, optimization of a thermal cracker.

Text Book:

1. Optimization of chemical process by T.F.Edgar, D.M.Himmelblau and L.S.Lasdon, 2nd edition, McGraw Hill(2001).

Reference Book:

1. Engineering Optimization: Theory and Practice by S.S.Rao, 3rd edition,New Age International(P) Ltd.,(1996)

CHE424 (D) FUEL CELL TECHNOLOGY

Lectures : 4 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs *Credits : **4***

Course Objectives

1. To provide an overall view of hydrogen economy and basic electro chemistry and thermodynamics of fuel cells.
2. To provide the knowledge of various types of fuel cells such as alkaline, phosphoric acid fuel cells and solid oxide fuel cells etc.
3. To provide the description of modeling and testing of fuel cells.
4. To describe the fuel processing techniques.

Course Outcomes

i. Ability to describe working principle and components of alkaline fuel cell.
ii. Ability to describe the benefits and limitations, components of the solid oxide cells.
iii. Ability to explain the mile stones in direct methanol fuel cell technology.
iv. Ability to apply the modeling and testing techniques to the processing of Membrane fuel cells..

UNIT–I

Introduction:

Fuel Cell relevance and importance, historical highlights, classification of fuel cells

Alkaline fuel cells:

Description of alkaline fuel cell, working principle, components of alkaline fuel cell, modules, fuel cell stacks, ammonia as AFC fuel, general performance characteristics

UNIT–II

Phosphoric acid fuel cells:

Electrodes, materials and manufacturing, stacks and systems

Solid oxide fuel cells:

Benefits and limitations, cell components, cathode materials, anode materials, configurations and performance

UNIT–III

Molting carbonate fuel cells:

Cell components, mechanism of electrode reactions, status of MCFCs

Direct Methanol Fuel cells:

Mile stones in direct methanol fuel cell technology, eletro oxidation of methanol, the electrolyte, non-catalytic aspects, state of art of methanol crossover in DMFC

UNIT–IV

Proton Exchange Membrane Fuel Cells:

Scientific challenges, technology development, fuel processing, modeling studies of PEMFC performance

Fuel Processing:

Processing hydrogen from alcohols, producing hydrogen from hydro carbons, hydrogen from other sources

Hydrogen Storage:

Hydrogen storage, hydrogen production, hydrogen as an engine fuel, methods of hydrogen storage

Text Book:

1. Fuel Cell Principles and Applications, B.Viswanathan, M.Aulice Scibioh, Universities Press

Reference Book:

1. Constructional features and operating characteristics of fuel cells, Weidlich Erhard

ChE 424 (E) INDUSTRIAL BIOTECHNOLOGY

Lectures : 4 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs *Credits : **4***

Course Objectives

1. To impart the knowledge on historical overview of biotechnology.
2. To provide the knowledge of production of some commercially important modern bioproducts .
3. To provide the knowledge of production of organic acids, vitamins and antibiotics.
4. To describe the production of various types of enzymes.

Course Outcomes

i. Ability to describe various steps involved in fermentation process and explain various types of sterilization.
ii. Ability to describe the steps involved in the production of bioproducts and methods to improve modern biotechnology.
iii. Ability to explain the production methods of organic acids, amino acids and vitamins & antibiotics.
iv. Ability to describes the various steps involved in enzyme production.

UNIT – I

Introduction to Fermentation Processes:
The range of fermentation processes, microbial biomass, microbial enzymes microbial metabolites, recombinant products, transformation processes, the chronological development of the fermentation industry.
Media for industrial fermentations: Typical media, medium formulation, energy sources, carbon sources, nitrogen sources, minerals, growth factors, nutrient recycle.
Sterilization: Medium sterilization, sterilization of the fermentor and feeds.

UNIT – II

Organic acids: Production of citric acid, acetic acid and lactic acid
Amino acids: Commercial uses of amino acids, strains for amino acid production, production of glutamic acid.
Vitamins & Antibiotics : Production of vitamin B_{12}, production of β-lactam, antibiotics, amino acid & peptide antibiotics and macro cyclic lactone antibiotics.

UNIT – III

Enzymes: Production of amylases, proteases, pectinases and lipases
Organic feed stocks: production of Ethanol, acetone / butanol
Ergot alkaloids: Occurrence and significance, structure, biosynthesis, production of ergot alkaloids, regulation of alkaloid production in cultures, strain development

UNIT – IV

Microbial transformations: Types of bioconversion reactions, procedures for bio transformation, transformation of steroids & sterols, non steroid compounds, antibiotics and pesticides.
Single Cell Protein (SCP) : Production of SCP form alkanes, methanol fermentations, SCP from wood, carbohydrates and sewage.

Newer Approaches to sewage treatment: Starter cultures for treatment processes, aerobic, sewage treatment-air lift process, aeration with pure oxygen, methane production.

