R.V.R. & J.C. COLLEGE OF ENGINEERING :: GUNTUR
(Autonomous)

REGULATIONS (R-18) FOR
Four Year BACHELOR OF TECHNOLOGY (B.Tech.) Degree Program

(w.e.f. the batch of candidates admitted into First Year B.Tech. from the academic year 2018-2019).

1 MINIMUM QUALIFICATIONS FOR ADMISSION

A candidate seeking admission into First Year of B.Tech. Degree Program 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 A candidate seeking admission into Second Year of B.Tech. Degree Program should have passed either 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 BRANCHES OF STUDY

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

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

3 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 candidates (Diploma Holders) admitted under lateral entry into Second Year B.Tech. is Three academic years consisting of two semesters in each academic year. The medium of instruction and the examination is English.

4 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 REGISTERING THE COURSES

5.1 A candidate has to register and secure 160 credits which include laboratory courses and project work. However, the candidate admitted under lateral entry has to register and secure 122 credits, which includes laboratory courses and project work.

5.2 A candidate has to register and secure at least minimum pass grade in Mandatory Courses, for which no credits are awarded.

5.3 A candidate has to secure at least minimum pass grade in Value Added Courses offered by the individual departments, for which no credits are awarded.

5.4 MOOCS (Massive Open Online Course):

- Enrolment of MOOCs courses of 12 weeks duration (421-Professional Elective & 422-Open Elective) will be initiated from the date of commencement of class work for Semester VI [Third Year] from the list of organisations offering MOOCS course(s) announced by the respective Board of Studies / Head of Departments and courses completion certificate must be submitted on or before the last instruction day of Semester VIII [Fourth Year].

- However, a student can register and complete more no.of MOOCs course(s) of his/her interest and must submit the completion certificate(s) on or before the last instruction day of Semester VII [Fourth Year], which will be reflected in the consolidated grade sheet.

5.5 Internship / Certification / Industrial Training (4 weeks in two spells) :

- Enrollment of Internship / Industrial Training will be initiated at the end of Semester IV [Second Year] and Semester VI [Third Year].

- Internship / Industrial Training completion certificate(s) must be submitted on or before the last instruction day of Semester VII [Fourth Year].

6 EVALUATION

The performance of the candidates in each semester shall be evaluated Course wise.

6.1 The distribution of marks between Sessional Examination (based on internal assessment) and Semester End Examination is as follows:

Nature of the Courses	Sessional Marks	Semester End Exam. Marks
Theory Courses / Design and / or Drawing / Practicals	40	60
Mini Project / Term paper / Mandatory Course / Value Added Course	100	---
Project work	40	60 (Viva voce)

6.2 In each of the Semesters, there shall be two Mid Term examinations and two Assignment Tests in every theory course. 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 candidate scores more marks and the remaining 3 marks (20% approx.) for other midterm examination in which the candidate 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 candidate scores more marks and remaining 2 marks (20% approx.) shall be given for the assignment test in which the candidate scores less marks.

A maximum of five marks are allotted for attendance in the respective theory courses in a graded manner as indicated in ***clause 8.2.*** The remaining 5 marks out of the 40 marks earmarked for the sessional marks are awarded (quiz / online examination) by the concerned teacher in the respective theory courses.

6.3 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 day-to-day 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 work shall be 15 and 25 respectively.

NOTE : A candidate 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.

6.4 A candidate 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.

7 LABORATORY / PRACTICAL COURSES

In any semester, a minimum of 10 experiments / exercises specified in the syllabus for laboratory course shall be completed by the candidate and get the record certified by the concerned faculty and Head of the Department, to be eligible to face the Semester End Examination in that Practical course.

8 ATTENDANCE REGULATIONS

8.1 Regular course of study means a minimum average attendance of 75% in all the courses 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 course as the denominator and the total number of hours / periods actually attended by the candidate in all the courses, as the numerator.

8.2 A weightage in sessional marks up to a maximum of 5 marks out of 40 marks in each theory course shall be given for those candidates 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%	- 2 mark
Attendance of 80% and above but less than 85%	- 3 marks
Attendance of 85% and above but less than 90%	- 4 marks
Attendance of 90% and above	- 5 marks

8.3 Condonation of shortage in attendance may be recommended on genuine medical grounds, up to a maximum of 10% provided the candidate puts in at least 65% attendance as calculated in ***clause 8.1***, provided the Principal is satisfied with the genuineness of the reasons and the conduct of the candidate. However, marks will not be awarded for condonation of shortage in attendance.

8.4 A candidate who could not satisfy the minimum attendance requirements in any semester as mentioned in ***clause 8.1***, is not eligible to appear for the Semester End Examinations and shall have to repeat the same Semester.

9 DETENTION

A candidate, who fails to satisfy either the minimum attendance requirements as stipulated in ***Clause-8***, or the requirement of minimum aggregate sessional marks as stipulated in ***Clause-6***, shall be detained. Such candidate shall have to repeat the same semester.

10 SEMESTER END EXAMINATION

10.1 For each theory course, there shall be a comprehensive Semester End Examination at the end of each Semester.

10.2 For each Practical course the Smester 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.

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

11 CONDITIONS FOR PASS

A candidate shall be declared to have passed in individual course if he / she secures a minimum of 35% marks in theory and 50% marks in Practical courses/drawing courses/Project Viva-voce in Semester End Examination and minimum of 40% marks in both Sessional & Semester End Examination put together.

12 AWARD OF CREDITS

12.1 Credits are awarded for each Theory Course / Practical Course and Project Work.

12.2 AWARD OF GRADES

S.No.	Range of Marks	Grade	Grade Points
1	≥ 90	O	10.0
2	≥ 80 - < 90	A^+	9.0
3	≥ 70 - < 80	A	8.0
4	≥ 60 - < 70	B^+	7.0
5	≥ 50 - < 60	B	6.0
6	≥ 40 - < 50	C	5.0
7	< 40	F	0.0
8	The grade 'W' represents withdrawal / absent	W	0.0

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

12.4 A candidate who has earned 'F' grade in any course can repeat the course and can improve the internal marks by re-registering a maximum of TWO Subjects per semester. However, a student, who is not on rolls due to detention (not promoted to the next semester), can register a maximum of SIX subjects comprising of all semesters, put together.

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

- The list of courses for each semester and corresponding credits and grades obtained
- The Semester Grade Point Average (SGPA) for each semester and
- The Cumulative Grade Point Average (CGPA) of all courses put together up to that semester.

SGPA is calculated based on the following formula: $\frac{\sum [\text{ No. of Credits X Grade Points }]}{\sum \text{ No. of Credits}}$

CGPA will be calculated in a similar manner, considering all the courses up to that semester.

12.6 A consolidated Grade Sheet shall be issued to the candidate, after completing all , indicating the CGPA of all the Four / Three years put together.

12.7 Conversion of CGPA into equivalent Percentage.: Percentage of Marks = 9.25 x CGPA

13 CONDITIONS FOR PROMOTION

13.1 A candidate shall be eligible for promotion to next semester, if he/she satisfies the minimum requirements of attendance and sessional marks as stipulated in ***Clauses 6 and 8***.

13.2 A candidate shall be eligible for promotion to Third Year, if he / she secures 26 credits (70% approx.) of the total number of credits (38) of First Year by the time the classwork commences for Third Year, in addition to satisfying the minimum requirements of attendance and sessional marks stipulated in ***Clauses 6 and 8*** in Semester IV [Second Year].

13.3 A candidate shall be eligible for promotion to Fourth Year, if he / she secures a minimum of 70% of the total number of credits of First & Second Years put together, by the time the classwork commences for Fourth Year, in addition to satisfying the minimum requirements of attendance and sessional marks stipulated in ***Clauses 6 and 8*** in Semester VI [Third Year].

S. No.	Branch	Total No. of Credits First & Second Years put together	Minimum No. of Credits required for promotion (70% approximately)
1	Computer Science & Business Systems	38+40 = 78	54
2	Chemical Engineering	38+40 = 78	54
3	Civil Engineering	38+46 = 84	58
4	Computer Science & Engineering	38+44 = 82	57
5	Electrical & Electronics Engineering	38+45 = 83	58
6	Electronics & Communication Engineering	38+45 = 83	58
7	Information Technology	38+44 = 82	57
8	Mechanical Engineering	38+44 = 82	57

13.4 A candidate (Diploma Holder) admitted under lateral entry into Second Year, shall be eligible for promotion to Fourth Year, if he/she secures a minimum of 70% of the total number of credits of Second Year by the time the classwork commences for Fourth Year, in addition to satisfying the minimum requirements of attendance and sessional marks stipulated in ***Clauses 6 and 8*** in Semester VI [Third Year]

S. No.	Branch	Total No. of Credits in Second Year	Minimum No. of Credits required for promotion (70% approximately)
1	Computer Science & Business Systems	40	28
2	Chemical Engineering	40	28
3	Civil Engineering	46	32
4	Computer Science & Engineering	44	30
5	Electrical & Electronics Engineering	45	31
6	Electronics & Communication Engineering	45	31
7	Information Technology	44	30
8	Mechanical Engineering	44	30

14 ELIGIBILITY FOR AWARD OF B.TECH. DEGREE

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

14.1 The candidate must have satisfied the conditions for pass in all the courses of all the years as stipulated in ***Clauses 11***.

14.2 **Maximum Time Limit for completion of B.Tech Degree**

A candidate, 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.

14.3 A candidate (Diploma Holder) admitted under lateral entry into Second Year B.Tech., who fails to fulfil 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.

15 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	5.5 or more but less than 6.5
4	Third Class	5.0 or more but less than 5.5

16 IMPROVEMENT OF CLASS

A candidate, after becoming eligible for the award of the Degree, may improve the CGPA by appearing for the Semester End Examination in any of the theory course as and when conducted. But this provision shall be within a period of two academic years after becoming eligible for the award of the Degree. However, this facility cannot be availed by a candidate who has taken the Original Degree Certificate.

17 AWARD OF RANK

The rank shall be awarded based on the following:

17.1 Ranks shall be awarded in each branch of study for the top five percent of the candidates appearing for the Regular Semester End Examinations or the top ten candidates whichever is minimum.

17.2 Only such candidates who pass the Final year examination at the end of the fourth/third academic year after admission as regular final year candidate 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/three academic years.

17.3 For the purpose of awarding rank in each branch, only such candidates who passed all courses in the first attempt only shall be considered.

18 SUPPLEMENTARY EXAMINATIONS

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

18.2 Instant examination will be conducted immediately after the declaration of Semester VIII [Fourth Year] results for those candidates who cleared all courses except one course in Semester VIII [Fourth Year].

19 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 candidates in which the candidates joins subsequently.

19.1 A candidate, studied under R-16 regulations of RVR & JCCE (Autonomous) curriculum, detained due to lack of academics/attendance at the end of the Semester II [First Year] or Semester III [Second Year], shall join in appropriate Semester of R-18 regulations. The candidate has to clear all the backlog subjects or equivalent subjects if any under R-18 curriculum by appearing the supplementary examinations, conducted by the college under R-18 curriculum. The class will be awarded based on the academic performance of the candidate as R-18 regulations.

19.2 A candidate, studied under R-16 regulations of RVR & JCCE (Autonomous) curriculum, detained due to lack of academics / attendance at the end of the Semester IV [Second Year] and also at the subsequent semesters will follow the same R-16 regulations/curriculum and he/she has to complete all the courses by appearing in the examination conducted by the college under R-16 curriculum. The class will be awarded based on the academic performance of the candidate as per R-16 regulations.

19.3 A candidate, transferred from other institutions / universities into Semester II [Second Year] and also at the subsequent semesters of B.Tech., shall join at appropriate semester of R-18 curriculum. Such candidate shall study all the courses prescribed for that batch, in which, the candidate joins. The candidate has to clear the backlog courses, if any, in the semesters which he/she has studied in the earlier institutions / universities by appearing the supplementary examinations conducted by the college in R-18 circulum courses / equivalent courses. The equivalent courses will be decided by concerned Board of Studies.

20 CONDUCT AND DISCIPLINE

20.1 Candidates shall conduct themselves within and outside the premises of the institute in a manner befitting the candidates of our institution.

20.2 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.

20.3 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.

a Lack of courtesy and decorum, indecent behaviour anywhere within or outside the campus.

b Wilful damage of college / individual property

c Possession, consumption or distribution of alcoholic drinks or any kind of narcotics or hallucinogenic drugs.

d Mutilation or unauthorized possession of library books.

e Noisy and unseemly behaviour, disturbing studies of fellow candidates.

f 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.)

g Usage of camera / cell phone in the campus

h Plagiarism of any nature

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

20.4 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.

20.5 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.

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

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

20.8 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.

20.9 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.

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

21 MALPRACTICES

21.1 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 candidates basing on the recommendations of the committee.

21.2 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.

22 AMENDMENTS TO REGULATIONS

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

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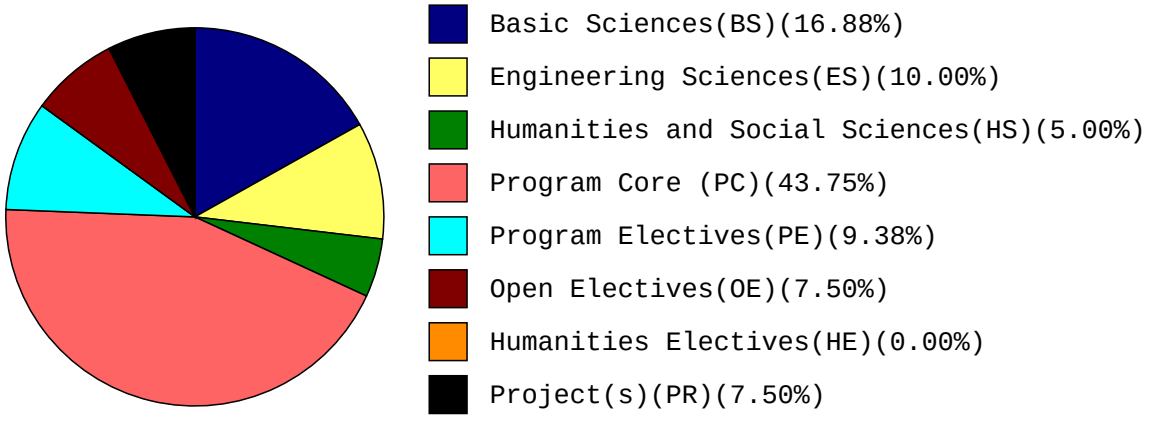
DEPARTMENT OF CHEMICAL ENGINEERING

B.TECH. CHEMICAL ENGINEERING

Program curriculum grouping based on course components

Course Component	Curriculum Content (% of total number of credits program)	Total number of contact hours	Total number of credits
Basic Sciences (BS)	16.88	30	27
Engineering Sciences (ES)	10	23	16
Humanities and Social Sciences (HS)	5	10	8
Professional Core (PC)	43.75	83	70
Professional Electives (PE)	9.38	12	15
Open Electives (OE)	7.5	9	12
Project(s) (PR)	7.5	20	12
Mandatory Course(s) (MC)	--	8	--
Total number of Credits			160



B.TECH. CHEMICAL ENGINEERING

(w.e.f. the batch of students admitted from the academic year 2018-2019)

Three Weeks Orientation Programme is Mandatory before starting Semester I [First Year]

Semester I [First Year] COURSE STRUCTURE

SNo.	Course Details		Scheme of Instruction			Scheme of Examination			Category Code
	Code No.	Subject Name	Periods per week			Maximum Marks		Credits	
			L	T	P	SES	EXT		
1	CH 111	Mathematics-I	3	1	-	40	60	4	BS
2	CH 112	Engineering Physics	3	1	-	40	60	4	BS
3	CH/CE/EE/ME 113	English for Communication Skills	2	-	-	40	60	2	HS
4	CH 151	Physics Lab	-	-	3	40	60	1.5	BS
5	CH/CE/EE/ME 152	English Language Communication Skills Lab	-	-	2	40	60	1	HS
6	CH/CS/EC/IT 153	Engineering Graphics & Design Lab	1	-	4	40	60	3	ES
7	MC 001	Constitution of India	2	-	-	100	-	-	MC
8	MC 003	Essence of Indian Traditional Knowledge	2	-	-	100	-	-	MC
		TOTAL	13	2	9	440	360	15.5	TPW-24

Semester II [First Year] COURSE STRUCTURE

SNo.	Course Details		Scheme of Instruction			Scheme of Examination			Category Code
	Code No.	Subject Name	Periods per week			Maximum Marks		Credits	
			L	T	P	SES	EXT		
1	CH 121	Mathematics-II	3	1	-	40	60	4	BS
2	CH 122	Chemistry	3	1	-	40	60	4	BS
3	CH/CE/CS/EE/ EC/IT/ME 123	Programing for Problem Solving	3	-	-	40	60	3	ES
4	CH/ME 124	Basic Electrical Engineering	3	1	-	40	60	4	ES
5	CH 161	Chemistry Lab	-	-	3	40	60	1.5	BS
6	CH/CE/CS/EE/ EC/IT/ME 162	Programing for Problem Solving Lab	-	-	4	40	60	2	ES
7	CH/CS/EC/IT 163	Workshop Practice Lab	1	-	4	40	60	3	ES
8	CH/ME 164	Basic Electrical Engineering Lab	-	-	2	40	60	1	ES
9	MC 002	Environmental Science	2	-	-	100	-	-	MC
10	CH V01	English Competency Development Programme	2	-	-	100	-	-	VC
		TOTAL	17	3	13	520	480	22.5	TPW-33

Semester III [Second Year] COURSE STRUCTURE

SNo.	Course Details		Scheme of Instruction			Scheme of Examination			Category Code
	Code No.	Subject Name	Periods per week			Maximum Marks		Credits	
			L	T	P	SES	EXT		
1	CH 211	Mathematics III (Probability and statistics)	3	-	-	40	60	3	BS
2	CH 212	Life Science for Engineers	2	-	-	40	60	2	BS
3	CH 213	Physical and Organic Chemistry	3	-	-	40	60	3	BS
4	CH 214	Chemical Process Calculations	3	-	-	40	60	3	PC
5	CH 215	Momentum Transfer	3	-	-	40	60	3	PC
6	CH 216	Mechanical Operations	3	-	-	40	60	3	PC
7	CH 251	Organic Chemistry Lab	-	-	2	40	60	1	PC
8	CH 252	Momentum Transfer Lab	-	-	2	40	60	1	PC
9	MC 004	Design Thinking & Product Innovation	2	-	-	100	-	-	MC
		TOTAL	19	0	4	420	480	19	TPW-23

Semester IV [Second Year] COURSE STRUCTURE

SNo.	Course Details		Scheme of Instruction			Scheme of Examination			Category Code
	Code No.	Subject Name	Periods per week			Maximum Marks		Credits	
			L	T	P	SES	EXT		
1	CH 221	Numerical Methods in Chemical Engineering	3	-	-	40	60	3	PC
2	CH 222	Material Technology	3	-	-	40	60	3	PC
3	CH 223	Industrial Instrumentation & Instrumental Methods of Analysis	3	-	-	40	60	3	PC
4	CH 224	Process Heat Transfer	3	-	-	40	60	3	PC
5	CH 225	Chemical Engineering Thermodynamics-I	3	-	-	40	60	3	PC
6	CH 226	Chemical Reaction Engineering-I	3	-	-	40	60	3	PC
7	CH 261	Process Heat Transfer Lab.	-	-	2	40	60	1	PC
8	CH 262	Mechanical Operations Lab.	-	-	2	40	60	1	PC
9	CH 263	Computational Programming Lab.	-	-	2	40	60	1	PC
		TOTAL	18	0	6	360	540	21	TPW-24

Semester V (Third Year) COURSE STRUCTURE

SNo.	Course Details		Scheme of Instruction			Scheme of Examination			Category Code
	Code No.	Subject Name	Periods per week			Maximum Marks		Credits	
			L	T	P	SES	EXT		
1	CH 311	Mass Transfer Operations-I	3	-	-	40	60	3	PC
2	CH 312	Chemical Engineering Thermodynamics-II	3	-	-	40	60	3	PC
3	CH 313	Chemical Reaction Engineering-II	3	-	-	40	60	3	PC
4	CH 314	Chemical Technology	3	-	-	40	60	3	PC
5	CH 315	Professional Elective-I	3	-	-	40	60	3	PE
6	CH 316	Open Elective-I	3	-	-	40	60	3	OE
7	CH 351	Mass Transfer Operations-I Lab.	-	-	2	40	60	1	PC
8	CH 352	Chemical Reaction Engineering Lab	-	-	2	40	60	1	PC
9	CH 353	Communicative English Lab	1	-	2	40	60	2	HS
		TOTAL	19	0	6	360	540	22	TPW-25

Semester VI [Third Year] COURSE STRUCTURE

SNo.	Course Details		Scheme of Instruction			Scheme of Examination			Category Code
	Code No.	Subject Name	Periods per week			Maximum Marks		Credits	
			L	T	P	SES	EXT		
1	CH 321	Mass Transfer Operations-II	3	-	-	40	60	3	PC
2	CH 322	Process Dynamics & Control	3	-	-	40	60	3	PC
3	CH 323	Industrial Pollution Control	3	-	-	40	60	3	PC
4	CH 324	Process Modeling and Simulation	3	-	-	40	60	3	PC
5	CH 325	Professional Elective-II	3	-	-	40	60	3	PE
6	CH 326	Open Elective-II	3	-	-	40	60	3	OE
7	CH 361	Mass Transfer Operations-II Lab	-	-	2	40	60	1	PC
8	CH 362	Chemical Technology Lab	-	-	2	40	60	1	PC
9	CH 363	INSTRUMENTATION & PROCESS CONTROL LABORATORY	-	-	3	40	60	1	PC
		TOTAL	18	0	7	360	540	21	TPW-25

Semester VII [Fourth Year] COURSE STRUCTURE

SNo.	Course Details		Scheme of Instruction			Scheme of Examination			Category Code
	Code No.	Subject Name	Periods per week			Maximum Marks		Credits	
			L	T	P	SES	EXT		
1	CH 411	Process Economics & Industrial Management	3	-	-	40	60	3	HS
2	CH 412	Transport Phenomena	3	-	-	40	60	3	PC
3	CH 413	Chemical Engineering Plant Design	3	-	-	40	60	3	PC
4	CH 414	Professional Elective-III	3	-	-	40	60	3	PE
5	CH 415	Professional Elective-IV	3	-	-	40	60	3	PE
6	CH 416	Open Elective-III	3	-	-	40	60	3	OE
7	CH 451	Computer Aided Process Design and Simulation lab	-	-	3	40	60	1.5	PC
8	CH 452	Pollution Control Lab.	-	-	2	40	60	1.5	PC
9	CH 453	Mini Project	-	-	4	100	-	2	PR
10	CH 454	Summer Internship	-	-	-	100	-	2	PR
		TOTAL	18	0	9	520	480	25	TPW-27

Semester VIII [Fourth Year] COURSE STRUCTURE

SNo.	Course Details		Scheme of Instruction			Scheme of Examination			Category Code
	Code No.	Subject Name	Periods per week			Maximum Marks		Credits	
			L	T	P	SES	EXT		
1	CH 421	Professional Elective-V (MOOC)	-	-	-	-	100	3	PE
2	CH 422	Open Elective-IV (MOOC)	-	-	-	-	100	3	OE
3	CH 461	Project	-	-	16	40	60	8	PR
		TOTAL	0	0	16	40	260	14	TPW-16

Professional Elective Courses

Code No.	Subject Name	Code No.	Subject Name
CHEL01	Petroleum Exploration well Logging	CHEL02	Petroleum Refinery Engineering
CHEL03	Petrochemical Technology	CHEL04	Natural Gas Production and its applications
CHEL05	General Pharmacy	CHEL06	Pre-formulation studies including stability Studies
CHEL07	Industrial Pharmacy	CHEL08	Quality control of pharmaceutical Dosage Forms
CHEL09	Computer Simulators	CHEL10	Computer Aided Process Engineering
CHEL11	Computer Aided Design	CHEL12	Computational Fluid Dynamics
CHEL13	Electrochemical Engineering	CHEL14	Industrial Hazards and Safety Analysis.
CHEL15	Fluidization Engineering	CHEL16	Bio-Chemical Engineering
CHEL17	Nanotechnology	CHEL18	Polymer Science and Engineering
CHEL19	Advanced Separation Processes	CHEL20	Optimization of Chemical Process

Value Added Courses

Code No.	Subject Name	Code No.	Subject Name

Open Elective Courses

Code No.	Subject Name	Code No.	Subject Name
CEOL01	Building Materials and Construction	CEOL02	Solid waste Management
CEOL03	Remote Sensing and GIS	CSOL01	Programming with Java
CSOL02	Relational Database Management Systems	CSOL03	Introduction to Python Programming
CSOL04	Internet of Things	ECOL01	Applied Electronics
ECOL02	Basic Communication	ECOL03	Basic Electronics & Communication Engineering
ECOL04	Microprocessors & Interfacing	ECOL05	Digital Image Processing
EEOL01	Renewable Energy Sources	EEOL02	Utilization of Electrical Energy
EEOL03	Power Converters	EEOL04	Energy Conservation
EEOL05	Electric Vehicles	ITOL01	Data Structures & Algorithms
ITOL02	Operating Systems	ITOL03	Big Data Analytics
ITOL04	Web Technologies	MEOL01	Automotive Engineering
MEOL02	Robotic Engineering	MEOL03	Introduction to Operations Research
MEOL04	Mechatronics	MEOL05	Applied Mechanics & Mechanical Engineering

Semester I [First Year]

CH 111 MATHEMATICS-I

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*1 hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*4*

Course Objectives

i. The objective of this course is to familiarize the prospective engineers with techniques in matrices, multivariate calculus and integral transforms.
ii. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

Course Outcomes

1) Know the basic linear algebraic concepts.
2) Solve multivariate calculus problems of double integrals and vector differentiation.
3) Find integration of vector functions and find Fourier series and transforms.
4) Find Laplace and inverse transforms of a function.

UNIT - I **CO: 1**

Rank of a matrix, Normal form, Inverse by Gauss Jordan method. System of linear equations: Non homogeneous, homogeneous systems.

Eigen values and Eigen vectors, Cayley-Hamilton Theorem (without proof), Diagonalization of matrices, reduction of quadratic form to canonical form.

UNIT – II **CO: 2**

Multiple Integrals - Double integrals (Cartesian and polar), Change of order of integration.

Change of variables: Cartesian to polar coordinates. Scalar and vector point functions, Gradient, directional derivative, divergence and curl, Del applied twice to point and product of point functions (without proofs).

UNIT – III **CO: 3**

Integration of vectors - Line integrals, surface integrals, Green's theorem in the plane (without proof), Stoke's theorem (without proof).

Fourier series - Half range cosine and sine series. Fourier transforms - Fourier transforms, Fourier sine and cosine transforms and inverse transforms.

UNIT – IV **CO: 4**

Laplace transforms - Introduction, properties of Laplace transforms, Evaluation of integrals by Laplace transforms.

Inverse Laplace transforms - Method of partial fractions, other method of finding inverse transforms t f(t)= L [- F(s)], Convolution theorem (without proofs).

LEARNING RESOURCES

TEXT BOOKS:

1) B.S.Grewal - Higher Engineering Mathematics, Khanna publishers, 42nd edition, 2017.

REFERENCE BOOKS:

1) Erwin Kreyszig - Advanced Engineering Mathematics, John Wiley & Sons, 2006.
2) N.P. Bali and Manish Goyal - A text book of Engineering Mathematics, LaxmiPublications, Reprint, 2010.

WEB RESOURCES:

1) http://nptel.iitm.ac.in/courses/

CH 112 ENGINEERING PHYSICS

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*1 hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*4*

Course Objectives

i. To understand about basic phenomena of light waves.
ii. To understand about Principle and applications of optical fiber and fundamentals of Laser, its types and applications.
iii. To understand development of Electromagnetic wave equations and various properties, applications of dielectric & magnetic materials.
iv. To understand Essential formulation of physics in the micro world by learning the prerequisite quantum physics.

Course Outcomes

1) Identify and illustrate wave phenomena such as interference in thin films, concept of diffraction, birefringence and production and detection of different polarized lights.
2) Understanding the basic concepts of lasers, fibers and their applications.
3) Acquire knowledge about the Maxwell's equations and various terms related to properties of materials such as permeability, polarization, etc
4) Some of the basic laws related to quantum mechanics such as wave particle duality, uncertainty principle, Schrodinger wave equation & its applications etc.

UNIT - I **CO: 1**

Interference & Diffraction: Introduction, Stoke's principle, interference in thin films due to reflected light (cosine law), Newton's rings (formation, derivation for diameters of bright and dark rings). Concept of diffraction, distinguish between Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit(quantitative), theory of a plane transmission grating, dispersive Power & resolving power of a grating.

Polarisation: Introduction, double refraction, construction & working of a Nicol prism, quarter waveplate, production & detection of circular and elliptical polarizations (qualitative), optical activity (optical rotation & specific rotation).

UNIT – II **CO: 2**

Fiber Optics & Lasers:

Fibre Optics: Introduction, structure of optical fibre, principle of optical fibre, numerical aperture, types of optical fibres, Fiberoptic sensors (intensity modulated temperature sensor, displacement sensor, & liquid level detector), applications.

Lasers: characteristics, spontaneous & stimulated emissions, population inversion, pumping, optical resonant cavity, types of lasers: solid state (Nd:YAG) laser, Gas laser(He-Ne), Semiconductor laser (Ga-As), industrial & medical applications of lasers.

UNIT - III **CO: 3**

Electromagnetism, Dielectrics and Magnetic Properties of Materials: Electromagnetism: induced electric fields, displacement current, Maxwell's equations-qualitative (integral &differential forms)-significance, velocity of an electromagnetic wave equation in free space.

Dielectrics & Magnetic Properties of Materials: Basic definitions, polar and non-polar dielectrics (qualitative), types of polarizations - electronic, ionic polarisations (quantitative), internal fields in solids, Clausius-Mossotti equation, applications of dielectrics. Magnetization,

permeability and susceptibility, origin of magnetic moment, classification of magnetic materials, hysteresis curve, soft & hard magnetic materials.

UNIT – IV **CO: 4**

Quantum Mechanics:

Introduction to quantum physics, blackbody radiation explanation using the photon concept (laws of black body radiation, Planck's radiation law-derivation), photoelectric effect (Einstein's equation), Compton effect (explanation, derivation). De-Broglie concept of matter waves, properties of matter waves, verification of matter waves (Davisson - Germer experiment), uncertainty principle-experimental verification (electron diffraction-single slit), Schrodinger time independent wave equation, physical significance of wave function, particle in box (one dimensional).

LEARNING RESOURCES

TEXT BOOKS:

1) M.N. Avadhanulu, P.G. Kshirasagar - Engineering Physics, S. Chand & Company Ltd., 9thedition, Ram Nagar, New Delhi, 2018. (UNIT I)

2) Md. Khan & S. Panigrahi - Principles of Engineering physics-1, Cambridge University Press- 2016. (UNIT II)

3) SL Kakani & Shubhra kakani - Engineering Physics, 3rd Edition, CBS Publications Pvt. Ltd., New Delhi. (UNITs III & IV)

REFERENCE BOOKS:

1) Fundamentals of physics: D. Halliday, R. Resick and J. Walker 6th edition, John Wiley and sons, Inc., New York, 2001..

2) Engineering Physics: Hitender K. Mallick, A.K.Singh McGraw Hill Education (India) Pvt. Ltd., New Delhi.

3) Concepts of Modern Physics: Arthur Beiser 6th edition, Tata McGraw Hill Education Pvt Ltd., New Delhi.

4) D.K.Bhattacharya & Poonam Tandon - Engineering Physics, Oxford University Press-2015.

CH 113 ENGLISH FOR COMMUNICATION SKILLS

Lectures	:	*2 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*2*

Course Objectives

i. To enable students improve their lexical and communicative competence and to equip students with oral and written communication skills.
ii. To help students understand and learn the correct usage and application of Grammar principles.
iii. To get them acquainted with the features of successful professional communication.
iv. To enable students acquire various specific features of effective written communication.

Course Outcomes

1) Use vocabulary contextually.
2) Compose effectively the various forms of professional communication.
3) Apply grammar rules efficiently in spoken and written forms.
4) Improve clarity to locate and learn the required information.

UNIT - I **CO: 1**

1.1 - Root words from foreign languages and their use in English.
1.2 - Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.
1.3 - Synonyms, antonyms, and standard abbreviations.
1.4 - One word substitutes

UNIT – II **CO: 2**

2.1 - Proposal writing
2.2 - Letter-writing
2.3 - Techniques for writing precisely (précis writing)
2.4 - E-mail writing

UNIT – III **CO: 3**

Identifying Common Errors in Writing

3.1 - Subject-verb agreement
3.2 - Noun-pronoun agreement
3.3 – Articles
3.4 – Prepositions
3.5 – Tenses
3.6 – Redundancies

UNIT – IV **CO: 4**

Nature and Style of Sensible Writing

4.1 - Description & Narration (Paragraph Writing). [CO:1,2,3]
4.2 - Essay Writing (Expository Essay). [CO:1,2,3]
4.3 - Note-Making and Note-Taking. [CO:1,2,4]
4.4 - Methods of preparing notes. [CO:1,2,4]

LEARNING RESOURCES

TEXT BOOKS:

1) Communication Skills. Sanjay Kumar and Pushpa Lata.Oxford University Press.

REFERENCE BOOKS:

1) Remedial English Grammar. F.T. Wood. macmillan.2007

2) On Writing Well. William Zinsser. Harper Resource Book. 2001
3) Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press.2006.
4) Practical English Usage. Michael Swan. OUP. 1995Press

CH 151 PHYSICS LAB

Practicals	: *3 hrs*		*Sessional Marks*	:	*40*
			Semester End Exam Marks	:	*60*
Semester End Exam.	: *3 hrs*		*Credits*	:	*1.5*

Course Objectives

i. Physics lab provides students the first-hand experience of verifying various theoretical concepts learnt in theory courses.

Course Outcomes

1) Use CRO, Function generator, Spectrometer for making measurements
2) Test the optical instruments using principles of interference and diffraction.
3) Understand the concepts learned in the Physics theory.
4) Carrying out precise measurements and handling sensitive equipment.
5) Draw conclusions from data and develop skills in experimental design.

List of Experiments:

1) Measurements using Vernier Calipers, Screw Gauge and Spherometer.
2) Newton's rings - Measurement of radius of curvature of plano-convex lens.
3) Determination of Energy band gap of a Semiconductor.
4) Optical fibers - Determination of Numerical Aperture.
5) Diffraction grating - Measurement of wavelengths using Spectrometer.
6) Magnetic field in Helmholtz coil.
7) Photo-Voltaic Cell - Determination of fill factor.
8) Series LCR resonance circuit - Determination of Q - factor.
9) Four probe method apparatus for measurements of resistivity and conductivity.
10) Determination of wavelengths using diffraction grating.
11) Variation of magnetic field along the axis of a circular current carrying coil.
12) Carey Foster's bridge - Determination of Specific Resistance.

REFERENCE BOOK: Physics Lab Manual, R.V.R. & J.C. CE, Guntur
Note: A minimum of 10(Ten) experiments have to be performed and recorded by the candidate to attain eligibility for Semester End Practical Examination.

CH 152 ENGLISH LANGUAGE COMMUNICATION SKILLS LAB

Practicals	*: 2 hrs*		*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*: 3 hrs*		*Credits*	*:*	*1*

Course Objectives

I To identify speaker's purpose and tone; make inferences and predictions about spoken discourse, discuss and respond to content of a lecture or listening passage orally and/or in writing.
ii To acquaint the students with the Standard English pronunciation, i.e., Receive Pronunciation (RP), with the knowledge of stress and intonation.
iii To develop production and process of language useful for social and professional life.
iv To develop in them communication and social graces necessary for functioning.
v Improve the dynamics of professional presentations.
vi To develop critical reading and comprehension skills at different levels.

Course Outcomes

1) Comprehend relationships between ideas and make inferences and predictions about spoken discourse.
2) Speak English with a reasonable degree of accuracy in pronunciation with success.
3) Develop appropriate speech dynamics in professional situations.
4) Use effective strategies and social graces to enhance the value of communication.
5) Develop effective communication and presentation skills and using language effectively to face interviews.

List of Exercises / Activities:

Oral Communication
(This unit involves interactive practice sessions in Language Lab).

1) Listening Comprehension.
2) Pronunciation, Intonation, Stress and Rhythm.
3) Common Everyday Situations: Conversations and Dialogues.
4) Interviews.
5) Formal Presentations.
6) Reading Comprehension

REFERENCE BOOK(S):

1 Communication Skills. Sanjay Kumar and Pushpa Lata. Oxford University Press.
2 Practical English Usage. Michael Swan. OUP. 1995 Press
3 Exercises in Spoken English. Parts.I- III. CIEFL, Hyderabad. Oxford University
4 Technical English .M. Sambaiah, Wiley Publications, New Delhi

CH 153 ENGINEERING GRAPHICS & DESIGN LAB

Practicals	*: 4 hrs*		*Sessional Marks*	*:*	*40*

Semester End Exam Marks : 60

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

Course Objectives

i. Expose the students to standards and conventions followed in preparation of engineering drawings.
ii. Make them understand the concepts of orthographic and isometric projections.
iii. Develop the ability of conveying the engineering information through drawings.
iv. Make them understand the relevance of engineering drawing to different engineering domains.
v. Develop the ability of producing engineering drawings using drawing instruments.
vi. Enable them to use computer aided drafting packages for the generation of drawings.

Course Outcomes

1) Prepare engineering drawings as per BIS conventions mentioned in the relevant codes.
2) Produce computer generated drawings using CAD software.
3) Use the knowledge of orthographic projections to represent engineering information / concepts and present the same in the form of drawings.
4) Develop isometric drawings of simple objects reading the orthographic projections of those objects.
5) Convert pictorial and isometric views of simple objects to orthographic views.

(Units I to IV shall be taught in conventional drawing method and Unit V shall be taught with the aid of computer)

UNIT - I

General: Principles of Engineering Graphics and their significance, usage of drawing instruments, lettering.

Conic sections: Construction of Ellipse, Parabola, Hyperbola and Rectangular Hyperbola. (General method only).

Curves: Cycloid, Epicycloid, Hypocycloid and Involute and Scales.

UNIT – II

Method of Projections: Principles of projection - First angle and third angle projection of points, Projection of straight lines inclined to both planes. Traces of lines.

Projections of planes: Projections of planes inclined to both the planes, projections on auxiliary planes.

UNIT – III

Projections of Regular Solids: Projections of solids (Prism, Pyramid, Cylinder and Cone) with varying positions.

Sections of Solids: Sections of Prisms, Pyramids, cylinders and Cones. True shapes of sections. (Limited to the cutting plane perpendicular to one of the principal plane).

Development of surfaces: Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only).

UNIT – IV

Isometric Projections: Principles of Isometric projection-Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids.

Orthographic Projections: Conversion of pictorial views into Orthographic views and Vice-versa. (Treatment is limited to simple castings).

Perspective Projections: Introduction to Perspective Projection.

UNIT V

Over view of Computer Aided drafting (AutoCAD): Introduction, starting and customizing AutoCAD screen, usage of different menus, toolbars(drawing, editing, dimension, text, object properties..etc), tabs (Object, snap, grid, polar, ortho, otrack..etc) and command prompt. Setting units, limits, layers and viewports (Isometric, Top, Front, back..etc).

2D drawings of various mechanical and structural components, electrical and electronic circuits. Orthographic and Isometric views of mechanical castings and simple structures.

LEARNING RESOURCES

TEXT BOOKS:

1) Bhatt N.D., Panchal V.M. & Ingle P.R. - Engineering Drawing, Charotar Publishing House, 2014.

REFERENCE BOOKS:

1) Shah, M.B. & Rana B.C. - Engineering Drawing and Computer Graphics, Pearson Education, 2008.

2) Agrawal B. & Agrawal C. M. - Engineering Graphics, TMH Publication, 2012.

3) Narayana, K.L. & P Kannaiah - Text book on Engineering Drawing, Scitech Publishers, 2008.

(Corresponding set of) CAD Software Theory and User Manuals

MC 001	CONSTITUTION OF INDIA [MANDATORY NON-CREDIT COURSE] Semester I [First Year]	L T P C Int Ext 2 - - - 100 -

COURSE OBJECTIVES:

To provide basic information about Indian Constitution.

COURSE OUTCOMES:

After successful completion of the course, the students are able to

1. study guidelines for the State as well as for the Citizens to be followed by the State in the matter of administration as well as in making the laws. It also includes fundamental duties of the Indian Citizens in Part IV A (Article 51A).
2. know how the State is administered at the State level and also the powers and functions of High Court.
3. understand special provisions relating to Women empowerment and also children. For the stability and security of the Nation, Emergency Provision are Justified.
4. understand election commission as an independent body with enormous powers and functions to be followed both at the Union and State level. Amendments are necessary, only major few amendments have been included.

UNIT I [CO:1]

Preamble to the Constitution of India Domicile and Citizenship. Fundamental rights under Part III, Leading Cases. Relevance of Directive Principles of State Policy under Part-IV, IV-A Fundamental duties.

UNIT II **[**CO:2]

Union Executive - President, Vice-President, Prime Minister, Union Legislature - Parliament and Union Judiciary - Supreme Court of India. State Executive - Governors, Chief Minister, State Legislature and High Court.

UNIT III **[**CO:3]

Special Constitutional Provisions for Scheduled Casters and Tribes, Women and Children and Backward Classes, Emergency Provisions.

UNIT IV [CO:4]

Electoral process, Centre State Relations (Amendment Procedure, 42nd, 44th, 74th, 76th, 86th and 91st Constitutional amendments).

LEARNING RESOURCES:

TEXT BOOK:

Durga Das Basu: "Introduction to the Constitution of India" (student edition) Prentice - Hall EEE,

19th/20th Edition, 2001.

REFERENCE BOOK(s):

1. M.V.Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2002.
2. Brij Kishore Sharma, "Introduction to the Constitution of India", PHI, Learning Pvt.Ltd., New Delhi, 2011.

MC 003	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE (Common for all Branches) **Semester I [First Year]**	L T P C Int Ext **2 - - - 100 -**

COURSE OBJECTIVES:

To Facilitate the students with the concepts of Indian traditional knowledge and to make them understand the importance of roots of knowledge system.

COURSE OUTCOMES:

At the end of the course, the students are able to

1. understand the concept of traditional knowledge and its importance.
2. Apply significance of traditional knowledge protection.
3. Analyze the various enactments related to the protection of traditional knowledge.
4. Evaluate the concepts of intellect.

UNIT [CO:1]

Introduction to traditional Knowledge: Definition of traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge,characteristics, the historical impact of social change on traditional knowledge syatems, traditional knowledge VS western knowledge, traditional knowledge vis-a-vis formal knowledge.

UNIT II [CO:2]

Protection of traditional knowledge: the need for protecting traditional knnowledge, Significance of TK Protection, Value of TK in global economy, Role of Government to harness TK.

UNIT III [CO:3]

A:Legal framework and TH: The Scheduled Tribes and Other Traditional Forest Dwellers(recognition of Forest Rights) ACt 2006; Plant Varities Protection and Farmer's Rights Act,2001 (PVPFR ACT)

B: The Biological Diversity Act 2002 and Rules 2004 and the protection of traditional knowledge bill, 2016

UNIT IV [CO:4]

Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and Traditional knowledge, Strategies to increase protection of traditional knowledge, Traditional knowledge in different sectors; Engineering, Medicine syatem, biotechnology and agriculture, Managment of biodiversity, Food security of the country and protection of TK.

LEARNING RESOURCES:

TEXT BOOK:

Traditional Knowledge System in India, by Amit Jha, ATLANTIC Publishers, 2009.

REFERENCE BOOK(s):

1. Traditional Knowledge System and Technology in India by Basanta Kumar, Mohanta and Vipin Kumar Singh ,PratibhaPrakashanPublishers,2012.
2. Knowledge Traditions and Practices of India by Kapil Kapoor and Michel Danino.