Text Books :

1. Principles of Fermentation Technology P.F. Stanbury, A Whitaker and S.J.Hall, 2nd Edition, Elsevier (Unit – I)
2. A Text book of Industrial Microbiology, Wulf.Cruger & Anneliese Cruger, 2nd Edition, Panima Publishing Corporation (Units-II,III,IV)

Reference Books :

1. Industrial Microbiology, J.E.Casida, New Age
2. Industrial Microbiology, Prescott & Dunn, Agrobios, Jodhpur
3. Industrial Microbiology, A.H.patel, McMillan

ChE 424 (F) INDUSTRIAL HAZARDS AND SAFETY ANALYSIS

Lectures : 4 periods / week *Sessional Marks : 40*

Semester End Exam Marks : 60

Semester end Exam: 3 hrs *Credits : **4***

Course Objectives

1. The Students are able to understanding the predominating hazards associated with objects, facilities, equipment and work practices in the work environment and of appropriate control procedures and devices to be considered - to control the hazards
2. The Students are able to participate actively in preparing a technical team safety project, analyzing a safety scenario and developing a program to correct the problem and prevent recurrences.
3. The Students are able to study the effect of toxic and flammable materials and conduct the management of a fire prevention and abatement program.
4. The Students are able to demonstrate knowledge of appropriate protective equipment, safety and health training procedures.

Course Outcomes

i. To attain the knowledge of human error and human factors principles and how they relate to Process Safety Management.
ii. To improve human performance by reducing human error-likely work situations through design, improved work instructions, training and the recognition of human factors hazards.
iii. To practice performing human factors and procedures analyses in realistic workshops and safety education training programmes.
iv. Able to reduce the process hazards by using protective equipments and communicate the safety and hazard analysis reports

UNIT – I

Introduction:

Definition of safety. The basis for safety. Chemical hazards and worker safety. Hazards of commercial chemical reactions and operations. Hazop studies, Fault Tree analysis, Event Tree Analysis.

UNIT – II

Safety:

Process design, instrumentation for safe operations, safety education and training.

UNIT – III

Risk:

Effect of toxic agents, flammable materials, Risk assessment, Work permit systems.

UNIT – IV

Protection:

Personnel protective equipment, fire extinguishing agents and their applications, measuring safety effectiveness.

Text Book:

1. Safety and accident prevention in Chemical operations by Fewcett H.H. and W.S.Wood, 2nd editon John Wiley and Sons Inc(1982).

Reference Book:

1. Safety Handling of Hazardous Chemicals by Rohatgi, A.K.Enterprises(1986)
2. Industrial safety practices by Bob skeltor
3. Chemical process safety –Learning from case histories by Roy E Sanders, 3rd edition, Elsevier Butterworth Heinemann (2004).

ChE 461 COMPUTER AIDED PROCESS EQUIPMENT DESIGN LABORATORY

Practicals : 3 periods / week *Sessional Marks : 40*

University Exam Marks : 60

University Exam : 3 hrs *Credits : **2***

Course Objectives

1. To acquire knowledge to design a system, component, process to meet desired needs within realistic constraints such as location, layout, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
2. An understanding to identify, formulate and solve chemical engineering problems.
3. To develop working knowledge, including safety and environmental aspects of material and energy balances, equilibria, heat, mass and momentum transfer rates, chemical reaction kinetics, continuous and stage-wise separation operations for a process.
4. To learn the importance of process economics with professional and ethical responsibility in process design.

Course Outcomes

i. Synthesize and analyze process flow sheets
ii. Effectively lead chemical engineering projects in industry
iii. Be able to perform process selection
iv. Analyze and design mass and heat transfer equipment

1. Flow chart symbols
2. Engineering drawings

Simulation using Aspen

3. Properties estimation
4. Material & Energy balances
5. Sensitivity Analysis
6. Design Specification
7. Mixers & Splitters
8. Pumps
9. Heat Exchangers
10. Columns
11. Reactors

ChE 462 PROJECT WORK

Practicals : 9 periods / week — *Sessional Marks : 80*

University Exam Marks : 120

University Exam : 3 hrs — *Credits : **10***

Course Objectives

1. To develop a comprehensive design of a chemical process or chemical plant.
2. The students are able to do literature survey regarding the current importance of the product and the various processes available for producing that product.
3. To perform material and energy balances on every unit operation included, if possible by using software such as ASPEN and design of chemical process equipment
4. To develop a brief plan of plant layout, location, safety, installation costs and profits.

Course Outcomes

i. Ability to analyze and improve a chemical process or a chemical plant.
ii. Ability to provide alternative methods to reduce energy requirements and raw material requirement.
iii. Ability to design a virtual chemical plant using computer software.
iv. Ability to create a comprehensive technical report and present it.

The project work should be

An Experimental work related to Chemical and allied Industrial products

(OR)

An Industry sponsored Project (theoretical or experimental)

(OR)

A Comprehensive design project of a chemical plant in the form of a report

The project report should contain the following chapters.

1. Introduction
2. Physical and chemical properties and uses.
3. Literature survey for different processes
4. Selection of the process
5. Material and energy balances
6. Specific equipment design / Experimentation
   (Process as well as mechanical design with drawing, including computer programs where possible, of heat transfer equipment / separation equipment / reactors)
7. General equipment specifications.
8. Plant location and layout
9. Materials of construction
10. Health and safety factors
11. Preliminary cost estimation
12. Bibliography.