WEB RESOURCES:

1. http://www.youtube.com/watch?v=LZP1StpYEPM
2. http://nptel.ac.in/courses/121106003/

CH 121 MATHEMATICS-II

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*1 hr*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*4*

Course Objectives

i. The objective of this course is to familiarize the prospective engineers with techniques in differential equations and to introduce the solution methodologies for second order Partial Differential Equations with applications in engineering.
ii. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

Course Outcomes

1) Solve differential equations which model physical processes.
2) Solve physical problems using Bessel's and Legendre's functions.
3) Develop their attitude towards problem solving of PDEs.
4) Solve problems in engineering involving PDEs.

UNIT - I **CO: 1**

Differentials equations of first order - Linear equations, Bernoulli's equation, exact equations, equations reducible to exact equations.
Differentials equations of higher order - Second order linear differential equations with constant coefficients - Method of variation of parameters, Cauchy's homogeneous linear equation and Legendre's linear equation.

UNIT – II **CO: 2**

Series solution of differential equations - When x = 0 is an ordinary point, Frobenius method. Bessel equation, Bessel function, recurrence formulae for $J^n(x)$, expansions for J^0 , J^1 , $J^{1/2}$, $J^{-1/2}$, Generating function, Orthogonality of Bessel functions.

Legendre's equation, Rodrigue's formula, generating function for $P^n(x)$, recurrence formulae for $P^n(x)$, Orthogonality of Legendre's polynomials.

UNIT – III **CO: 3**

Partial differential equations - Introduction, Formation of partial differential equations, Equations solvable by direct integration, Linear equations of the first order.
Applications of partial differential equations - Introduction, Method of separation of variables. Solution of the one-dimensional wave equation.

UNIT – IV **CO: 4**

Solution of one-dimensional heat flow equation.
Solution of Laplace's equation.

LEARNING RESOURCES

TEXT BOOKS:

1) B.S.Grewal - Higher Engineering Mathematics, Khanna publishers, 42nd edition, 2017.

REFERENCE BOOKS:

1) Erwin Kreyszig - Advanced Engineering Mathematics, John Wiley & Sons, 2006

2) N.P. Bali and Manish Goyal - A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.

CH 122 CHEMISTRY

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*1 hr*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*4*

Course Objectives

i. To understand the concepts of bonding in Inorganic and Organic molecules.
ii. To know about the stereochemistry of organic molecules.
iii. To learn about the reactivity of organic compounds and relates it to synthesis methodologies.

Course Outcomes

1) Know the structure of molecules and relate it to spectral and magnetic properties.
2) Relate the structure of molecules to its reactivity.
3) Apply the bonding concept in arriving at the mechanisms of reactions.
4) Design simple mechanisms for reactions.

UNIT - I **CO: 1**

Significance of Schrodinger equation, Molecular Orbital Theory, Structure, Bonding and energy levels of diatomic molecules (O2, N2, CO, NO).
Crystal field theory-Electronic spectra and magnetic properties of complexes in tetrahedral and octahedral geometry.

UNIT – II **CO: 2**

Stereochemistry: Geometrical isomerism: Definition, cis and trans forms, E-Z configuration-sequence rules and examples.
Stereo isomerism-Optical isomer, Optical isomerism in Lactic acid and Tartaric acid, R-S notation for optical active compounds. Enantiomers and Diastereomers, Conformers of cyclic systems-Bayerâ€™s strain theory and acyclic systems (n-butane).

UNIT – III **CO: 3**

Reactivity of organic molecules-Inductive effect, Mesomeric effect, Electromeric effect and hyper conjugation.
Factors influencing acidity and basicity of molecules, Nucleophilic addition, Substitution and elimination reactions and their mechanisms.

UNIT – IV **CO: 4**

Synthesis of Organic compounds: Methods for preparation and chemical reactions of acids, Phenols, Carbonyl and amine compounds.
Reactive intermediates-Preparation, Structure, stability and properties of Carbocations, Carbanions and Free radicals. Rearrangement- Aldol condensation, Claisen condensation, Deckmann condensation, Cannizaro reaction, Perkin reaction.

LEARNING RESOURCES

TEXT BOOKS:

1) Madan, Malik and Tuli - Inorganic chemistry, 17th edition, S.Chand and company. (UNIT I)
2) Arun Bahl and B.S. Bahl - Organic chemistry, 22nd edition, S.Chand and company. (UNIT II, III & IV)

REFERENCE BOOKS:

1) J.D. Lee - Concise Inorganic chemistry, 5th edition, Wiley Publications.

2) F. Albert Cotton, Geoffrey Wilkinson, Paul L. Gaus - Basic Inorganic Chemistry, 3rd Edition.
3) Morrison Boyd & Bhattacharjee - Organic Chemistry, 7 edition.
4) Raj K. Bansal - Organic Reaction Mechanisms, 4th edition, New Age International Publishers.

CH 123 PROGRAMING FOR PROBLEM SOLVING

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To understand the basic problem solving process using Flow Charts and algorithms.
ii. To understand the basic concepts of control structures in C.
iii. To learn concepts of arrays, functions, pointers and Dynamic memory allocation in C.
iv. To use the concepts of structures, unions, files and command line arguments in C.

Course Outcomes

1) Develop algorithms and flow charts for simple problems.
2) Use suitable control structures for developing code in C.
3) Design modular programs using the concepts of functions and recursion.
4) Develop code for complex applications using structures, pointers and file handling features.

UNIT - I **CO: 1**

Introduction to Programming: Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc) **Idea of Algorithm:** Steps to solve logical and numerical problems, Representation of Algorithm: Flowchart / Pseudocode with examples, from algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code, Arithmetic expressions and precedence.

UNIT – II **CO: 2**

Conditional Branching and Loops: Writing and evaluation of conditionals and consequent branching, Iteration and loops.
Arrays: Arrays (1-D, 2-D), Character arrays and Strings Basic Algorithms: Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations.

UNIT – III **CO: 3**

Function: Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference.
Recursion: Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series.

UNIT – IV **CO: 4**

Structures: Structures, Defining structures and Array of Structures.
Pointers: Idea of pointers, Defining pointers, Use of Pointers in self-referential structures.
File handling: Defining and opening a file, closing a file, input/output operations on files using file handling functions, random access to files.

LEARNING RESOURCES

TEXT BOOKS:

1) Byron Gottfried - Programming with C (Schaum's Outlines), Third Edition, Tata McGraw-Hill.

REFERENCE BOOKS:

1) Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.
2) Programming in C by Stephen G. Kochan, Fourth Edition, Pearson.

3) C Complete Reference, Herbert Sheildt, TMH., 2000
4) Programming with C by K R Venugopal & Sudeep R Prasad, TMH., 1997.

WEB RESOURCES:

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

CH 124 BASIC ELECTRICAL ENGINEERING

Lectures	*: 3 hrs*		*Sessional Marks*	*:*	*40*
Tutorial	*: 1 hr*		*Semester End Exam Marks*	*:*	*60*
Semester End Exam.	*: 3 hrs*		*Credits*	*:*	*4*

Course Objectives

i. To introduce fundamental laws, basic electrical elements, sources and their characteristics.
ii. To develop the ability to apply circuit analysis to AC circuits.
iii. To provide students with fundamental concepts on the construction and operation of transformers and electrical machines.

Course Outcomes

1) Understand the basic electrical circuits and batteries.
2) Gain the knowledge on the concept of AC circuits.
3) Get the knowledge on the principle and operation of single phase transformer.
4) Understand the operation of electrical machines.

UNIT - I **CO: 1**

Batteries: Lead-acid, Nickel-iron, Nickel-Cadmium batteries (Operation only). Elementary calculations for energy consumption.

DC Circuits: Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems.

UNIT – II **CO: 2**

AC Circuits: Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor.

Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), three phase balanced circuits, voltage and current relations in star and delta connections.

UNIT – III **CO: 3**

Transformers: Magnetic materials, BH characteristics, working principle of single phase transformer, ideal and practical transformer, and equivalent circuit form O.C and S.C tests.

Losses in transformers, regulation and efficiency. Auto-transformer - Working principle, comparison with two winding transformer.

UNIT – IV **CO: 4**

Electrical Machines: Construction, working principle of DC generator and motor (Elementary treatment only), torque-speed characteristic of separately excited dc motor.

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency. Construction and working of synchronous generators.

LEARNING RESOURCES

TEXT BOOKS:

1) T.K.Nagasarkar and M.S.Sukhija - Principles of Basic Electrical Engineering, Oxford University Press, 2018.
2) D. P. Kothari and I. J. Nagrath - Basic Electrical Engineering, Tata McGraw Hill, 2010.

REFERENCE BOOKS:

1) D. C. Kulshreshtha - Basic Electrical Engineering, McGraw Hill, 2009.
2) L. S. Bobrow - Fundamentals of Electrical Engineering, Oxford University Press, 2011.

3) E. Hughes - Electrical and Electronics Technology, Pearson, 2010.
4) V. D. Toro - Electrical Engineering Fundamentals, Prentice Hall India, 1989.
5) J.B Gupta - Basic Electrical Engineering, S. K. Kataria & Sons, 6th Edition 2015

WEB RESOURCES:

1) http://www.egate.ws/
2) http://cosmolearning.org/courses/circuit-theory/
3) http://www.nptelvideos.in/2012/11/circuit-theory.html
4) http://elearning.vtu.ac.in/P9/notes/06ES34/Unit1-KCV.pdf
5) http://pbtstudies.blogspot.in/

CH 161 CHEMISTRY LAB

Practicals	*: 3 hrs*		*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*: 3 hrs*		*Credits*	*:*	*1.5*

Course Objectives

i. To learn the concepts of equivalent weight, molecular weight, normality, molarity, weight percent, volume percent.
ii. To know the methods of determining hardness and chloride ion content of water sample.
iii. To know principles and methods involved in using instruments like Conductivity Bridge and potentiometer.
iv. To know synthetic methods for preparation of drugs and polymer.
v. To learn the systematic analysis of organic compounds.

Course Outcomes

1) Estimate the Fe (II) content of a given solution and chloride/hardness content of water.
2) Systematically analyze a given organic compounds.
3) Measure conductance of solutions, redox potentials of a cell.
4) Synthesize a small drug molecule and polymer.

List of Experiments:

1) Determination of Hardness of water using EDTA method
2) Estimation of Mohr's salt using $K_2Cr_2O_7$.
3) Determination of Fe(II) strength using $K_2Cr_2O_7$ potentiometrically
4) Determination on strength of NaOH using HCI conductometrically
5) Preparation of Benzanilide
6) Preparation of m-dinitrobenzene
7) Preparation of Phenol Formaldehyde resin
8) Systematic analysis of Organic compound-I.
9) Systematic analysis of Organic compound-II.
10) Systematic analysis of Organic compound-III.
11) Determination of rate constant of ester hydrolysis.
12) Determination of Rf value using TLC

CH/CE/CS/EE/EC/IT/ME 162 PROGRAMING FOR PROBLEM SOLVING LAB

Practicals	*:*	*4 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*2*

Course Objectives

i. To understand the basic problem solving process using Flow Charts and algorithms.
ii. To understand the basic concepts of control structures in C.
iii. To learn concepts of arrays, functions, pointers and Dynamic memory allocation in C.
iv. To use the concepts of structures, unions, files and command line arguments in C.

Course Outcomes

1) Develop algorithms and flow charts for simple problems.
2) Use suitable control structures for developing code in C.
3) Design modular programs using the concepts of functions and recursion.
4) Develop code for complex applications using structures, pointers and file handling features.

List of Exercises / Activities:

[The laboratory should be preceded or followed by a tutorial to explain the approach or algorithm to be implemented for the problem given.]

1 **Tutorial 1 : Problem solving using computers:**
Lab1: Familiarization with programming environment
2 **Tutorial 2: Variable types and type conversions:**
Lab 2: Simple computational problems using arithmetic expressions
3 **Tutorial 3: Branching and logical expressions:**
Lab 3: Problems involving if-then-else structures.
4 **Tutorial 4: Loops, while and for loops:**
Lab 4: Iterative problems e.g., sum of series.
5 **Tutorial 5: 1D Arrays: searching, sorting:**
Lab 5: 1D Array manipulation.
6 **Tutorial 6: 2D arrays and Strings:**
Lab 6: Matrix problems, String operations.
7 **Tutorial 7: Functions, call by value:**
Lab 7: Simple functions.
8 **Tutorial 8 & 9: Numerical methods (Root finding, numerical differentiation, numerical integration):**
Lab 8 and 9: Programming for solving Numerical methods problems.
9 **Tutorial 10: Recursion, structure of recursive calls:**
Lab 10: Recursive functions.

10 **Tutorial 11: Pointers, structures and dynamic memory allocation:**
Lab 11: Pointers and structures
11 **Tutorial 12: File handling:**
Lab 12: File operations.

CH/CS/EC/IT 163 WORKSHOP PRACTICE LAB

Practicals	*:*	*4 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Course Objectives

i. Engineers, whatever be their line of activity, must be proficient with all aspects of manufacturing, however it should not be forgotten that practice without theory is blind and the theory without practice is lame.

ii Students involved in acquiring manufacturing skills must have balanced knowledge of theory as well as practice.

iii Imparts basic knowledge of various tools and their use in different sections of manufacture such as fitting, carpentry, tin smithy, moulding, casting, welding, electrical wiring, PCB work on electronic circuits and practice with machine shop tools & equipments.

Course Outcomes

1) Will gain knowledge of the different manufacturing processes which are commonly employed in the industry to fabricate components using different materials.

List of Experiments:

1) Welding shop (both arc &gas welding)
   -Square butt joint
   -Lap joint
   -Single v butt joint
   -Gas welding & Cutting
2) Fitting Shop& Casting
   -Inclined fit
   -Half round fit
   -V fit
   -Moulding and casting of Hand wheel
3) Practice on electrical wiring and Electronic circuit boards
   -One bulb controlled by one switch &one bulb controlled by two switches
   -Two bulbs controlled by one switch (Stair case connection)
   -Tube light connection
   -Measurement of resistance, voltage and current with the help of a multi-meter & soldering on an electronic PCB circuit.
4) Machine Shop
   -Practice of machining operations on Lathe, Milling, Shaping, Drilling and Slotting Machines.
5) Carpentry
   -Lap joint
   -Cross lap joint
   -Dovetail joint
   -Turning on wood turning Lathe
5) Tin Smithy
   -Rectangular tray
   -Funnel
   -Pipe joint
   -Rectangular Scoop
   -Plastic mounding and glass cutting

Plastic moulding and glass cutting

Note: A minimum of 2 (two) from each trade – Total 12 (twelve) experiments – have to be performed and recorded by the candidate to attain eligibility for Semester End Practical Examination.

CH/ME 164 BASIC ELECTRICAL ENGINEERING LAB

Practicals	*:*	*2 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*1*

Course Objectives

i. To conduct experiments on electrical circuits.
ii. To design experimental setups for theorems.
iii. To know the response of electrical circuits for different excitations.

Course Outcomes

1) Get an exposure to common electrical components and their ratings.
2) Make electrical connections by wires of appropriate ratings.
3) Understand the usage of common electrical measuring instruments.
4) Understand the basic characteristics of resonance.
5) Verify the network theorems.

List of Experiments:

1) Familiarization of Electrical Installations and Electrical Testing Equipment: Miniature circuit breakers (MCBs), Moulded Case Circuit Breakers (MCCBs), Earth-leakage circuit breakers (ELCBs), Fuses, Types of Wires, Wire Gauges, continuity test, megger, Cables and Earthing.
2) Basic safety precautions. Introduction and use of measuring instruments â€“ voltmeter, ammeter, wattmeter, multi-meter, oscilloscope, measurement of basic parameters.
3) Verification of KVL& KCL
4) Verification of Superposition Theorem
5) Verification of Thevenin's Theorem
6) Verification of Norton's Theorem
7) Transformers: Observation of the no-load current waveform on an oscilloscope (non sinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonics)
8) OC & SC tests on single phase transformer
9) Loading of a transformer: measurement of primary and secondary voltages and currents, and power
10) Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
11) Swinburne's test on dc motor
12) Speed control of dc motor
13) Experiments on three-phase induction motors. Direction reversal by change of phase-sequence connections, Torque-Slip Characteristics of an induction motor.
14) Synchronous Machine operating as a generator: stand-alone operation with a load, control of voltage through field excitation.
15) Determination of choke coil parameters.

Note: A minimum of 10 (Ten) experiments have to be performed and recorded by the candidate to attain eligibility for Semester End Practical Examination.

MC 002	ENVIRONMENTAL SCIENCE [MANDATORY NON-CREDIT COURSE - ACTIVITY BASED] **Semester II [First Year]**	**L T P C Int Ext** **2 - - - 100 -**

COURSE OBJECTIVES:

To enable the students to

1. understand that humans are an integral part of environment and hence their activities reflect on the environment.
2. realize and appreciate the importance of ancient practices and their importance in the present times
3. appreciate the contribution of individuals for the upkeep of environmental standards, in turn help the humans live better.
4. describe and discuss the environmental pollution implications with related environmental acts and relevant case studies.

COURSE OUTCOMES:

After successful completion of the course, the students are able to

1. evaluate the implications of human activities and thereby promote ecofriendly technologies.
2. promote awareness among the members of the society for a sustainable environment.
3. include and give priority to environmental protection in all developmental projects.
4. understand the causes, effects and controlling measures of different types of environmental pollutions with some case studies.

A. AWARENESS ACTIVITIES - SMALL GROUP MEETINGS

I. Source of water for human consumption/activities:

- **a.** collection of information pertaining to water resources and consumption in Andhra Pradesh
- **b.** Water resource on campus: General / Laboratory use and
- **c.** Drinking water - understand the background and adopt judicious management.
- **d.** Recycled water for Gardening - Particularly Lawns.
- **e.** Cut down wastage of electricity in class rooms / labs / hostels etc. by avoiding misuse.

II. After the group meetings and exposure to the local issues and healthy practices, students motivated to make:

- **a.** Posters
- **b.** Slogans/One liners for promoting awareness

III. Lectures from Experts (at least 2 in the course duration)

IV. A walk in the neighborhood to promote a chosen theme on environmental consciousness.

B. ACTUAL ACTIVITIES

1. Plantation on Campus and on the sides of approach road.
2. Distribution of saplings to the local colony dwellers and encourage plantation.
3. Development of Kitchen garden on campus - Cultivation of atleast leafy vegetables and creepers like cucumber etc. for use in college canteen/hostels etc.
4. Adoption of "NO PLASTICS" on campus.
5. Field trip to gain knowledge of biodiversity, water shed, mining, pollution and other local issues.

6. Preparation of working models for energy generation/transformation etc.

C. THEORY SYLLABUS FOR ASSESSMENT

Part-I

1. Introduction to Environmental Studies, Scope and Importance.
2. Natural resources Renewable and Non-Renewable; Definition and importance of the following resources in detail: a. Forest b. Water c. Land d. Energy
3. Sustainable development - Concept and Measures.
4. Biodiversity - Definition, Types of Biodiversity, Values and threats to Biodiversity, Conservation of biodiversity, IUCN classification: Endangered, Threatened, Vulnerable, Rare species;

Endemic and Exotic species.

5. Climate change - Global warming, Ozone depletion and Acid rain.

Part - II

6. Water shed, water shed management in detail.
7. Solid wastes and Solid waste management.
8. Environmental Legislation, Environmental acts - Wild life protection act, Water act, Forest conservation act, Air act and Environmental protection act.
9. Case studies: Chernobyl nuclear disaster, Bhopal gas tragedy, Narmada bachao andolan, Silent valley, Story of Tuvalu, Story of Ganga.
10. Earth summit and Kyoto protocol; Measures at individual level for conservation of natural resources and sustainable development.

Text Books

1. Anubha Kaushik and C.P.Kaushik - Environmental Studies, 3rd Edition, New Age International Publishers, New Delhi., 2012.
2. R. Rajagopalan - Environmental studies from crisis to cure, 3rd Edition, Oxford University press, 2012.

ASSESSMENT

1. Two assessments each of 40 marks will be done in the semester. The split up of each assessment is as follows:
   a. Two internal theory examinations will be conducted for 18 marks each.
   b. Evaluation of the prepared activity sheets and working models will be done for 12M (continual evaluation) twice in the semester in line with the theory examination.
   c. 5 Marks for attendance and 5 marks for oral test.

Note: Weightages for a, b & c will be taken as per the assessment guidelines of the R-18 curriculum and projected to 100 marks.

CH 211 MATHEMATICS III (PROBABILITY AND STATISTICS)

Lectures	*:*	*3 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Course Objectives

i. To familiarize the students with statistical techniques.
ii. To equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling various problems in the discipline.

Course Outcomes

1) Understand the ideas of random variables and various discrete and continuous random variables and their properties.
2) Apply various probability distribution concepts to solve the engineering problems.
3) Understand the basic ideas of statistics including correlation, regression , least squares fit to various curves.
4) Apply the statistical methods for analyzing experimental data by testing the hypotheses.

UNIT - I **CO: 1**

Basic Probability:

Discrete random variables and their properties, Expectation of Discrete Random Variables, Continuous random variables and their properties, Expectation of Continuous Random Variables, Distribution functions and densities.

UNIT – II **CO: 2**

Discrete and Continuous Probability Distributions:

Binomial distribution, infinite sequences of Bernoulli trials, Poisson approximation to the Binomial distribution, Normal, Exponential and Gamma densities.

UNIT – III **CO: 3**

Applied Statistics:

Correlation and regression – Rank correlation. Curve fitting by the method of least squares-fitting of straight lines, second degree parabolas and more general curves.

UNIT – IV **CO: 4**

Small and large sample tests:

Small sample test for single mean, difference of means, Chi-square test for goodness of fit for Binomial and Poisson Distributions, and independence of attributes.
Large sample test for single mean, difference of means.

LEARNING RESOURCES

TEXT BOOKS:

1) Miller & Freund's Probability and Statistics for Engineers – Richard A. Johnson

REFERENCE BOOKS:

1) Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2) P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003
3) S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
4) W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, 3rd Ed., Wiley, 1968
5) N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, 2010.
6) B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.

CH 212 LIFE SCIENCES FOR ENGINEERS

Lectures	:	*2 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*2*

Course Objectives

i. To recall the basics of biology viz. cellular organization, function and classification.
ii. To provide an understanding of the basic structure and functions of major biomolecules.
iii. To describe the transfer of genetic information and Introduce the techniques used for modification of living organisms.
iv. To describe the applications of rDNA technology and biomaterials.

Course Outcomes

1) Understand and appreciate the cellular organization and its diversity.
2) Recognize and understand the molecular basis of different forms of life and their applications.
3) Identify the complementarily in the structure and functions of biomolecules.
4) Differentiate the genetic phenomena and demonstrate the genetic engineering of organisms.

UNIT - I **CO: 1**

Living Organisms:

Comparison of biological organisms with manmade systems, Classification of living organisms, Cellular basis of life.

Differences between prokaryotes and eukaryotes, classification on the basis of carbon and energy sources, molecular taxonomy.

UNIT – II **CO: 2**

Proteins and Enzymes

Water, Biomolecules – carbohydrates, proteins and lipids, structure and functions of proteins and nucleic acids, hemoglobin, antibodies.

Enzymes: Basic Structure and Classification of Enzymes; Enzymes in Fermentation and industrial applications.

UNIT – III **CO: 3**

Cell Physiology

Bioenergetics, Respiration: Glycolysis and TCA cycle, Electron transport chain and oxidative phosphorylation.

Mechanism of photosynthesis; Neurons, synaptic and neuromuscular junctions.

UNIT – IV **CO: 4**

Genes and genetic material (DNA and RNA)

Mendel’s laws, gene mapping, Mitosis and Meiosis, single gene disorders in humans, Genetic code, DNA replication, Transcription, Translation.

Recombinant DNA Technology: recombinant vaccines, transgenic microbes, animal cloning, biosensors, biochips.

LEARNING RESOURCES

TEXT BOOKS:

1) N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, "Biology: A global approach", Pearson Education Ltd, 2018.

2) Arthur T Johnson, Biology for Engineers, CRC press, 2011.

REFERENCE BOOKS:

1) Alberts et al. The molecular biology of the cell, 6th edition, Garland Science, 2014.

2) E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, "Outlines of Biochemistry", John Wiley and Sons, 2009.

3) John Enderle and Joseph Bronzino Introduction to Biomedical Engineering, 3rd edition, 2012.

CH 213 PHYSICAL AND ORGANIC CHEMISTRY

Lectures	*:*	*3 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Course Objectives

i. Learn concepts of kinetics and catalysis with their mechanisms.
ii. Know about conductance, reduction potentials, cell e.m.f.
iii. Understand mechanisms of important reactions like sulphonation, nitration, etc
iv. Know terms and mechanisms related to polymers.

Course Outcomes

1) Judge the mechanisms of catalysis and determine the order of a reaction.
2) Choose a suitable method for corrosion prevention related to potential of a system
3) Write the mechanisms for a given organic reaction.
4) Explain the chemistry of polymer formation.

UNIT - I **CO: 1**

Kinetics Rate of reaction, Factors influencing rate of reaction, Order and Molecularity of reactions, Kinetic equations-First order and second order (2A Products & A+B Products), Half life period-Simple problems, Methods to determine order of reaction.

Catalysis: Definition of catalyst-criteria of characteristics of catalyst-types of catalysis-Homogenous and Heterogeneous catalysis with examples-Mechanism of catalytic action, adsorption theory, catalytic poison and promoter, Autocatalysis-acid - base catalysis.

UNIT – II **CO: 2**

Electrochemistry: Electrical conductance, Specific conductance, Equivalent conductance, variation with dilution, Kohlrausch's law and its applications, Half cell potentials, electrochemical series and its significance, Nernst equation.

Corrosion: Theories of corrosion-Dry and Wet corrosion, Protection methods-Design, Cathodic protection, Corrosion inhibitors.

UNIT – III **CO: 3**

Aromatic Substitution Benzene - Aromaticity, Molecular Orbital description of Aromaticity – Introduction of groups on Benzene and Mechanism of alkylation, acylation, Catalytic Nitration and Sulfonation of Benzene.

Phenol-preparation methods-chemical reactions-Reimer Tiemann-reaction, Kolbe reaction-mechanisms. Toluene- preparation methods-chemical reactions.

UNIT – IV **CO: 4**

Organic reactions: Nitrobenzene-Catalytic hydrogenation of Nitrobenzene (H2/Ni or Pt), LiAlH4, (NH4)2S, Reduction in Neutral Medium (Zn dust+NH4Cl) and Reduction in alkaline medium), Aniline–Reductive Alkylation reactions of aniline, Hoffmann degradation reaction-mechanism, Diazotisation reaction, synthetic applications of benzene diazonium chloride, Xylenes-Oxidation of Xylenes.

Polymers–Monomer, Functionality, Degree of Polymerization, Addition Polymerization–Polyethylene, Polypropylene, Mechanism of Free-radical Polymerization, Condensation Polymerization–Nylon 6:6 and Polyester.

LEARNING RESOURCES

TEXT BOOKS:

1) Engineering chemistry, P.C.Jain and Monica Jain, 16th edition, Dhanpat Rai Publishing Company. (UNIT-I,II& IV)

2) A text book of Organic chemistry by Arun Bahl and B.S. Bahl, 22nd edition, S.Chand and company. (UNIT-III & IV)

REFERENCE BOOKS:

1) Chemical Kinetics, K. J. Laidler. 3rd Edition, Tata McGraw-Hill.

2) Organic Chemistry, 7 editions, by Morrison Boyd & Bhattacharjee.

CH 214 CHEMICAL PROCESS CALCULATIONS

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. Understand the stoichiometric approach to chemical reactions.
ii. Designs the humidification and dehumidification operations.
iii. Comprehends and solves the material balances in a chemical operation with or/and without by pass, recycle and purge.
iv. Solves the energy balance in unit operations and processes.

Course Outcomes

1) Convert units of process quantities from one set of units to another set of units.
2) Estimate the composition of the given vapour-gas mixture using the principles of vapour pressure.
3) Solve material balances on chemical operations & processes including bypass, recycle and purge.
4) Evaluate energy balances on unit operations and processes.

UNIT - I **CO: 1**

Stoichiometric and composition relationships:

Units and dimensions, Conservation of mass, Stoichiometric relations, Basis of calculations, methods of expressing the composition of mixtures and solutions, density and specific gravity**.**
Behavior of ideal gases:
Introduction, Applications of the Ideal-gas law, gaseous mixtures, volume changes with changes in composition, Gases in Chemical reactions.

UNIT – II **CO: 2**

Vapor Pressures:

Introduction, Effect of temperature on vapor pressure, vapor pressure plots, vapor pressure of immiscible liquids, solutions.
Humidity and Saturation:
Introduction, vaporization process, condensation, wet-bulb and dry-bulb-thermometry, psychometric chart.

UNIT – III **CO: 3**

Material Balances:

Material balances without chemical reaction, inert, tie component, Calculations involving condensation, evaporation drying, dissolution and crystallization.
Material balances with chemical reaction, recycle, bypass, and purge.

UNIT – IV **CO: 4**

Thermo Physics:

Introduction, Energy, energy balances, heat capacity of gases, heat capacities of solids, heat capacity of liquid and solutions, latent heats, heat of vaporization
Thermo Chemistry:

Introduction, Thermo chemistry of solution, Effect of pressure on heat of reaction, Heat of reaction at constant pressure and at constant volume, Effect of temperature on heat of reaction, temperature of reaction, theoretical flame temperature, actual flame temperature.

LEARNING RESOURCES

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

REFERENCE BOOKS:

1) Stoichiometry by B. Bhatt and S. Vora, fourth edition, Tata McGraw Hill (2004).
2) Stoichiometry and Process Calculations by K. V. Narayanan and B. Lakshmikutty, Prentice-Hall of India Private Limited, New Delhi.
3) Elementary Principles of Chemical Processes, Felder, R. M.; Rousseau, R. W., third Edition, John Wiley & Sons, 2000.
4) Process Calculations, V. Venkataramani, N. Anantharaman, Begum, K. M. Meera Sheriffa, Second Edition, Prentice Hall of India.
5) Chemical Process Calculations, D. C. Sikdar, Prentice Hall of India.

CH 215 MOMENTUM TRANSFER

Lectures	*:*	*2 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Course Objectives

i. To introduce basis and models for fluids.
ii. To provide an understanding about Quantitative laws and equation of fluid flow for laminar and turbulent flows.
iii. To work with compressible fluids and flow past immersed bodies.
iv. To handle important engineering tasks for transporting and measuring of flow in various conduits.

Course Outcomes

1) Apply the concept of hydrostatic equilibrium and to have a knowledge on fluid flow Phenomena.
2) Develop the continuity, momentum, and energy balance equations and to solve the fluid flow problems in pipes.
3) Determine flow rates, pressure changes and effect of forces acting on flow past immersed bodies and fluidization.
4) Identify the appropriate fluid moving and metering machinery based on the process requirement.

UNIT - I **CO: 1**

Introduction: Unit operations, unit systems, dimensional analysis, basic concepts. Fluid statics and its applications-hydrostatic equilibrium, applications of fluid statics- manometers and decanters.

Fluid Flow Phenomena: Laminar flow, Shear rate, Shear stress, Rheological properties of fluids, Turbulence, flow in boundary layers, its formation and growth in tubes and on plates.

UNIT – II **CO: 2**

Basic Equations of Fluid Flow: Mass balance in a flowing fluid; Continuity, differential momentum balance; equations of motion, macroscopic momentum balances, Mechanical energy equations.

Incompressible Flow in Pipes and Channels: shear stress and skin friction in pipes, laminar flow in pipes and channels, turbulent flow in pipes and channels, friction from changes in velocity or direction.

UNIT – III **CO: 3**

Flow of compressible fluids: definitions and basic equations, processes of compressible flow, isentropic flow through nozzles, adiabatic frictional flow and isothermal frictional flow.

Flow past immersed bodies: drag and drag coefficient, flow through bed of solids, motion of particles through fluids, fluidization and applications of fluidization.

UNIT – IV **CO: 4**

Transportation of fluids: Introduction to: pipe and tubing, joint and fittings, gate valves and globe valves, plug cocks and ball valves, check valves. Pumps: Types, Selection,

Applications, Performance characteristics of centrifugal and reciprocating pumps. Constructional features and working principle of jet ejectors, compressors.
Metering of fluids: Constructional features and working principles of: venturi meter, orifice meter, Rota meters, Pitot tube, target meters, vortex-shedding meter, turbine meter, magnetic meters.

LEARNING RESOURCES

TEXT BOOKS:

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

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. R.

CH 216 MECHANICAL OPERATIONS

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
			Semester End Exam Marks	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To make the students exposed to different geometrical sizes of raw materials used in the industries, area of calculation of the particles w.r.t their sizes.
ii. To get familiarity with the different laws of grinding.
iii. To do the power consumption calculations.
iv. To learn different separation process on their physical properties.

Course Outcomes

1) Do the Separation of materials (useful and gangue) from their physical properties.
2) Understand the Selection of Machinery for size reduction of the raw materials.
3) Perform Power consumption calculation for crushing and grinding.
4) Apply different techniques for separation.

UNIT - I **CO: 1**

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 particles. 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 **CO: 2**

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 **CO: 3**

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 **CO: 4**

Gravity Sedimentation Processes:

Gravity classifiers, sorting classifier; sink and float methods, differential settling methods, clarifiers and thickeners. Centrifugal sedimentation processes; cyclones, hydro-cyclones, 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 non-cohesive solids, and mixers of cohesive solids.

LEARNING RESOURCES

TEXT BOOKS:

1) Unit perations 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).

MC 004	DESIGN THINKING & PRODUCT INNOVATION [MANDATORY NON-CREDIT COURSE]	L T P C Int Ext 2 - - - 100 -

Semester III [Second Year]

COURSE OBJECTIVES:

1. Identify the design thinking processes and methods.
2. Plan research activities to gather and empathze from a user's viewpoint.
3. Ideate techniques to help arrive at the best solution and evaluation.
4. Identify design thinking approaches for business challenges.

COURSE OUTCOMES:

After successful completion of the course, the students are able to

1. Interpret the concepts of Design Thinking.
2. Investigate a problem to getermine its root cause.
3. Take part in group thinking and experiment with different solutions.
4. Develop innovative thinking and creative problem solving.

UNIT I **[CO1]**

Introduction to Design thinking - Origin of Design Thinking, Features & Principles of Design Thinking, Applications of Design Thinking, Role of Research in Design Thinking.

UNIT II **[CO2]**

Modules of Design Thinking - Inspiration - methods & tools used in Explore and Empathize phases of Design Thinking, Case study - activity.

UNIT III **[CO3]**

Modules of Design Thinking - Ideation and implementation - methods & tools used in experiment, Engage and Evolve phases of Design Thinking, Case study - activity

UNIT IV **[CO4]**

Design Thinking applied in Business & Strategic Innovation - Ten Design Thinking Principles that redefine business- Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competetion, Standardization , Creative Culture, Strategy and Organization- Design Thinking and approaches

LEARNING RESOURCES:

TEXT BOOK(s):

1. Design Thinking for Entrepreneurs and Small Businesses by Beverly Rudkin Ingle, Apress. [UNIT-I]
2. Change by design, Tim Brown, Harper Collins, 2009 [UNIT-II]

3. Design Thinking- The Guide Book- Facilitated by the Royal Civil service Commission, Bhutan.[UNIT-I,III]
4. Idris Mootee, Design Thinking for Strategic Innovation, John Wiley & Sons (2013).[UNIT-IV]

REFERENCE BOOK(s):

1. Design Thinking Business Innovation, Rio de Janeiro - 2012 1st edition, MJV press.
2. Design Thinking- Understanding How Designers Think and Work by Nigel Cross, Berg publishers.

WEB RESOURCES:

1. IDEO: Design Thinking for Educators toolkit https://designthinkingforeducators.com
2. https://dschool.stanford.edu/resources/a-virtual-crash-course-in-design-thinking
3. https://dschool-old.stanford.edu/groups/designresources/wiki/4dbb2/

CH V01 ENGLISH COMPETENCY DEVELOPMENT PROGRAMME L T P C I E

[NON-CREDIT COURSE - ACTIVITY BASED] **2 - - 100 -**

Semester II [First Year]

LECTURE PLAN

Session Topic

1. Self Introduction
2. Self Introduction
3. Introducing Others
4. Mind Mapping -Small Talk
5. Random Operation
6. JAM & Extempores
7. Starting a Conversation-Rapid Fire
8. Story Telling
9. Narrating Life Stories
10. Tense Buster
11. Describing people
12. Picture Perception & Description
13. Movie Reviews
14. News Articles-Open Discussion & Debate
15. Everyday Life-Communicative Activities
16. Role Plays
17. Short Versions
18. Contemporary Novels-Critical Appreciation Round

References :

* Contemporary Novels-Critical Appreciation Round
* eslflow.com/Personality Vocabulary Survey
* eslflow.com/Celebrity Interview
* eslflow.com/Telling stories
* eslflow.com/ First Impressions/speaking activity
* Speaking work sheets/Out & About 1 - PHOTOCOPIABLE, Cambridge University Press 2015
* Speaking Unplugged: 30 activities for one-to-one classes by online TEFL training
* Think Teen work book
* The guardian weekly/News based English language activities
* Walkietalkie https://www.teacherspayteachers.com/Store/Walkietalkie
* Alen Maley's Conversation/Rob Nolasco & Lois Arthur/Oxford University Press
* Alen Maley's Project Work/Diana L.Fried-Booth/Oxford University Press
* Cambridge English/Objective PET/Louise Hashemi & Barbara Thomas
* Cambridge English Business Benchmark/Guy Brook-Hart
* British Council / Learn English Select Face-to-Face Course / APSCHE Communication Skills Project
* Self- Designed Handouts

CH 251 ORGANIC CHEMISTRY LAB

Practicals	*:*	*2 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*1*

Course Objectives

i.	To know how various types of reactions can be applied in organic compound preparations.
ii.	To acquire knowledge about the qualitative analysis of organic compounds.
iii.	To learn how the yield of an organic compound can be determined.
iv.	To describe the preparation of suitable derivatives of organic compounds selected for analysis.
v.	To apply the basic knowledge about functional groups in identifying the given organic compound.

Course Outcomes

1) Prepare solutions of different concentrations.
2) Propose suitable mechanism for an organic reaction.
3) Prepare the required organic compound or derivative and confirm its identity by suitable methods.
4) Identify the nature and type of a given organic compound.

List of Experiments:

1) Preparation of Aspirin
2) Preparation of Benzanilide
3) Preparation of m-dinitrobenzene
4) Preparation of p-bromo acetanilide
5) Preparation of Phenol Formaldehyde resin
6) Detection of Extra elements
7) Analysis of compound – 1
8) Analysis of compound – 2
9) Analysis of compound – 3
10) Analysis of compound – 4
11) Analysis of compound – 5
12) Analysis of compound – 6

CH 252 MOMENTUM TRANSFER LAB

Practicals	*:*	*2 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*1*

Course Objectives

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

Course Outcomes

1) Collect quality raw data from an operation.
2) Compare observed with predicted performance.
3) Communicate the results of their analysis effectively in written and oral reports.
4) Function effectively in a lab team.

List of Experiments:

1) Determination of Friction factor
2) Determination of Minor losses
3) Orifice meter
4) Venturi meter
5) Open Orifice
6) V-Notch
7) Rectangular Notch
8) Centrifugal Pump Characteristics
9) Reciprocating Pump Characteristics
10) Reynolds Apparatus
11) Packed Bed
12) Fluidized Bed
13) Pitot Tube

CH 221 NUMERICAL METHODS INCHEMICAL ENGINEERING

Lectures	*:*	*3 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Course Objectives

i. To understand the methods to solve the linear and non-linear algebraic and transcendental equations.
ii. To know how to interpolate the data and also to understand the numerical differentiation and integration concepts.
iii. To understand the methods for the numerical solution of ordinary differential equations.
iv. To be able to solve the partial differential equations numerically.

Course Outcomes

1) Apply the numerical methods to solve the linear and non-linear algebraic solutions.
2) Gain the knowledge of applying the interpolating, numerical differentiation, regression analysis and numerical integration to solve a few chemical engineering problems.
3) Apply the numerical methods to solve both initial and final value problems of ordinary differential equations.
4) Apply the Finite Difference Method to discretise and solve the partial differential equations numerically.

UNIT - I **CO: 1**

Introduction, Approximation, Concept of Error and Error Analysis. **Solution of Non-Linear algebraic and transcendental equations**: Newton-Raphson method, Bisection method, Regular Falsi method and Secant methods.

Chemical Engineering Applications: Pressure Drop in a pipe, minimum fluidization velocity of a particle, molar volume estimation in Vander wall's Equation of State, dew point and bubble point calculations using Raoult's law.

UNIT – II **CO: 2**

Solution of Linear Algebraic Equations: Matrix Inverse Method, Cramer's Rule, Gauss Elimination method, Gauss – Jordan Method, LU Decomposition method, Jacobi's method, Gauss-Siedel method.

Chemical Engineering applications – Material Balance Problems involving total and component balance equations.

Interpolation: Newton's Forward & Backward interpolation, Lagranges interpolation, Newton's & Lagranges polynomials, **Regression analysis**: Fitting of polynomial, parabolic equations by least squares method.

UNIT – III **CO: 3**

Numerical Differentiation: Tylor Series method to find the First, Second and Third derivatives of a function. **Numerical Integration**: Trapezoidal Rule, Simpson's 1/3 Rule, Simpson's 3/8 Rule.

Numerical Solution of Ordinary Differential Equations: Euler's Method, Modified Euler's Method. Runge-Kutta fourth order method. Predictor-Corrector Methods – Adam-Bashforth Method, Milne's Method.

UNIT – IV **CO: 4**

Numerical Solution of Partial Differential Equations: Classification of PDEs, Standard Five Point & Diagonal Five Point formulae, Solution of Laplace Equation, Solution of Poisson's Equation.

Solution of Heat Conduction Equation:Schmidt Method, Bender – Schmidt Method, Crank – Nicholson Method.

LEARNING RESOURCES

TEXT BOOKS:

1) Numerical methods in Engineering & Science by B.S.Grewal, 7th edition Khanna Publishers (2005) (All UNITs)

2) Introduction to Numerical Methods in Chemical Engineering by Pradeep Ahuja, PHI Learning.(UNITs I & II)

REFERENCE BOOKS:

1) Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 2012

2) S.C. Chapra & R.P. Canale, "Numerical Methods for Engineers with Personal Computer Applications", McGraw Hill Book Company, 1985.

CH 222 MATERIAL TECHNOLOGY

Lectures	*:*	*3 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Course Objectives

i. To provide the background knowledge about the structure and properties of various metallic and Non-metallic materials of construction starting from fundamentals.
ii. To develop the understanding of present-day materials demand a thorough knowledge of basic Engineering and scientific principles, including heat treatment techniques, elastic and plastic behavior.
iii. To understand the various types of materials with an emphasis on structure-property relationships and materials selection.
iv. To graduate the students who contribute to their profession and society through engineering practice, research and development.

Course Outcomes

1) Predict the properties of simple metals and alloys based on their phase diagrams, phase transitions and Metal forming process.
2) Apply and integrate knowledge from the major elements of the field structure, properties, processing, and performance) to solve materials selection and design problems and Heat treatment process.
3) Use the techniques, skills and modern engineering tools necessary engineering practice for failure of metals and alloys.
4) Identify various types of corrosion, illustrate methods to mitigate corrosion and select suitable material for various chemical processes.

UNIT - I **CO: 1**

Phase diagrams: The phase rule, single component systems, binary phase diagrams, micro structural changes during cooling, and the lever rule, summary of phase diagram rules.
Forming Processes: General aspects, Cold & Hot processing, Rolling, Forging, Extrusion, Drawing.

UNIT - II **CO: 2**

Strengthening of metals and alloys: Introduction, Strengthening Grain refinement, strain hardening, solid solution strengthening, precipitation or age hardening, dispersion hardening, Particulate Strengthening, Phase transformation Harding, Strain ageing.
Heat treatment process: Annealing, Normalizing, Hardening, tempering.

UNIT - III **CO: 3**

Deformation of Metals: Deformation, Slip, Critical resolved shear stress, twinning, difference between slip and twinning.
Creep: Definition, Mechanism of creep, methods to reduce Creep in materials. Fracture: Ductile fracture, Brittle fracture, methods of protection against fracture.

UNIT - IV **CO: 4**

Semiconductors: Characteristic of semiconductors, Examples of semiconducting materials, intrinsic and extrinsic semiconductors, doping, p-type and n-type

semiconductors, Applications of semiconductor materials, difference between semiconductor, conductor and insulator.

Corrosion: General aspects, Factors influenced in corrosion, General types of corrosion, Various types of corrosion, Control and prevention of corrosion, Criteria of selection of materials in process industry.

LEARNING RESOURCES

TEXT BOOKS:

1) Material Science and Engineering by R.K.Rajput,3 rd edition S.K.Kataria& Sons, Delhi (2005).

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

REFERENCE BOOKS:

1) Material Science and Metallurgy - V.D.Kodgire, Everest Publishers, 2008.

2) Material Science for Engineering,D.CallistersJr,Weily& Sons, New Delhi (2006).

3) Elements of Material Science and Engineering by Van Vlock, L.H,6 th edition., PHI, New Delhi (1989).

CH 223 INDUTRIAL INSTRUMENTATION & INTRUMENTAL METHODS OF ANALYSIS

Lectures	*:*	*3 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Course Objectives

i. To understand the qualities of measurement and also the application of instrumentation for any industrial process.
ii. To understand the measurement of temperature by using expansion & resistance thermometers, thermo couples and pyrometers.
iii. To understand the measurement of pressure, head and level by using various methods & also flow metering.
iv. To understand the principles of various instruments and analytical equipment.

Course Outcomes

1) Understand the instrumentation and apply to various industrial processes.
2) Understand the use of various thermometers to measure the temperature of different ranges.
3) Understand the principles of manometers to measure the pressure and instrumentation to measure the level and head and also flow metering.
4) Analyze the composition of various industrial products by the application of analytical instrumentation.

UNIT - I **CO: 1**

Qualities of Measurement: Elements of instruments, static characteristics, dynamic characteristics, dynamic response of 1st order systems.

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

UNIT - II **CO: 2**

Expansion thermometers: mercury in glass thermometer, bimetallic, pressure spring, accuracy and response of thermometers. **Thermo-electric temperature measurement**: thermos electricity, industrial thermocouples, thermocouple lead wires, thermal wells, response of thermocouples, mill voltmeter, null potentiometer.

Resistance thermometers: Thermal coefficient of resistance, industrial resistance – thermometer bulbs, resistance thermometer circuits - wheat stone bridge, calendar Griffiths Bridge, **Radiation temperature measurement**: laws of radiation, radiation receiving elements, radiation pyrometers, photoelectric pyrometer and optical pyrometers.

UNIT - III **CO: 3**

Measurement of Pressure and vacuum: liquid column manometers, measuring elements for gauge pressure and vacuum, indicating elements for pressure gauges, measurement of absolute pressure, measuring pressure in corrosive liquids.

Measurement of head and level: Head, density and specific gravity, direct measurement of liquid level, pressure measurement in open vessels, level measurements in pressure vessels, measurement of interface level, density measurement.

UNIT - IV **CO: 4**

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.

LEARNING RESOURCES

TEXT BOOKS:

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

REFERENCE BOOKS:

1) Principles of Industrial Instruments by Patrenabis, 3rd 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, 2nd edition, McGraw Hill (2012).

CH 224 PROCESS HEAT TRANSFER

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
			Semester End Exam Marks	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To describe formulae for steady/ unsteady rate of heat transfer by conduction problems in simple geometries
ii. To teach how to estimate the heat transfer coefficients for different flow geometries
iii. To impart knowledge on the phenomenon of natural convection & radiation and involving phase change operations
iv. To explain the working and design of double pipe, shell and tube heat exchangers and evaporators

Course Outcomes

1) Solve steady state and un-steady heat conduction problems in simple geometries
2) Determine heat transfer coefficients in laminar and turbulent flow conditions and in forced convection
3) Estimate heat transfer from natural convection & radiation and involving phase change operations
4) Design heat exchange equipment such as double pipe & shell and tube heat exchangers used in chemical industry and estimate the performance of a given single/multiple effect evaporators

Course Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	3	1	1	2	3	-	2	3	1	1	3	3
CO2	3	2	3	1	1	2	3	-	2	3	1	1	3	3
CO3	3	2	3	1	2	2	3	-	2	3	1	1	3	3
CO4	3	2	3	1	2	2	3	-	2	3	1	1	3	3

UNIT - I **CO: 1**

Introduction: Modes of heat transfer, basic laws of heat transfer.

Heat Transfer by Conduction: Fourier law of heat conduction, thermal conductivity, steady state conduction in plane & composite walls, compound resistances in series, heat flow through a cylinder & spheres.

Unsteady state heat conduction: One-dimensional heat flow with constant surface temperature and variable surface temperature, total heat transferred. Semi-infinite solid.

UNIT – II **CO: 2**

Principles of heat flow in fluids : Typical heat exchange equipment, energy balances, heat flux and heat transfer coefficients, electrical analogy, critical radius of insulation**.**

Heat Transfer to Fluids without Phase change : Regimes of heat transfer in fluids, boundary layers, heat transfer by forced convection in laminar flow, heat transfer by forced convection in turbulent flow, heat transfer in transition region, heat transfer to liquid metals, heating and cooling of fluids in forced convection outside tubes.

UNIT – III **CO: 3**

Natural Convection: Natural convection to air from vertical shapes and horizontal planes, effect of natural convection in laminar-flow heat transfer.

Heat transfer to fluids with phase change: Heat transfer from condensing vapors, Heat transfer to boiling liquids.

Radiation: Introduction, properties and definitions, emission of radiation, black body radiation, real surfaces and the Gray body, absorption of radiation by opaque solids, radiation between surfaces, radiation shielding, radiation to semi-transparent materials, combined heat transfer by conduction, convection and radiation.

UNIT – IV **CO: 4**

Heat-Exchange Equipment: General design of heat exchange equipment, shell and tube heat exchangers, heat exchanger effectiveness (NTU method), plate-type exchangers, extended surface equipment, heat pipes, scrapped surface exchangers, scraped surface heat exchangers, condensers & vaporizers, heat transfer in agitated vessels, heat transfer in packed beds.

Evaporation: Types of evaporators, performance of tubular evaporators (capacity and economy), Multi effect evaporators; methods of feeding, vapor recompression.

LEARNING RESOURCES

TEXT BOOKS:

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).

CH 225 CHEMICAL ENGINEERING THERMODYNAMICS-I

Lectures	*:*	*3 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Course Objectives

i. To understand the thermodynamic system, properties and application of first law of thermodynamics to closed to and open systems.
ii. To understand the concept of second law and to apply the thermodynamics to various processes.
iii. To understand and derive the relation among various thermodynamic properties and also to understand how power is generated through thermodynamic processes.
iv. To apply the thermodynamic relations to flow processes in order to estimate the heat and work rates of the same and also to understand the principles of refrigeration.

Course Outcomes

1) Define a thermodynamic system and apply the thermodynamics to closed and open systems to estimate the heat and work interactions.
2) Apply the entropy balance to the thermodynamics systems and be able to calculate the efficiencies of heat engines.
3) Derive the thermodynamic relations among various properties to estimate the unknown properties and also be able to estimate the efficiency of power cycles.
4) Derive the thermodynamic property relations for various flow processes and also be able to understand the principles of heat pump and refrigeration.

UNIT - I **CO: 1**

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 **CO: 2**

PVT behavior of pure substances: PT and PV diagrams, the ideal gas equations for process calculations (for an ideal gas in any mechanically reversible closed- system process): isothermal process, isobaric process, isochoric process, adiabatic process, and polytrophic process.
Virial equations of state, Application of the virial equations, introduction to cubic equations of state: Vander Waals equation, theorem of corresponding states; accentric factor. Generalized correlations for gases and liquids.

UNIT - III **CO: 3**

The Second Law of Thermodynamics: Statements of the second law, heat engines, thermodynamic temperatures scales, thermodynamic temperature and the ideal gas scale. Entropy changes of an ideal gas, mathematical statement of the second law, the third law of thermodynamics, calculation of ideal work and lost work.

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

UNIT – IV **CO: 4**

Applications of Thermodynamics to Flow Processes: Principles of conservation of mass, entropy and energy for flow systems, analysis of expansion processes; turbines, throttling; compression processes –compressors and pumps.

Refrigeration: Carnot refrigeration, vapor – compression cycle, choice of refrigerant, absorption refrigeration, Heat pump, **liquefaction processes**: Linde liquefaction process, Claude liquefaction process.

LEARNING RESOURCES

TEXT BOOKS:

1) Introduction to Chemical Engineering Thermodynamics by J.M.Smith, H.C.Vanness and M.M. Abbott 7th Edition (In SI units), Tata McGraw Hill.

REFERENCE BOOKS:

1) M J Moran, H N Shapiro, D D Boettner and M B Bailey, Principles of Engineering Thermodynamics, 8th Edition, Willey.

2) Y.V.C.Rao, "Chemical Engineering Thermodynamics", University Press, Hyderabad,1997

CH 226 CHEMICAL REACTION ENGINEERING-I

Lectures	*:*	*3 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Course Objectives

i. To provide knowledge on different types of reactions, reaction rate, collection, analysis of reaction rate data to derive rate expressions and thermal characteristics of various reactions.
ii. To provide knowledge on different kinetic models to analyze the batch reactor data.
iii. 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.
iv. 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

1) Analyze kinetic data and determine the rate expressions (reaction order and specific reaction rate) for a reaction.
2) Derive and solve design equations for batch, semi batch and steady state flow reactors. Solve appropriate rate expressions for series, parallel and reversible reactions.
3) Understand the performance characteristics and the advantages and disadvantages of major reactor types.
4) Analyze multiple reactions to determine selectivity and yield.

UNIT - I **CO: 1**

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 **CO: 2**

Interpretation of Batch Reactor Data:

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

UNIT - III **CO: 3**

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 **CO: 4**

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.

LEARNING RESOURCES

TEXT BOOKS:

1) Chemical Reaction Engineering, Octave Levenspiel, 3rd edition, Wiley Eastern.

REFERENCE BOOKS:

1) Elements of chemical reaction engineering, H.S.Fogler, 2nd edition, PHI.
2) Chemical Engineering Kinetics, J.M.Smith, 3rd edition, McGraw Hill.
3) Chemical Reaction Engineering, Octave Levenspiel, 2nd edition, Wiley Eastern.

CH 261 PROCESS HEAT TRANSFER LAB

Practicals	*:*	*2 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*1*

Course Objectives

i. To apply the concepts of heat transfer, fluid dynamics and thermodynamics to the design and operation of heat transfer experiments.
ii. To develop practical understanding of common heat transfer equipment.
iii. To develop skills in experimental design and troubleshooting.
iv. To develop skills in data collection, analysis and interpretation.

Course Outcomes

1) Collect quality raw data from an operation.
2) Compare observed with predicted performance.
3) Communicate the results of their analysis effectively in written and oral reports.
4) Function effectively in a lab team.

List of Experiments:

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) Heat transfer coefficient for a fluid through a lagged pipe.
8) Temperature distribution through composite walls.
9) Overall heat transfer coefficient for a fluid flow in a shell and tube heat exchanger.
10) Unsteady state heat transfer in a rod.
11) Overall Heat transfer coefficient for a fluid flow in agitated vessels.
12) Overall Heat transfer coefficient for a fluid flow in a jacketed kettle.
13) Rate of evaporation in single effect evaporator.
14) Heat flux for a fluid flow through heat pipe.

CH 262 MECHANICAL OPERATIONS LAB

Practicals	*:*	*2 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*1*

Course Objectives

i. To have sound knowledge on properties of solids and size reduction principles.
ii. To use the screening methods and settling methods.
iii. To understand the best separation techniques.
iv. To learn the effective solid-liquid separation methods.

Course Outcomes

1) Understand the properties of solids and different types of size reduction principles.
2) Use the best screening and settling methods in chemical industries.
3) Decide the best separation operation needed in chemical process industries.
4) Design liquid solid separation equipments.

List of Experiments:

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 Separators

CH 263 COMPUTATIONAL PROGRAMMING LAB

Practicals	:	*2 hrs*	*Sessional Marks*	:	*40*
			Semester End Exam Marks	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*1*

Course Objectives

i. To understand the classification of various mathematical equations.
ii. To understand the application of numerical methods (iterative) to solve the non-linear, transcendental and linear algebraic equations.
iii. To understand the application of computational tool to solve mathematical model equations of chemical processes/operations.
iv. To understand how to write the programmes to solve the mathematical equations of chemical processes such as linear, non-linear, ordinary differential equations and partial differential equations.
v. To interpolate and extrapolate the given data by using interpolation formulae or plotting in computational platforms.
vi. To understand how to write programme for numerical differentiation and numerical integration to solve chemical engineering problems.

Course Outcomes

1) Apply the numerical method to solve various equations.
2) Write the algorithms for various numerical methods to solve model equations.
3) Write the programmes to compute various chemical quantities by solving the model equations.
4) Interpolate the data by using computational tools.

List of Experiments:

1) To solve a non-linear algebraic equations and Transcedantal equations by Bisection Method.
2) To solve a non-linear algebraic equations and Transcedantal equations by Regula - Flasi Method.
3) To solve a non-linear algebraic equations and Transcedantal equations by Newton - Raphson Method.
4) To Solve the simultaneous non-linear algebraic equations by Newton's method.
5) To Solve the Linear Algebraic Equations by Matrix Inverse method and Crammers rule.
6) To Solve the Linear Algebraic Equations by Gauss Elimination method.
7) Lagranges of interpolation formula.
8) Newton's interpolation - forward and backward interpolations.
9) Solution of Ordinary Differential Equations by Euler and R-K fourth order methods.
10) Estimating the pressure drop in a pipe by mathematical method.
11) Estimation of Molar Volume bu using a mathematical method.
12) Computation of Bubble point and Dew point temperatures by using mathematical algorithms.
13) Computation of material and energy balance equations by using mathematical algorithms.

CH 311 MASS TRANSFER OPERATIONS – I

Lectures	*:*	*3 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Prerequisites:

1) Chemical Process Calculations
2) Momentum Transfer
3) Process Heat Transfer

Course Objectives

i. To impart the principles of mass transfer.
ii. To learn the concepts of mass transfer coefficient and its estimation.
iii. To understand the principles of various mass transfer equipment.
iv. To describe the drying and humidification processes.

Course Outcomes

1) Estimate the rate of material transfer in different mass transfer operations.
2) Calculate mass transfer coefficients at interfaces of multiphase mass transfer systems.
3) Appraise different types of equipment and their operation for gas-liquid separations and design of the absorption tower.
4) Design the drying and humidification.

UNIT - I **CO: 1**

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.

Diffusion in binary gas mixtures–equimolar counter diffusion, non-equimolar counter diffusion, estimation of diffusivities in liquids and gases, diffusion in solids.

UNIT – II **CO: 2**

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.

Interphase Mass Transfer: Diffusion on both sides of an interface, relationship of overall mass transfer coefficient with either side mass transfer coefficient**. Material Balances (theory only):** Steady – state co current process, Steady – state counter current process, Cross flow cascades and Countercurrent cascades.

UNIT - III **CO: 3**

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.

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 **CO: 4**

Drying: Batch drying, rate of batch drying, time of drying, mechanism of batch drying, equipment for batch and continuous drying operations.

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.

LEARNING RESOURCES

TEXT BOOKS:

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).
4) Principles of Mass Transfer and Separation Processes, Binay K. Dutta, 2nd edition, Prentice Hall of India, 2007
5) Diffusion - Mass Transfer in Fluid Systems, E.D. Cussler, Cambridge University Press, Cambridge 1984.
6) Principles of Unit Operations, S. Foust, 2nd Edition, Wiley, New York, 1980.

CH 312 CHEMICAL ENGINEERING THERMODYNAMICS –II

Lectures	*: 3 hrs*		*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*: 3 hrs*		*Credits*	*:*	*3*

Course Objectives

i. To make students understand the concepts of Heat Effects in the industrial reactions
ii. To impart the knowledge of thermodynamic applications for various solutions and mixtures & making them understand the property relations through thermodynamic models.
iii. To understand the concept of Vapor Liquid equilibrium and be able to estimate bubble point and dew point of the mixtures and also to understand concepts of phase equilibria.
iv. To make the students apply the concepts of thermodynamics at chemical reaction equilibrium and derive the property relations.

Course Outcomes

1) Compute the sensible heat integral and apply the same in industrial reactions to estimate the heats of reaction and final temperatures.
2) Estimate fugacity & fugacity coefficients of gas mixtures & solutions, and be able to apply the property models to estimate the activity coefficients.
3) Apply the Raoult's law and Modified Raoult's law for VLE to perform bubble and dew point calculations.
4) Estimate the reaction equilibrium constant and the composition of the mixtures at chemical equilibrium conditions.

UNIT - I **CO: 1**

Heat effects: Sensible heat effects, temperature dependence of heat capacity, Evaluation of Sensible-Heat Integral, Latent Heats of Pure Substance.
The standard heats of reaction, formation and combustion, temperature dependence of heat of reaction, heat effects of industrial reactions.

UNIT - II **CO: 2**

Solution Thermodynamics - Theory: 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: Models for excess Gibb's energy, property changes of mixing.

UNIT – III **CO: 3**

Vapor-Liquid Equilibrium: Nature of equilibrium, The Phase Rule - Duhem's Theorem, VLE: Qualitative behavior, VLE by Raoult's law – Dew Point and Bubble Point calculations, VLE by Modified Raoult's Law – Dew Point and Bubble Point calculations
Topics in phase Equilibria: VLE from cubic equations of state, Equilibrium and stability, liquid-liquid equilibrium (LLE), vapor- liquid–liquid equilibrium (VLLE), solid-liquid equilibrium (SLE), solid vapor equilibrium (SVE).

UNIT – IV **CO: 4**

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**.**

LEARNING RESOURCES

TEXT BOOKS:

1) Introduction to Chemical Engineering Thermodynamics by J.M.Smith, H.C.Vanness and M.M. Abbott 7th Edition (In SI units), Tata McGraw Hill.

REFERENCE BOOKS:

1) M J Moran, H N Shapiro, D D Boettner and M B Bailey, Principles of Engineering Thermodynamics, 8th Edition, Willey.

2) Y.V.C.Rao, "Chemical Engineering Thermodynamics", University Press, Hyderabad,1997.

CH 313 CHEMICAL REACTION ENGINEERING - II

Lectures	*:*	*3 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Course Objectives

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

Course Outcomes

1) Explain the thermal characteristics and design of adiabatic reactors for single and multiple reactions.
2) 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.
3) Develop the progressive conversion model and shrinking core model for explaining the fluid particle reaction.
4) Understand the principles and mechanisms involved in heterogeneous catalysis and analyze the data of heterogeneous catalytic reactions.

UNIT - I **CO: 1**

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 **CO: 2**

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 **CO: 3**

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 **CO: 4**

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.

LEARNING RESOURCES

TEXT BOOKS:

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).

CH 314 CHEMICAL TECHNOLOGY

Lectures	*:*	*3 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Course Objectives:

i. To impart the knowledge of Unit operations unit processes involved in manufacture of widely employed inorganic chemicals like Chlor-alkalis, cements, Glasses and industrial gases.
ii. To provide the knowledge of Unit operations unit processes involved in manufacture of Fertilizers like Ammonia, Urea, Nitric acid, Phosphoric acid and superphosphates.
iii. To impart the knowledge of Unit operations unit processes involved in manufacture of organic chemicals like Rubbers, fibres, plastics and soaps.
iv. To impart the knowledge of Unit operations unit processes involved in manufacture of organic chemicals like Papers, Sugars, Fermentation products and Petroleum refining.

Course Outcomes:

1. Demonstrate chemical technologies used in the manufacturing of Chlor-alkalis & Cements, Glasses and Industrial gases.
2. Interpret manufacturing process for Nitrogen, phosphorous fertilizers, Sulphuric acid and Hydrochloric acid.
3. Describe organic chemical technologies involved in Industrial Processes such as phenol-formaldehyde, Styrene - Butadiene Rubber polymerizations, Synthetic fibres , oils ,soaps and detergents manufacture.
4. Interpret the manufacturing operations and processes for the production of natural products (sugar, pulp and paper, Fermentation industry) and Petroleum refining.

UNIT I **[CO:1]**

Introduction: Objectives, unit processes and unit operations. General Fundamentals.
Alkali Industries: Soda ash, Caustic soda and Chlorine.
Cement: Raw materials, types, manufacture, special Cements.
Glass: Raw materials, manufacture, special Glasses.
Industrial gases: Nitrogen, Carbon dioxide, Hydrogen and Oxygen.

UNIT II **[CO:2]**

Nitrogen industries: Synthetic Ammonia, Urea, Nitric acid.
Phosphate Industries: Phosphoric Acid, Calcium phosphate and Super phosphate
Sulfur and sulfuric acid: Manufacture of Sulfur and Sulfuric acid.
Hydrochloric acid: Manufacture of Hydrochloric acid.

UNIT III **[CO:3]**

Synthetic Fibres: Classification, manufacture of Nylon 6,6, Polyester Fibre, Viscose rayon Fibre.
Plastic industry: Classification of plastics, Manufacture of phenols (From Cumene, Toluene), Formaldehyde, Vinyl Chloride .Manufacture of phenol-formaldehyde resin and PVC.

Rubbers: Classification, Natural Rubber, monomers of Synthetic Rubber, manufacture of SBR.
Oils, soaps and detergents: Definitions, extraction and expression of vegetable oils, Hydrogenation of oils, continuous process for the production of Fatty acids and Soap, production of Detergents.

UNIT IV **[CO:4]**
Petroleum Refining: Constituents of petroleum, Products of Refining, petroleum refining process- Cracking, Reforming, Polymerization, Alkylation, Isomerization, Hydro-cracking.
Pulp and paper industry: Methods of pulping, production of Sulphate and Sulphite pulp, production of Paper–wet process.
Sugar and starch industry: Manufacture of Cane sugar, production of starch from maize.
Fermentation industry: Manufacture of Alcohol from molasses, manufacture of Penicillin.

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).
2. Shreve's Chemical Process Industries byG.T. Austin, McGraw Hill, 5th edition (1984)

Reference Books:

1. A Text Book of Chemical Technology (Volume I&II), G.N.Panday, Vikas Publishers
2. Chemical Process Technology by Jacob A.Moulijin, MIchielMakkee and Annelies Van Diepen, John Wiley & Sons(2001)

CH 351 MASS TRANSFER OPERATIONS-I LAB.

Practicals	:	*2 hrs*	*Sessional Marks*	:	*40*
			Semester End Exam Marks	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*1*

Course Objectives:

i.	To determine the diffusion coefficient in binary systems of liquids and gases.
ii.	To understand surface evaporation in stationary surfaces.
iii.	To study hydrodynamics column.
iv.	To determine the kinetic and equilibrium parameters of drying of wet solids.

Course Outcomes:

1)	Estimate the diffusivity of material in mass transfer operations.
2)	Predict the mass transfer coefficients.
3)	Prepare the characteristic curves of drying.
4)	Predict the mass transfer coefficients in humidification and dehumidification.

List of Experiments:

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)	Mass transfer coefficient in a wetted wall tower.
7)	Mass transfer coefficient in a Packed bed absorption.
8)	Mass transfer coefficient in a perforated plate tower.
9)	Batch drying.
10)	Humidification.
11)	Dehumidification.
12)	Mutual solubility curve.

CH 352 CHEMICAL REACTION ENGINEERING LAB

Practicals	:	*2 hrs*	*Sessional Marks*	:	*40*
			Semester End Exam Marks	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*1*

Course Objectives:

i.	To provide a core foundation for the analysis and design of chemical reactors.
ii.	To provide instruction in the analysis of experimental data to obtain rate equations and kinetic and thermodynamic data.
iii.	To provide the information of parametric study of the various chemical reactions.
iv.	To give students experience with a flexible bench scale experiment that can be used to study the processes of liquefaction.
v.	To gain knowledge in the design of reactors.

Course Outcomes:

1)	Design ideal continuous reactors operating at isothermal conditions given kinetic data and conversion.
2)	Solve for conversion in a non-ideal reactor given a residence time distribution.
3)	To understand how to measure reaction rates using integral and differential methods.
4)	Students are aware that materials, construction, operability, safety and ethical issues must be considered in reactor.

List of Experiments:

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.

CH 353 COMMUNICATIVE ENGLISH LAB

Practicals	*:*	*2 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*2*

Course Objectives

i. To build confidence and enable students speak better English.
ii. To motivate students to use English in different situations and contexts.
iii. To enable students understand the importance of preparation and practice in presentations.
iv. To enable them to understand the basic nuances for effective language communication.
v. Practice comprehensible pronunciation of English.

Course Outcomes

1) Recognize the need of good communication skills for professional courses.
2) Understand the basic tenets of communication.
3) Articulating syllables clearly, speaking fluently with correct pronunciation.
4) Develop their self-awareness.
5) Understand the importance of group dynamics.

UNIT - I **CO: 1**

Basics of Presentations

Ice breaking session
Student Presentation-I

Learning about Presentations

> - Presentation structure
> - Managing nerves in a presentation
> - Mini Presentations
> - Feedback on presentations

UNIT - II **CO: 2**

Professional and Personal Grooming

Functional English
Non Verbal Communication
Stage Manners
Understanding and preparing a Presentation
Team presentations

UNIT - III **CO: 3**

Speech Nuances
Pronunciation
MTI-Mother Tongue Influence
Stress in English
Tempo of Speech
Indianisms and Often Made Mistakes
Idioms & Phrasal verbs

UNIT - IV **CO: 4**

Free Talk

Dilemma Questions

Paraphrasing an article or a video in student's own words(Team task)

Impromptu speeches

Introducing TED TALKS

Movie based Learning-Karate Kid Movie-Understanding Life Skills

LEARNING RESOURCES

REFERENCE BOOKS:

1) Making Successful Presentations :A Self-Teaching Guide-Terry C. Smith,19846

2) Professional Presentations -Malcom Goodale

3) Giving Presentations -Jo Billingham

4) APA ART Speak Well I

5) HANDOUTS

CH 321 MASS TRANSFER OPERATIONS–II

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. Understand the concept of vapor liquid equilibrium and distillation processes.
ii. To explain the principles of Liquid-Liquid – extraction and equipment.
iii. To learn the concepts of absorption.
iv. To comprehend the operations of leaching and adsorption.

Course Outcomes

1) Analyze different types of distillation such as: batch & continuous, flash vaporization, steam distillation and differential distillation and design distillation columns using McCabe Thiele and Ponchon-Savarit methods.
2) Evaluate the equilibrium data for the liquid–liquid extractions and design the LLE.
3) Develop the equilibrium data and design the adsorption equipment.
4) Design of solid extractor.

UNIT - I **CO: 1**

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

UNIT – II **CO: 2**

Liquid-Liquid Extraction: Choice of solvent, ternary equilibrium, tie line, calculations for insoluble liquids – single stage, multi stage cross current operations.
Counter current operations, equipment – mixer-settler, perforated plate tower, rotating disk contactor, pulsed columns.

UNIT – III **CO: 3**

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.
Ion-Exchange: Principles of Ion-Exchange, techniques and applications, rate of Ion-Exchange.

UNIT – IV **CO: 4**

Leaching: Preparation of solids, percolation tanks, Shanks system, filter press leaching, agitated vessels, Rotocel, Kennedy extractor, Bollman extractor, single and multi-stage leaching calculation.
Crystallization: Crystal Geometry, Equilibrium and yields, nucleation and crystal growth rates, controlled growth of crystals, incorporation of principles into the design of the equipment.
Introduction to Membrane Separations: Definitions, modules, Dialysis.

LEARNING RESOURCES

TEXT BOOKS:

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).

4) Principles of Mass Transfer and Separation Processes, Binay K. Dutta, 2nd edition, Prentice Hall of India, 2007.

5) Diffusion - Mass Transfer in Fluid Systems, E.D. Cussler, Cambridge University Press, Cambridge 1984.

6) Principles of Unit Operations, S. Foust, 2nd Edition, Wiley, New York, 1980.

CH 322 PROCESS DYNAMICS & CONTROL

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. 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.
ii. To provide the students with fundamental background of process control theory and working knowledge of automatic control systems for chemical process.
iii. To provide the students the knowledge of stability analysis, frequency response analysis and control system design approaches.
iv. 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

1) Analyze typical process dynamics with and without feedback control using both time domain and Laplace domain approaches.
2) Analyze open loop and closed coop system properties and stability of control systems by using Routh test & root locus.
3) Apply frequency response based analysis for control system stability and performance.
4) Design, simulation and analysis of feedback, multi-loop and model based controllers & control valves.

UNIT - I **CO: 1**

Basic Principles and problems of process control: Laplace transforms 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 **CO: 2**

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

UNIT – III **CO: 3**

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 **CO: 4**

Advanced control strategies: Cascade control, feed forward control, ratio control and internal model control.
Controller tuning and process identification: Tuning, tuning rules, process identification.
Control Valves: Valve construction, sizing, characteristics, and positioner.

LEARNING RESOURCES

REFERENCE BOOKS:

1) Chemical Process Control: An introduction to Theory and Practice, George Stephanopoulos, Pearson
2) Process Control, Peter Harriot, Tata-McGraw-Hill, New Delhi
3) Process Control Modeling, Design and Simulation, B.W.Bequette, PHI
4) Process Control and Instrumentation, R.P.Vyas, 4th Edition, Dennett & Co.

CH 323 INDUSTRIAL POLLUTION CONTROL

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. 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.
ii. To provide knowledge of the unit operations and unit processes that can be used for water pollution abatement.
iii. To provide knowledge on the sources, affects and control measures of air pollution.
iv. To provide knowledge of the concepts of waste minimization, clean technology and green chemistry in chemical process industries.

Course Outcomes

1) Understand Significance of environmental pollution, such as air, water, land, noise, various pollutants sources, adverse effects, and environmental legislation.
2) Describe the unit operations and unit processes involved in waste water treatment.
3) Design air pollution control systems.
4) Apply specific treatment methods for effluents of chemical process industries such as fertilizer, petroleum refineries & petrochemical units and pulp & paper industries.

UNIT - I **CO: 1**

Introduction: Man & Environment, Types of Pollution (Air, water, land and noise), Pollution control aspects of Air and Water.

Industrial Pollution emissions & Indian Standards: Industrial emissions-Liquids, Gases, Environmental Legislation, Water quality management in India, Air Act -1981.

UNIT - II **CO: 2**

Water Pollution:

Removal of BOD: Biological oxidation, Biological oxidation units-Activated sludge process, and trickle filter, stabilization ponds, aerated lagoons, oxidation ditches and fluidized bed contactors, Anaerobic treatment.

Removal of Chromium: Reduction-Precipitation, ion exchange, reverse osmosis, lime coagulation and adsorption.

Removal of Mercury: Removal of mercury from gaseous and liquid streams.

Removal of Ammonia, Urea: Physico-chemical processes, biological methods, Algae-bacterial flocculation system.

Treatment of Phenolic effluents: Steam gas stripping, Adsorption/ion exchange, Solvent extraction and oxidation methods.

UNIT - III **CO: 3**

Air Pollution:

Removal of Particulate matter: Introduction, separation of particulate matter from effluent gases, preliminary methods of separations, cyclone separators, fabric filters, electrostatic precipitators.

Wet scrubbers: spray towers, centrifugal scrubbers, packed beds and plate columns venturi scrubbers Removal of Sulfur dioxide: Harmful effects of SO2, control methods, process changes, desulfurization of fuels, reduction of SO2concentration, wet processes & dry processes.

Removal of Oxides of Nitrogen: Control measures.

Removal of Organic vapors from Effluent: Absorption of vapors in suitable liquids and media, incineration of organic vapors.

UNIT - IV **CO: 4**

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.

LEARNING RESOURCES

TEXT BOOKS:

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 by C.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)

CH 324 PROCESS MODELING AND SIMULATION

Lectures	*:*	*3 hrs*	*Sessional Marks*	*:*	*40*
Tutorial	*:*	*---hrs*	*Semester End Exam Marks*	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Course Objectives

i. To introduce the methods and techniques of first principles modelling of plant and process dynamics.
ii. To provide training to build mathematical models for various chemical processes.
iii. To provide an overview of numerical methods used for continuous simulation.
iv. To provide an overview of computer simulation.

Course Outcomes

1) Analyze physical and chemical phenomena involved in various processes.
2) Develop the mathematical models for various chemical processes.
3) Apply the appropriate numerical methods to solve the non-linear, algebraic, ordinary differential equations and also to understand the general concepts of simulation.
4) Develop simulation algorithms for various chemical engineering systems.

UNIT - I **CO: 1**

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 motion, Transport equations, Equations of state, Equilibrium and Chemical kinetics.

UNIT – II **CO: 2**

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.

Modelling of Single component vaporizer, Multi-component flash drum, Batch reactor, Reactor with mass transfer, Ideal binary distillation column and Batch distillation with holdup.

UNIT – III **CO: 3**

Methods for solving non-linear equations: Interval Halving method, Newton-Raphson method, False Position method, Wegstein method. Numerical integration of ordinary differential equations: Euler Algorithm and Runge-Kutta (Fourth-Order) methods.

General Concepts of Simulation for Process Design: Introduction, modular approaches to process simulation- sequential modular approach, simultaneous modular approach, equation solving approach, Partitioning and tearing.

UNIT – IV **CO: 4**

Computer simulation: Simulation examples: Gravity flow tank, Three CSTRs in series with constant hold-up open loop system and Three CSTRs in series with constant hold-up closed loop system.

Simulation of Non-isothermal CSTR, Binary distillation column and Batch reactor.

LEARNING RESOURCES

TEXT BOOKS:

1) Process Modeling Simulation and Control for Chemical Engineers, 2nd edition, W.L.Luyben, McGraw Hill (1990).

2) Chemical Process Computations by Raghu Raman, Elsevier Applied Science

REFERENCE BOOKS:

1) Process Modeling and Simulation by R.W.Gaikwad and Dr. Dhirendra, 2nd edition, Central Techno Publications (2006).

2) Chemical Process Modeling 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).

CH 361 MASS TRANSFER OPERATIONS-II LAB

Practicals	*:*	*2 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*1*

Course Objectives

i. Determines the diffusion coefficient in binary systems of liquids and gases.
ii. Understands surface evaporation in stationary surfaces.
iii. Study the hydrodynamics of a column.
iv. Determines the kinetic and equilibrium parameters of drying of wet solids

Course Outcomes

1) Compile the equilibrium data.
2) Analyze differential distillation and steam distillation.
3) Judge the HETP.
4) Evaluate the minimum or no of stages required for a particular separation.

EXPERIMENTS:

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) Mass transfer coefficient in a wetted wall tower.
7) Mass transfer coefficient in a Packed bed absorption.
8) Mass transfer coefficient in a perforated plate tower.
9) Batch drying.
10) Humidification.
11) Dehumidification.
12) Batch Crystallization.
13) Mutual solubility curve.

CH 362 CHEMICAL TECHNOLOGY LAB

Practicals	*:*	*2 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*1*

Course Objectives

i. To instill students with the fundamental principles and concepts of Inorganic and Organic Chemical Technology.
ii. To provide students with the fundamental aspects of chemical process technology and professional knowledge in selected areas of Inorganic and Organic chemical technology.
iii. To provide knowledge in soap manufacturing, analysis and estimation.
iv. To provide knowledge in oil (testing), analysis and estimation of glucose and sugar.

Course Outcomes

1) Demonstrate knowledge on fundamental principles of chemistry, Inorganic chemical technology and on contemporary applications.
2) Design and conduct experiments, as well as critically analyze and interpret experiment results.
3) Demonstrate the principles of organic chemical technology and other applications.
4) Design a component process or system to meet the required product quality.

List of Experiments:

1) Determination of total dissolved solids and pH of water
2) Determination of chloride in tap water.
3) Determination of Sulphate in tap water.
4) Preparation of copper pigment
5) Preparation of chrome yellow
6) Preparation table salt
7) Proximate analysis
8) Estimation of nitrogen content in urea
9) Estimation of Glucose
10) Estimation of Cane sugar.
11) Preparation of soap by semi boiled process
12) Total fatty matter in soaps

CH 363 INSTRUMENTATION & PROCESS CONTROL LABORATORY

Practicals	:	*3 hrs*	*Sessional Marks*	:	*40*
			Semester End Exam Marks	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*1.5*

Course Objectives

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

Course Outcomes

1) To obtain and analyze the dynamic responses of the physical systems.
2) To calibrate and use the measuring instruments.
3) To obtain the transfer function of the unknown processes.
4) To obtain tuning parameters of Pneumatic P+I controller, to control a particular process.

List of Experiments:

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 in thermal wells.
7) Response of U-Tube manometer
8) Response of temperature control trainer for step input forcing function
9) Tuning of temperature control trainer by open loop method.
10) Response of level control trainer for step input forcing function
11) Tuning of flow control trainer by closed loop method.
12) Response of flow control trainer for sinusoidal input forcing function
13) Tuning of pressure control trainer by open loop method
14) Response of pressure control trainer for sinusoidal input forcing function

CH 411 PROCESS ECONOMICS & INDUSTRIAL MANAGEMENT

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. 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.
ii. To provide students with an ability to integrate knowledge about various production systems, functions and controlling techniques etc.
iii. To enable the student to demonstrate a thorough working knowledge about Industrial Management and various functional areas of management.
iv. To motivate the student for entrepreneurship activities.

Course Outcomes

1) Gain insight on contemporary issues in General and Industrial Management.
2) Identify, analyze and interpret various concepts of Finance, systems of production to enable the student to meet the needs of Industry.
3) Understand the impact of various Industrial Management solutions and techniques with focus on economic, environmental and societal context.
4) Recognition of the need and ability to engage in perpetual learning.

UNIT - I **CO: 1**

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 **CO: 2**

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 **CO: 3**

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 **CO: 4**

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.

LEARNING RESOURCES

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.

CH 412 TRANSPORT PHENOMENA

Lectures	*:*	*3 hrs*	*Sessional Marks*	*:*	*40*
Tutorial	*:*	*---hrs*	*Semester End Exam Marks*	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Course Objectives

i. To provide knowledge on mechanisms of momentum transport and velocity distributions in laminar flow.
ii. To provide knowledge on equations of change and velocity distributions in turbulent flow and also the estimation of friction factors.
iii. To provide knowledge on mechanisms of energy transport and temperature distributions in solids and in laminar flow.
iv. To provide training on mechanisms of mass transport and concentration distributions.

Course Outcomes

1) Develop the shell momentum balances, equations of change and solve them to obtain a velocity profiles in laminar flow.
2) Develop the equations of change and velocity profiles in turbulent flow and to estimate the friction factors.
3) Develop shell energy balances and solve them to obtain a temperature profile.
4) Develop the shell mass balances and solve them to obtain a concentration profiles.

UNIT - I **CO: 1**

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 **CO: 2**

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 **CO: 3**

Energy Transport: Steady state conduction, thermal conductivity and 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 **CO: 4**

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.

Concentration distributions in solids and in laminar flow: 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.

LEARNING RESOURCES

TEXT BOOKS:

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

REFERENCE BOOKS:

1) Transport process and separation process principles by Christie John Geankoplis, 4 th edition, PHI (2003).

2) Transport Phenomena, A Unified approach by Roberts, Broadkey and Harry C. Hershey, McGraw Hill.

3) Transport Phenomena, Chemical Processes by Sunil Kumar Thamida, Studium Press(India) Pvt. Ltd.

CH 413 CHEMICAL ENGINEERING PLANT & EQUIPMENT DESIGN

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To introduce the basic principles of process design.
ii. To appraise principle criteria involved in the design of process heat transfer equipment.
iii. To develop working knowledge on Mass transfer, chemical reaction kinetics and design various types of columns and reactors.
iv. To teach the fundamentals of Mechanical design of process equipment.

Course Outcomes

1) Identify health and safety hazards, fire & explosion hazards, plant location & layout for a given process, loss prevention methods and draw process flow diagrams.
2) Compare preliminary design with firm process design and design heat transfer equipment.
3) Design mass transfer equipment such as tray columns & packed columns and reactors such as batch, PFR and CSTR.
4) Apply mechanical design concepts to process equipment.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	-	2	-	-	2	3	3	3	-	-	2	3	2	2
CO2	-	2	3	-	2	-	-	-	-	3	-	-	2	3
CO3	2	-	3	3	2	2	-	-	-	3	-	-	2	3
CO4	2	-	3	3	2	3	-	-	-	3	-	-	2	3

UNIT - I **CO: 1**

Introduction: Overall design considerations, Optimum design, Practical considerations in design and Engineering ethics in Design.

General design considerations: Health and safety hazards, loss prevention, Environmental protection, plant location and plant layout.

UNIT – II **CO: 2**

Process Design Development: Development of Design Database, Process Creation, Process Design, and Process Flow diagrams, Equipment design specifications, Preliminary Design.

Heat transfer equipment design: Theory of heat transfer, Determination of heat transfer coefficients and pressure drop in heat exchangers, selection of heat transfer equipment, Methods for design of heat exchangers.

UNIT – III **CO: 3**

Mass Transfer Equipment Design: Finite stage contactors (sieve, valve, bubble-cap), Continuous contactors (packed columns).

Reactor equipment design: Reactor principles, Equations for reactor-design (Batch, Tubular plug-flow, Back-mix reactors).

UNIT – IV **CO: 4**

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

LEARNING RESOURCES

TEXT BOOKS:

1) Plant Design and Economics for Chemical Engineers, Peters M. S., Timmerhaus K.D. and West R.E., Fifth Edition, McGraw Hill. (UNIT I to III)

2) Introduction to Chemical Equipment Design, Mechanical aspects, B.C.Battacharyya, CBS Publishers and Distributors, New Delhi. (UNIT IV)

REFERENCE BOOKS:

1) Chemical Engineering, Vol-6, Coulson J.M., Richardson J.F. and Sinnott, R.K., Pergamon press.

2) Process Equipment Design, Joshi, M.V. and Mahajani V.V, Macmilan India Ltd.

3) Coulson & Richardson's Chemical Engineering, Volume : 2, J.F. Richardson, J. H. Harker and J. R. Backhurst, 4th edition, Elsevier.

CH 451 COMPUTER AIDED PROCESS DESIGN AND SIMULATION

Practicals	*:*	*3 hrs*	*Sessional Marks*	*:*	*40*
			Semester End Exam Marks	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*1.5*

Course Objectives

i. To teach the importance of modeling and simulation for the design of chemical processes and equipment
ii. To introduce the simulating design environment
iii. To impart the hands on design experience by using the simulator ASPEN PLUS
iv. To make sure the student is proficient enough to perform design calculations in ASPEN PLUS

Course Outcomes

1) Understand the importance of simulators in Chemical Process and Equipment Design
2) Estimate the physical and thermodynamic properties of pure substances by using ASPEN Properties
3) Utilize the ASPEN PLUS simulating environment to solve the flow sheeting, analysis and design problems
4) Perform the Shortcut and Detailed Design calculations of various chemical equipment

List of Experiments:

1) Estimation of physical, chemical and thermodynamic properties of pure substances
2) Generation of VLE data of binary and multi-component mixtures
3) Simulation of Flash column to estimate the bubble point and dew point temperature as well as pressure
4) Simulation of a mixer and a splitter
5) Simulation of stoichiometric reactor
6) Simulation of CSTR, PFR and Gibb's reactors
7) Simulation of columns
8) Performing Material and Energy Balance calculations using ASPEN PLUS
9) Shortcut and Detailed Design of a Heat Exchanger using ASPEN PLUS
10) Shortcut and Detailed Design of a Distillation Column
11) Estimation of design parameters of various chemical process flow sheets

CH 452 POLLUTION CONTROL LABORATORY

Practicals	:	*2 hrs*	*Sessional Marks*	:	*40*
			Semester End Exam Marks	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*1*

Course Objectives

i. To determine the oxygen levels, Biological oxygen demand, chemical oxygen demand in municipal ground sewage and industrial effluent waters.
ii. To determine the dissolved suspended solids fixed and volatile solids in the give sample of water.
iii. To determine the optimum amount of coagulant and alums required for municipal sewage and industrial affluent water.
iv. 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

1) Determine the amount of oxygen and the extent of pollution of water due to organic matter.
2) Determine the extent of suspended and dissolved solid pollution in the given sample of water.
3) Predict the optimum dosage of alum and coagulant required for purification of water.
4) Determine the salt dyes and metallic components in a given sample of water.

List of Experiments:

1) Suspended solids in air sample using high volume sampler
2) CO2 and CO concentrations in a given sample
3) SO2 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

CH 451 MINI PROJECT /TERM PAPER

Practicals	*:*	*4 hrs*	*Sessional Marks*	*:*	*100*
Semester End Exam.	*:*		*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.,)

CH 461 PROJECT WORK

Practicals	:	*16 hrs*	*Sessional Marks*	:	*40*
			Semester End Exam Marks	:	*60*
Semester End Exam.	:		*Credits*	:	*8*

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.

CHEL 01 PETROLEUM EXPLORATION WELL LOGGING

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To understand the logging technologies
ii. To delineate hydrocarbons through direct and indirect means/methods
iii. To determine the formation lithology through logs like S.P, G.R etc. and also depositional environment with the help of Gamma rays spectroscopy and Dip-meter tools
iv. To determine the physical properties of the subsurface, strata like resistivity, porosity, thickness etc. through tools like latero, induction, density, neutron, etc.

Course Outcomes

1) Know various well logging methods.
2) Know resistivity logs method.
3) Know the gamma ray log and density logs methods.
4) Do cased hole logging and production logging methods.

UNIT - I **CO: 1**

Direct Methods: Mud logging- coring – conventional and sidewall coring - Core analysis. **Concepts of well logging:** What is well logging? - Logging terminology-Borehole environment-Borehole temperature and pressure-Log header and depth scale-Major components of well logging unit and logging setup- Classification of well logging methods-Log presentation- Log quality control.
Open-hole logging: SP Logging- Origin of SP, uses of SP log-Calculation of salinity affirmation water- Shaliness-Factors influence SP log.

UNIT – II **CO: 2**

Resistivity log: Single point resistance log (SPR) - Conventional resistivity logs- Response of potential and gradient logs over thin and thick conductive and resistive formations-Limitations of conventional resistivity tools. Focused resistivity log- Advantages of focused resistivity tools over conventional resistivity tools.
Micro resistivity log: Conventional and focused micro resistivity logs and their application. **Induction log:** Principle of induction tool and the advantages. Criteria for selection of induction and lateral logging tool. Determination of true resistivity (Rt) of the formation-Resistivity index-Archie's equation.

UNIT – III **CO: 3**

Gamma ray log: principle of radioactivity-Uses of gamma ray log- Determination of shaliness of formation-API counts- Calibration of Gamma ray tool-Statistical fluctuation-Time constant. Natural Spectral Gamma ray log: Principle and application. Caliper log: Principle and application of caliper tool.

Density log: Principle of density tool- Environmental corrections-Porosity determination-Tool calibration. Litho density log. Neutron log: Principle and application of neutron tool. Porosity determination. Sonic log: Principle and application of sonic log-Bore hole

compensation-Determination of primary and secondary porosity, determination of mechanical properties of rock, elastic constants, fractures etc.

Cased hole logging: Gamma ray spectral log-Neutron decay time log-Determination of fluid saturation behind casing-Cement bond log- Casing collar log-Depth control- Perforation technique- Free point locater and Plug setting-Casing inspection logs.

UNIT – IV **CO: 4**

Production logging: Solving production problems with the help of Fluid Density log-Temperature log and Flow meter logs.

Advances in Well logging: Dip meter log-Formation tester-Cased hole resistivity logs – Nuclear magnetic resonance log & Scanner logs (Sonic scanner, MR scanner Rt scanner).Calculating the dip of the formations, collection of fluid samples from wells for confirmation of log interpretation, and also recording resistivity in cased holes.

Interpretation: Quick look interpretation- Cross plots. Neutron- Density, Sonic- Density, Sonic-Neutron cross plots-Hingle plot-Mid plot –Correlation- Hydrocarbon reserve estimate.

LEARNING RESOURCES

TEXT BOOKS:

1) Well logging and formation evaluation, Toby Darling, Elsevier, New York, 2005

REFERENCE BOOKS:

1) Well Logging for Earth Scientists, Darwin V. Ellis, Julian M. Singer, Springer, 2007.
2) Hydrocarbon well logging recommended practice, Society of professional well log analysts.
3) Well Logging Handbook, Oberto Serra, Editions Technip, 2008.
4) Well Logging & Reservoir Evaluation, Oberto Serra, Editions Technip, 2007.

CHEL 02 PETROLEUM REFINERY ENGINEERING

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To understand the properties and their significance of crude oils and Petroleum fractions.
ii. To understand, design and analyze the various petroleum refinery processes including primary, secondary and supporting processes.
iii. To understand the process technologies for the petrochemical products.
iv. To understand suitable thermal/catalytic conversion (cracking) processes for Vacuum gas oil/residue upgradation and to produce desired fuel blend components and petrochemical feed stocks.

Course Outcomes

1) Able to the overall scenario of quality of crude oil.
2) Able to calculate different Petroleum Products and their specifications.
3) Able to know the different processes involving for up gradation of petroleum fractions.
4) Able to do Thermal & Catalytic cracking processes.

UNIT - I **CO: 1**

Origin, formation and composition of petroleum: Origin and formation of petroleum, Reserves and deposits of world, Petro Glimpses and petroleum industry in India, Dehydration and desalting of crudes.

Refinery feed stocks: Crude oil classification-Composition and properties-Composition of petroleum crude suitable for asphalt/coke manufacture – Evaluation of crude oils.

UNIT – II **CO: 2**

Petroleum Products and their specifications: LPG- Gasoline- Diesel fuels- Jet and turbine Fuels – Blending of gasoline.

Lube oils-Heating oil's – Residual fuel oils - wax and asphalt- Petroleum coke- All Product specifications-Product blending.

UNIT – III **CO: 3**

Crude distillation: Atmospheric and Vacuum distillation units, Auxiliary equipment such as pipe still heaters and heat exchanger trains etc

Catalytic reforming and isomerization: Catalytic reforming processes (for petroleum and petrochemical feed stocks) – Isomerization Processes -Feed stocks-Feed preparation – Yields.

Thermal & Catalytic cracking processes: Visbreaking- Delayed Coking –Fluid Catalytic cracking and Hydrocracking - Feed stocks — Catalysts - Process variables –Product Recoveries-Yield estimation.

UNIT – IV **CO: 4**

Hydrotreating & Hydroprocessing: Naphtha, Kerosene, Diesel, VGO & Resid. Hydrotreating / Hydroprocessing – Feed stocks – Process description and Process variables. Transportation of petroleum products: road, rail, sea and pipeline; Importance of pipeline transportation.

LEARNING RESOURCES

TEXT BOOKS:

1) Petroleum Refining: Technology and Economics, J.H. Gary and G.E.Handwerk, 4th Edition, Marcel Dekkar, Inc., 2001.

REFERENCE BOOKS:

1) Petrochemical Process Technology, ID Mall, Macmillan India Ltd., 2007.
2) Handbook of Petrochemicals Production Processes, R.A. Meyers, TRW, Inc., 2005.
3) Petrochemicals, P.Wiseman, Ellis Horwood, 1986
4) Modern Petroleum Refining Processes, B.K. BhaskaraRao, 5th Edition, Oxford & IBH Publishing, 2011.

CHEL03 PETROCHEMICAL TECHNOLOGY

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To make a thorough understanding of the availability of petroleum feed stocks for petrochemicals
ii. To understand methods to produce various petro Chemicals from ethylene and C3, C4 and higher carbon atoms.
iii. To know the various chemical processes, kinetics and safety accepts of petrochemicals.
iv. To methodolically furnishing the conversion of petroleum feedstock's to chemical and intermediates.

Course Outcomes

1) Know Petrochemical industry-Feedstock, various important Chemicals produced from methane, ethane, ethylene.
2) Produce different petrochemicals from C3, C4 and higher carbon atoms, polymerization and production of various polymers.
3) Produce different petroleum aromatics.
4) Produce different intermediate chemicals, synthetic fibers.

UNIT - I **CO: 1**

Petrochemical industry-Feed stocks: Petrochemical industry in India, feed stocks for petrochemicals. **Chemicals from Methane:** Methanol, Iso-butylene, Formaldehyde, Acetic acid, Hexamethylenetetramine, PTFE, methyl amine, Hydrogen cyanide.
Production & Chemicals from Ethane-ethylene-Acetylene: Ethylene production, Vinyl chloride monomer, vinylacetate monomer, ethylene oxide, ethylene glycol, acetaldehyde. Acrylic acid, Isoprene.

UNIT – II **CO: 2**

Chemicals from C3, C4 and higher carbon atoms: Isopropyl alcohol, acrylonitrile, acrylic acid, phenol, bisphenol-A, iso and n-butanol, methyltertbutylether, methacrylic acid, malic anhydride.
Polymers of olefins: Polymer structure, methods of polymerization, high density polyethylene (HDPE), low density polyethylene (LDPE), polypropylene, polyvinylchloride, polystyrene.

UNIT – III **CO: 3**

Petroleum aromatics: Higher olefins: Benzene, toluene, xylene, phenol and StyreneBenzene Derivatives – Aniline, Styrene; Benzoic acid, Products from Toluene-caprolactum, terephthalic acid, phthalic anhydride
Production of intermediate chemicals: Acrylonitrile, ethylene oxide, propylene oxide, ethyl chloride vinyl acetate and vinyl chloride.

UNIT – IV **CO: 4**

Synthetic fibres: Production techniques of synthetic fibres, production of polyethylene Terephthalate, acrylic fibers, polypropylene. **Synthetic detergents:** Classification of detergents, general manufacture of sulphonates, keryl benzene sulphonate
Non-ionic detergents-preparation of Alkylated phenol detergents, Cationic Detergents. Production of Carbon black

LEARNING RESOURCES

TEXT BOOKS:

1) A Text on Petrochemicals, B.K.BhaskaraRao, 3rd Edition, Khanna Publishers, New Delhi

REFERENCE BOOKS:

1) Petrochemical processes, Vol.2, 2nd edition, by A.Chanvel and G. Lefebvre, Gulf publishing company
2) Shreve's chemical process industries, 5th edition, by George T. Austin, McGraw Hill Publishers

CHEL 04 NATURAL GAS PRODUCTION AND ITS APPLICATIONS

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To gain basic knowledge of NG and its prospective.
ii. To understand different processes, transportation and storage of Natural gas (NG).
iii. To learn different liquefaction technologies of NG.
iv. To have knowledge on different functional units on receiving terminals.

Course Outcomes

1) Have knowledge on Natural Gas potential, composition and resources.
2) Apply different liquefaction techniques.
3) Understand different steps in NG processing.
4) Have knowledge associated with safety aspects of NG, transportation and storage.

UNIT - I **CO: 1**

Introduction: Composition of Natural Gas, Utilization of Natural Gas, Natural Gas Industry, Natural Gas Reserves.
Types of Natural Gas Resources, Future of the Natural Gas Industry.

UNIT – II **CO: 2**

Properties of Natural Gas: Physical properties of natural gas and hydrocarbon liquids associated with natural gas. Reservoir aspects of natural gas. Calorific value of gas and measurement.
Gas Compression: Types of Compressors, Selection, Thermodynamics of Compressors, Compression calculations. Heat and Mass Transfer Principles and Applications in Natural Gas Engineering, Use of Mollier Diagrams.

UNIT – III **CO: 3**

Gas Flow Measurement: Process control and instrumentation in natural gas processing plants temperature processing, Liquefaction Process.
Dehydration of Natural Gas, Sweetening of Natural gas and sulphur recovery. Processing for LPG, CNG, system, Conversion of gas to liquid. Custody transfer- principles and measurements.
Gas Gathering, Transport and Storage: Gas Gathering System. Steady Flow in Simple Pipeline System, Steady State and un-Steady State Flow in Pipelines, Solution for Transient Flow.

UNIT – IV **CO: 4**

Transmission of Natural Gas, Specifications. Underground Storage and Conservation of Natural Gas.
Unconventional gas: Coal Bed Methane, Natural Gas Hydrate, Basin Centered Gas, Tight Gas Sands, Shale Gas. Current Technology for Shale Gas and Tight Gas Exploration and Production.
LNG: Production and Utilization: Issue and Challenges to Enhance Supply of Natural Gas.

LEARNING RESOURCES

TEXT BOOKS:

1) LNG: Basics of Liquified Natural Gas, I st Edition, Stanley Huang, Hwa Chiu and Doug Elliot, PETEX, 2007

REFERENCE BOOKS:

1) LNG: A Nontechnical Guide, Michael D'Tusiani, Gordon Shearer Penn Well Books, 2007

2) Natural Gas Transportation, Storage and Use, Mark Fennell Amazon Digital Services, Inc., 2011

3) Liquified Gas Handling Principles on Ships and in Terminals, 3rd Edition, McGuire and White, Witherby Publishers, 2000.

CHEL 05 GENERAL PHARMACY

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To impart fundamental knowledge on various calculations used in pharmaceutical formulation, packaging and labeling requirements and educate on various extraction methods for active crude drug extraction.
ii. To impart a fundamental knowledge on the art and science of pharmaceutical formulations, prerequisites, ingredients, unit operations and excipients in different types of dosage forms.
iii. To understand various types of liquid dosage forms including monophasic and biphasic systems with emphasis on HLB system and key excipients.
iv. To educate about liquid concentrate/semisolid and aerosol formulations, production and packaging along with applications.

Course Outcomes

1) Perform the calculations required for extraction methods, formulations, packaging materials used and labeling requirements.
2) Explain the different types of pharmaceutical formulations, unit operations and packaging requirements.
3) Demonstrate monophasic and biphasic liquid preparations depending on formulation prerequisites and HLB scale.
4) Prepare liquid concentrates, semisolid and liquid-gas dosage forms for potential applications.

UNIT - I **CO: 1**

Units and Measures; Systems of Weights and Measures-Metric and Imperial systems– Percentage calculations and adjustment of products-Inter-conversions-Use of alligation method in calculations - Isotonic solutions and proof spirits - Weighing -Selection and care of Weights and balances. Calculations involving displacement value.

Extraction Methods for crude drugs: Percolation (various types including processes for concentrated preparations, constant hot percolation), maceration (various types including processes for organized and unorganized drugs, for concentrated preparations, double and triple maceration processes), Decoction.

Packaging and Labelling of Pharmaceuticals: Desirable features of a container -Types of containers - Study of glass and plastics as materials for containers and rubber as a material for closures - their merits and demerits-Labeling requirements. Overview of new generation packing and packaging; Biodegradable and edible packaging.

UNIT – II **CO: 2**

Pharmaceutical Dosage Forms: Introduction and classification-Definitions and characteristics of different dosage forms - Formulation and its purpose.

Unit Operations in Pharmaceutical Formulations: Mixing, Blending, Grinding, Sieving, Drying, Filling and Packaging.

Formulation of Additives: Excipients/fillers/solvents, Vehicles for Liquids, Antioxidants, Preservatives, Colouring agents, Sweetening and flavouring agents in Liquid dosage forms.

UNIT – III **CO: 3**

Liquid Dosage forms: Introduction, classification and formulation prerequisites.

Monophasic Liquid dosage forms; Introduction, formulation and uses of Solutions, Aromatic Waters, Spirits, Syrups, Elixirs, Dry Syrups, Mixtures. **Liquid formulation for tropical uses:** Lotions, Liniments, throat paints, gargles, mouthwashes, glycerins, collodions, Ear drops, Nasal drops and Sprays, Douches - preparations.

Biphasic liquid dosage Forms: Hydrophilic–lipophilic balance (HLB) Scale, Surfactant and plasticizers. Suspensions and Emulsion: Introduction, Types, Ideal requirements, additives and formulation methods and applications.

UNIT – IV **CO: 4**

Liquid Concentrate and semisolid dosage forms: **Liquid Concentrate -** Introduction, Types: Medicated and non-medicated; formulations - gelatin shells and capsules. Application: external and internal. **Suppositories**: Definition, types and excipients; bases and types, formulation methods and applications.

Semisolid dosage forms: Definitions, classification, excipients and formulation prerequisites of ointments, pastes, creams and gels.

Liquid-Gas formulation: Aerosols: Introductions to aerosol system and types. Propellant: definition and types. Two phase versus three phase system. Solvent, Container and Uses: external versus internal.

LEARNING RESOURCES

TEXT BOOKS:

1) Introduction to General Pharmacy by Gaurav Agarwal.

2) A T. B. of General and Dispensing Pharmacy by Kambham Venkateswarlu and N. Devanna.

3) Pharmaceutical Dosage Form: Basics and Beyond by Kamlesh J Wadher and Milind J Umekar, 2019, PharmaMed Press 2017.

REFERENCE BOOKS:

1) Lachmann. Theory and Practice of Industrial Pharmacy, Lea & Febiger Publisher, The University of Michigan.

2) Pharmaceutical Sciences, Remington's, 21st Edition.

CHEL 06 Pre-formulation studies including stability Studies

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives:

1. Impart knowledge about Pre-formulation studies to be conducted in the new dosage form design
2. Promote understanding of the studies involved in the assessment of rate and extent of drug that reaches into systemic circulation.
3. Provide awareness on ICH guidelines for bioavailability and bioequivalence studies.
4. Divulge information on assessing the stability of formulations as per ICH guide lines

Course Outcomes: Upon completion of the course, the student shall be able to

1. Understand and carry out Pre-formulation studies for the successful development of dosage form.
2. Apply the knowledge of various factors influencing the absorption and evaluate drug release by dissolution studies.
3. Choose appropriate study design involved in the bioavailability and bioequivalence.
4. Utilize the knowledge of ICH guidelines for conducting stability & photo-stability studies.

UNIT – I **[CO1]**

Introduction to Pre-formulation studies & It's Objectives; Multidisciplinary development of a drug candidate, Principal areas of Pre-formulation research; Essential information helpful in designing the Pre-formulation evaluation of a new drug.

Bulk Characterization: Crystallinity & Polymorphism; Hygroscopicity; Fine particle characterization; Bulk density and powder flow properties.

UNIT – II **[CO2]**

Drug Solubility, Factors affecting solubility, Methods for enhancement of solubility. Drug absorption. Drug transport mechanisms, factors and kinetics involved. Physico- chemical and biological factors involved in Drug absorption - Formulations and dosage form considerations in drug absorption.

Drug Dissolution: Mechanisms, Factors and Kinetics of dissolution, Dissolution rate - Significance, Methods for enhancement of dissolution rate.

UNIT – III **[CO3]**

Bioavailability: Concept, definition, objectives of bioavailability study, Measurement of Bioavailability as per ICH Guide lines.

Bioequivalence: Concept, definitions, study designs for bioequivalence studies, Study protocol and analysis of data as per ICH Guide lines.

UNIT – IV **[CO3]**

Stability Testing: Solid state drug stability, dosage form stability, accelerated stability testing, shelf life calculations, strategies for prolonging shelf life.

Effect of packaging materials on dosage form stability. Basic principles of ICH for stability testing of new drug substance and formulations. Photo Stability and oxidative stability, role of containers in Stability: ICH stability guidelines

LEARNING RESOURCES
TEXT BOOKS:

1. Industrial pharmacy by Libermann & Lachman, 4th Edition.
2. The science and practice of pharmaceutical dosage forms by ME Alton 2nd Edition
3. BioPharmaceutics and Pharmacokinetics, D.M. Bramankar and Sunil B. Jaiswal.

REFERENCE BOOKS:

1. BioPharmaceutics and Pharmacokinetics, D.M. Bramankar and Sunil B. Jaiswal, 3rd Edition Pharmaceutical Sciences by Remington's, 21st Edition
2. Modern pharmaceutics by Banker & Rhodes, 12th Edition.

CHEL07 INDUSTRIAL PHARMACY

Lectures	*:*	*3 hrs*	*Sessional Marks*	*:*	*40*
Tutorial	*:*	*---hrs*	*Semester End Exam Marks*	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Course Objectives

i. To provide an understanding of large scale production of solid dosage forms - prerequisites, equipments and processes.
ii. To impart knowledge on liquid dosage form manufacturing: both monophasic & biphasic and production of suspension and emulsion: micro and macro.
iii. To give a real time working knowledge of semisolid and aerosol formulation manufacturing, equipments, and processes.
iv. To provide an understanding of sterile formulations: production prerequisites, production section, filling and containers.

Course Outcomes

1) Demonstrate pharmaceutical skills in solid dosage form manufacturing.
2) Prepare liquid dosage forms, both monophasic and biphasic and formulate macro and micro emulsion; coarse and fine suspension.
3) Design production of semisolid and aerosol formulations.
4) Develop sterile formulations with an understanding of prerequisites, method of manufacturing and packaging.

UNIT - I **CO: 1**

Pharmaceutical Manufacturing: Introduction, formulation units and its sections, filling/packing, packaging and storage. Space management and interior design. Pilot plant: scale-up techniques.

Solid dosage forms: Tablet Manufacturing, equipment and instruments, material and process. Coating and evaluation of tablets. Capsule; Hard Vs. soft gelatin capsules; granules and powders, Equipments, Filing and evaluation of capsules.

UNIT – II **CO: 2**

Liquid dosage forms: Formulation of monophasic liquid dosage forms: Equipments, Unit operations, active ingredients and excipients, Evaluation of monophasic liquid dosage forms

Formulation of biphasic Liquid Dosage forms: Equipments, Unit operations, active ingredients and excipients. Suspension; coarse Vs. fine, Emulsion; Micro-emulsion Vs. Macro-emulsion. Oil in water Vs. water in oil emulsion.

UNIT – III **CO: 3**

Formulation of Semisolid dosage forms & Pharmaceutical Aerosols: Semisolids: study of the principles, formulation, manufacturing process and equipment for semisolid dosage forms.

Pharmaceutical Aerosols: study of the Propellants, principles, formulation, manufacturing process and filling equipments for Aerosols.

UNIT – IV **CO: 4**

Formulation of sterile dosage forms: Parenterals: Prerequisites; formulation, workplace and containers. Materials and production techniques, filling machines, sterilizers, and layout for production of parenterals.

Ophthalmic preparations: Materials and production techniques, filling machines and sterilizers, for production of eye drops & Eye Lotions.

LEARNING RESOURCES

TEXT BOOKS:

1) Pharmaceutics – I: General and Dispensing Pharmacy by Ashok K. Gupta, CBS Publishers, 2018.

2) Modern Dispensing Pharmacy Book by G. D. Gupta and N. K. Jain, 2015, 2019; Vedams eBooks (P) Ltd (New Delhi, India

REFERENCE BOOKS:

1) Libermann & Lachman, The Theory and Practice of Industrial Pharmacy.

2) ME Alton, The Science and Practice of Pharmaceutical Dosage forms.

CHEL 08 Quality control of pharmaceutical Dosage Forms

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives: Impart required knowledge

1. To deal with the analysis of tablets and capsules as per official compendium
2. To analyze the quality of solutions, suspensions and emulsions as per official compendium
3. To evaluate the quality of sterile products as per official compendium
4. To assess the quality of semisolid preparations as per official compendium
5. To perform the quality analysis of suppositories, pessaries and Oral controlled release dosage forms as per official compendium

Course Outcomes: Upon completion, the student shall be able to

1. Perform the procedure for assessing the quality of tablets and capsules.
2. Evaluate the quality of solutions, suspensions and emulsions.
3. Perform the quality control tests for sterile products.
4. Undertake the procedure for assessing the quality of topical preparations and aerosols.
5. Choose and carry out the procedure for evaluating the quality of suppositories, pessaries and oral controlled release dosage forms

UNIT - I

Tablets: Quality control tests for various types of tablets as per IP

Capsules: Quality control tests for Hard and soft gelatin capsules as per IP.

UNIT- II

Mono phasic liquids: Quality control tests for various types of solutions and elixirs as per IP.

Bi phasic liquids: Quality control tests for Suspensions and Emulsions as per IP.

UNIT – III

Parenterals: Quality control tests for Parenteral preparations as per IP.

Ophthalmic Preparations: Quality control tests for Eye, Ear and Nasal drops as per IP.

UNIT – IV

Topical Preparations: Quality control tests for Ointments, Creams, Pastes and Jellies as per IP.

Aerosols: Quality control tests for Aerosols as per IP.

UNIT - V

Suppositories & Pessaries: Quality control tests for Suppositories and Pessaries as per IP.

Oral Controlled Release Dosage forms: Quality control tests for Oral controlled release dosage forms.

Learning Resources

Text Books

1. Quality Assurance and Quality Management in Pharmaceutical Industry, by Y. Anjaneyulu and R. Marayya, Pharma book SyndicatePublishers.
2. Quality Analysis of Drugs in Pharmaceutical Formulations, by P.D. Sethi, Third edition, CBS Publishers and distributors.
3. Indian pharmacopoeia by Libermann & Lachman, Vol. 1, 2& 3.

Reference Books

1. Pharmaceutical Sciences by Remington's, 21st Edition
2. Modern pharmaceutics by Banker & Rhodes, 12th Edition

CHEL09 COMPUTER SIMULATORS

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To make students understand the concepts of numerical and computer simulation.
ii. To make the students understand how to apply the MATLAB tool for the simulation of chemical engineering models.
iii. To impart the knowledge of modelling the chemical equipment and simulating by using programming as well as Simulink tool.
iv. To demonstrate the techniques of simulation of the chemical engineering models by using design software like ASPEN Plus.

Course Outcomes

1) Apply the numerical methods to simulate the chemical engineering problems.
2) Utilize the MATLAB programming for the simulation of chemical engineering model equations.
3) Simulate the chemical processes in the controlling environment by using the Simulink.
4) Design the Chemical Engineering Processes involving various chemical equipment by using ASPEN Plus Design software.

UNIT - I **CO: 1**

Chemical Process Simulation: Introduction, Process simulation Techniques- sequential, simultaneous and equation oriented approaches, Partitioning and Tearing, The Flow sheet Simulator.

Numerical Methods in Chemical Engineering: application of numerical techniques to simulate chemical engineering problems.

UNIT – II **CO: 2**

Introduction to MATLAB, MATLAB Scripts, MATLAB Arrays, Linear models, graphing data in MATLAB, MATLAB Array Math.

Applications of MATLAB: Polynomials, Curve fitting, Linear Algebra, Solution of Ordinary Differential Equations, Numerical Integration.

UNIT – III **CO: 3**

Simulation Examples of: Heat exchanger, Distillation column, Plug flow reactor, CSTR.

Simulation using Simulink: Introduction to Simulink, process modelling and simulation using Simulink tool, examples of application of Simulink for modelling chemical processes.

UNIT – IV **CO: 4**

Aspen simulation: Introduction to ASPEN Properties, thermodynamic property methods, property estimation of pure component, binary and ternary mixtures, bubble point and dew point estimation.

Introduction to ASPEN Plus: Process flow sheet, Simple Simulation Examples by using Aspen Plus: Flash column, mixers and splitters, reactors, pipes, pumps and compressors, distillation columns.

LEARNING RESOURCES

TEXT BOOKS:

1) Chemical Process Computations by Raghu Raman, Elsevier Applied Science Publishers, the University of Michigan (1985). (Unit-1)

2) Getting Started With MATLAB: A Quick Introduction For Scientists And Engineers, Rudra Pratap, Oxford Universit Press, 2010. (Unit-2,3)

3) Process Simulation and Control Using Aspen, Amiya. K. Jana, PHI, 2009. ((Unit-4)

REFERENCE BOOKS:

1) Introduction to Chemical Engineering Computing by Bruce.A.Finlayson, Wiley-Interscience, 2006.

2) Chemical Process Modeling 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).

CHEL10 COMPUTER AIDED PROCESS ENGINEERING

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To understand the simulation of mathematical equations by using various simulators.
ii. To understand the application of simulators in chemical reaction equilibrium and mass balances.
iii. To understand the simulation of mass - transfer equipment and chemical reactors.
iv. To understand the simulation of heat transfer equipment and industrial flow sheets.

Course Outcomes

1) Use the simulators like MATLAB and ASPEN PLUS to solve the mathematical model equations.
2) Apply the simulators to compute mass balances.
3) Use the simulators to simulate mass transfer equipment and chemical reactors.
4) Use the simulators to simulate heat exchanging equipment and some industrial examples.

UNIT - I **CO: 1**

Introduction: Organization, Algebraic Equations, Process Simulation, Differential Equations. Equation of State: Mathematical Formulation, Solution of Equation of State using Excel, MATLAB and Aspen Plus, Example of Chemical Engineering Problems solved using MATLAB and Aspen Plus.

Vapor-Liquid Equilibrium: Flash and Phase Separation, Thermodynamic parameters, Examples using MATLAB and Aspen Plus, Non ideal liquids-Test of Thermodynamic model.

UNIT – II **CO: 2**

Chemical Reaction Equilibrium: Chemical Equilibrium expression, Example of Hydrogen for fuel cells, Solution using MATLAB, Chemical Equilibria with two or more equations, Chemical Equilibria with Aspen Plus.

Mass Balances with Recycle Systems: Mathematical Formulation, Simulation without and with recycle using Aspen Plus.

UNIT – III **CO: 3**

Simulation of Mass Transfer Equipment: Thermodynamics, Simulation of Multi-Component distillation Column by shortcut methods, Mathematical Development, Simulation of packed bed absorption equipment, Problems using Aspen Plus.

Chemical Reactors: Mathematical Formulation of Reactor Problems-Plug Flow Reactors and Batch Reactor, Continuous Stirred Tank Reactor. Simulation of the Chemical Reactors with MATLAB and Aspen Plus, CSTR with Multiple Solutions-Solutions using MATLAB.

UNIT – IV **CO: 4**

Simulation of Heat Transfer Equipment using Aspen Plus: Heat Transfer in a SLAB, Transient Heat Transfer, Shortcut and Detailed design of a shell and tube heat exchanger.

Steady State Simulation: Simulation examples of Industrial Chemical Processes using Aspen Plus: Process flow sheet of Vinyl Chloride Monomer, Process flow sheet of Distillation Train, Process flow sheet of Cyclohexane production by hydrogenation of Aniline in a CSTR. Process Flow sheet of Ammonia process.

LEARNING RESOURCES

TEXT BOOKS:

1) Introduction to Chemical Engineering Computing by Bruce.A.Finlayson, Wiley-Interscience, 2006.

REFERENCE BOOKS:

1) Process Simulation and Control Using Aspen, Amiya. K. Jana, PHI, 2009.
2) Chemical Process Modeling and Computer Simulation, Amiya K. Jana, 2nd edition, PHI (2011).
3) Computational methods for process simulation by W. F. Ramirez,2nd edition, Butterworth's series in Chemical Engineering (1998).

CHEL11 COMPUTER AIDED DESIGN

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To introduce the students to the available computational tools for process flow design development and general design considerations.
ii. To understand the Development of system design skills for chemical processes.
iii. To experience solving a complex engineering design problem.
iv. 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

1) Prepare process flow sheets for design showing reactors, distillation columns and other process equipment.
2) Apply knowledge of mathematics, science and engineering in design.
3) Design a system, component, or process to meet desired needs.
4) Use the techniques, skills and modern engineering computer tools necessary for engineering practice.

UNIT - I **CO: 1**

Introduction: Tracing the Historical Development, Task of the process engineer, what is Mathematical modeling and simulation, Scope and structure.
Fugacity of gases and vapors – pure gases, gas mixtures, fugacity of liquids, Estimation of Enthalpy - gas and gas mixtures, pure liquids and liquid mixtures.

UNIT – II **CO: 2**

CAD of flow of fluids in pipes: Flow of Newtonian fluids in pipes: Sizing of pipes for Newtonian flow with algorithms and computer programming, Flow of non-Newtonian fluids in pipes: Sizing of pipes for Newtonian flow with algorithms and computer programming, Pipe network calculations.
CAD of heat transfer equipment: Introduction: design and rating calculations, Shell and Tube Exchangers without phase change – algorithm with programme.

UNIT – III **CO: 3**

Condensers: condenser calculations with algorithm and programme, Reboilers: boiling heat transfer coefficient, vertical thermo siphon reboiler, algorithm and programme for vertical reboiler calculations.
CAD of mass transfer equipment: Introduction, Distillation: algorithm and programme for McCabe Thiele method and Ponchon-Savarit method. Gas Absorption: absorption and stripping in plate columns, algorithm and programme for plate column absorption calculations, absorption in packed columns.

UNIT – IV **CO: 4**

Liquid extraction: stage wise calculations – cross current and counter current processes with algorithms and programmes, extraction in packed columns.

CAD of chemical reactors: Introduction, Extent of reaction, analysis of rate data, Temperature effects in homogeneous reactors.

LEARNING RESOURCES

TEXT BOOKS:

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).

CHEL12 COMPUTATIONAL FLUID DYNAMICS

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To understand the widely used techniques in developing governing equations for a given fluid flow system.
ii. To know how to apply finite difference methods to solve diffusion heat conduction problems.
iii. To understand the application finite difference methods to solve problems involving convective transfer.
iv. To understand how to write algorithms for the chemical engineering problems.

Course Outcomes

1) Understand the basic principles of formulation of governing equations.
2) Apply the finite difference techniques.
3) Apply the finite difference techniques to solve convective equations.
4) Write the algorithms for one, two and three dimensional equations.

UNIT - I **CO: 1**

Conservation Laws of Fluid Motion: Governing equations of fluid flow and heat transfer, Equation of state, Navier Stokes equations for a Newtonian fluid.
Governing equations of the flow of compressible Newtonian fluid – Differential and integral forms of the general transport equations.

UNIT – II **CO: 2**

Finite Volume Method for Diffusion Problems: Introduction, One-dimensional, two dimensional and three dimensional steady state diffusion problems.
The Finite Volume Method for Convective- diffusion problems: Steady one-dimensional convective and diffusion, the Central differencing scheme, properties of discretization schemes.

UNIT – III **CO: 3**

The Finite Volume Method for Convective- diffusion problems: Assessment of the central differencing scheme for convective diffusion problems, The upwind differencing scheme, The hybrid differencing scheme.
Higher order differencing schemes for convective diffusion – Discretization of transient convection-diffusion equation, the power-law scheme.

UNIT - IV **CO: 4**

Solution Algorithms For Pressure-Velocity Coupling In Steady Flows: Introduction – The staggered grid – The momentum equations – The SIMPLE algorithm.
The SIMPLER algorithm – The SIMPLEC algorithm – The PISO algorithm – Transient SIMPLE algorithm.

LEARNING RESOURCES

TEXT BOOKS:

1) Versteeg. H. K and Malalasekera. W. An introduction to computational fluid dynamics – The finite volume method, Longman Group Ltd 1995.

2) Ferziger. J.H, and Peric. M. Computational Methods for Fluid Dynamics, Springer, 2002.

CHEL13 ELECTROCHEMICAL ENGINEERING

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To apply Chemical Engineering principles to develop mathematical models for Electro Chemical Processes.
ii. To provide knowledge on Paired redox reactions; diffusion and migration processes to overall transport rates in electro chemical systems and Electrodes used in different electro chemical industries.
iii. To explain the principles and describe the design and operation of electrochemical reactors and processes, fuel cells and batteries; Concept of electrode potentials and their use in predicting spontaneous and non-spontaneous.
iv. To provide the knowledge on electrodes and corrosion.

Course Outcomes

1) 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.
2) Understand the reaction mechanisms and kinetics to obtain electrode over potentials and mass-transfer phenomena, including the estimation of limiting currents.
3) Explain the principles and working conditions of the different types of primary and secondary batteries.
4) Understand the uses of electrodes in various electro industries and acquire basic knowledge on corrosion.

UNIT - I **CO: 1**

Review of basics of Electro - Chemistry: Mechanism of Electrolysis, Degree of dissociation, Laws of Electrolysis, ionic mobility's, Transference Numbers, Nernst equation.
The electrical double layer: Its role in Electro-chemical process, Helmota layer, Gucy, Steven's layer, fields at the interface.

UNIT - II **CO: 2**

Mass transfer in Electro-Chemical systems: Polarization, Diffusion controlled Electro-chemical reaction, the importance of convection and the concept of limiting current, mass transfer over potential or concentration polarization.
Measurements and Systems Analysis: Conductivity measurements - Conduct metric analysis - Titrations, Measurements of pH, Potential - Potentiometric titrations.

UNIT - III **CO: 3**

Primary Batteries: Lechlanche dry cell, Alkaline manganese cell, mercury cell.
Secondary Batteries: The lead acid accumulator, The Redox-Fuel cell and Hydrogen /Oxygen Cells, Ni-Cd, Ni-Fe, sodium-sulphur, Li ion cell.

UNIT - IV **CO: 4**

Electrochemical Industries: Different electrodes used in electrochemical Industries, semi conducting type etc.

Applications: Types of metal finishing process – Electro Plating, Electro deposition, Electro refining, Electro forming, Electro polishing, Anodizing and Basics of Corrosion- Chemical Corrosion, Electro Chemical Corrosion.

LEARNING RESOURCES

TEXT BOOKS:

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 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).

CHEL14 INDUSTRIAL HAZARDS AND SAFETY ANALYSIS

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To understand the predominating hazards in the work environment and of appropriate control procedures and devices to be considered - to control the hazards and communicate the safety and hazard analysis reports.
ii. 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.
iii. To study the effect of toxic and flammable materials and conduct the management of a fire prevention and abatement program.
iv. To demonstrate knowledge of appropriate protective equipment, safety and health training procedures.

Course Outcomes

1) Attain the knowledge of human errors and human factors, principles and how they relate to Process Safety Management.
2) Improve human performance by reducing human error-likelihood by work situations through design, improved work instructions, training and the recognition of human factors hazards.
3) Practice performing human factors, procedures and analyses in realistic situations dealing with toxic and flammable materials.
4) Reduce the process hazards by using protective equipment.

UNIT - I **CO: 1**

Introduction: Definition of safety. The basis for safety. Chemical hazards and worker safety. Hazards of commercial chemical reactions and operations.

Risk Assessment- Fault Tree analysis, Event Tree Analysis, Hazard and operability (HAZOP) study: Introduction, basic concepts, conducting a HAZOP study.

UNIT - II **CO: 2**

Process design: Introduction, the technique of safe process design- reactor, separation, materials handling, and storage, safe control of process variables.

Instrumentation for safe operations- Self- acting temperature and pressure regulators, pneumatic controllers, Potentiometric controllers, float switches, alarms, annunciators, and interlocks. Safety education and training.

UNIT - III **CO: 3**

Risk: Effect of toxic agents on skin, eyes, respiratory and digestive system. Flammable materials-Fires and Explosions: Fire Triangle, Distinction between Fires and Explosions, Flammability Characteristics of Liquids and Vapors, Concepts to Prevent Fires and Explosions: Explosion-Proof Equipment and Instruments, Ventilation, Sprinkler Systems.

Work permit systems: Hazardous operation permits, hazardous work area permits, special hazard permit and equipment operating permits.

UNIT - IV **CO: 4**

Protection: Personnel protective equipment for head& ear protection, gloves, aprons and safety footwear.

Fire extinguishing agents and their applications – Classification of fires, extinguishing agents and methods of application, mechanism of extinguishment. Measuring safety effectiveness-criteria for effective measures.

LEARNING RESOURCES

TEXT BOOKS:

1) Safety and accident prevention in Chemical operations by Fawcett H.H. and W.S.Wood, 2nd editon John Wiley and Sons Inc. (1982).

REFERENCE BOOKS:

1) Industrial safety practices by Bob skeltor.(UNIT I 2nd part).

2) Chemical Process Safety by Daniel A..Crowl and Joseph F.Louvar 3 rd edition,Pearson (UNIT III 1st part).

CHEL15 FLUIDIZATION ENGINEERING

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

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

Course Outcomes

1) Explain the difference between fixed and fluidized beds.
2) Explain about various types of fluidized beds and their use in industries.
3) Derive minimum fluidization mass velocity and pressure drop equation for minimum fluidization.
4) Predict the Pressure drop in stick-slip flow, aerated flow, beds, cyclones and fluidized bed reactors.

UNIT - I **CO: 1**

Introduction: Phenomena of fluidization, liquid like behavior 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 **CO: 2**

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 **CO: 3**

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 **CO: 4**

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. Siltation 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.

LEARNING RESOURCES

TEXT BOOKS:

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

REFERENCE BOOKS:

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

CHEL16 BIO-CHEMICAL ENGINEERING

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To provide the fundamental background of the principles of biology and biochemistry to understand, design and operation of biochemical processes.
ii. To provide the knowledge of determination of rates of enzyme catalyzed reactions and the immobilization of enzymes.
iii. To provide knowledge of cell growth patterns and design of various bioreactors.
iv. To expose the students to the unit operations and unit processes involved in the downstream processing.

Course Outcomes

1) Understand and use the basic principles of biology and biochemistry to operate a biochemical process.
2) Derive the kinetic expression for the rates of enzyme catalyzed reactions.
3) Understand the factors effecting cell growth and the design various bioreactors.
4) Apply various unit operations and unit processes for downstream processing.

UNIT - I **CO: 1**

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 **CO: 2**

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 **CO: 3**

The kinetics of cell growth: Ideal reactors for kinetics measurements, Monod growth kinetics, and 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 **CO: 4**

Product recovery operations: Recovery of particulates - Filtration, centrifugation, sedimentation.

Production Isolation: Extraction, precipitation, Chromatographic techniques, membrane separations, drying and crystallization.

LEARNING RESOURCES

TEXT BOOKS:

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)

CHEL17 NANOTECHNOLOGY

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To provide the students strong knowledge of the molecular nanotechnology.
ii. To provide the strong knowledge about the concepts of nano powders, nano tubes and nonmaterial's.
iii. To provide the exposure to the students about the synthesis of rotaxanes , catenanes, molecular Computers, Proteins, lipids and DNA.
iv. To provide the strong knowledge of the nano biometrics.

Course Outcomes

1) Explain about molecular nanotechnology, nanolithography.
2) Explain the concept of preparation of nanomaterials, sol-gels.
3) Explain the applications of rotaxanes, catenanes Proteins, lipids and DNA.
4) Explain about drug delivery systems and impact on environment.

UNIT - I **CO: 1**

Introduction to nanotechnology and materials, Nano sizes, nano properties comparison with the bulk materials, different shapes, sizes and morphology, Nano tweezers, atom manipulation, nano dots, nano lithography.

Nanomaterial's characterization: Microscopies SEM, TEM, Atomic Forced Microscopy, Scanning and Tunneling Microscopy.

UNIT – II **CO: 2**

Nano powders and Nanomaterial's: Preparation, Plasma arcing, Chemical vapor deposition, Sol-gels, Electro deposition, Ball milling.

Carbon nanotubes: Structure, Types, formation, assemblies, purification, properties and uses.

UNIT – III **CO: 3**

Catenanes and rotaxanes, various molecular switches, synthesis of rotaxanes and catenanes, molecular computers, Properties of light in nanotechnology and interaction.

Nano biometrics: Self-assembled monolayer's, Proteins, Lipids, Liposomes, DNA, DNA structure, using DNA to build Nano-cubes, switches, hinges, smart glue, wire template.

UNIT – IV **CO: 4**

Nanobiology: Biological methods of synthesis. Applications in drug delivery, Nano containers and Responsive Release of active agents, Layer by Layer assembly for Nano spheres.

Safety and health Issues of Nanomaterial, Environmental Impacts, Case Study for Environmental and Societal Impacts.

LEARNING RESOURCES

TEXT BOOKS:

1) Nanotechnology (Basic Science and Emerging Technologies) by Mick Wilson, K.K.Geoff Smith, Michella Simmons and BurkhardRaguge, Overseas Press.

REFERENCE BOOKS:

1) Introduction to Nanotechnology by Charles P. Poole, Jrl and Frank J Owens, 1st edition, Wiley Inter-science.

CHEL18 POLYMER SCIENCE AND ENGINEERING

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To provide knowledge to understand polymerizations leading to polymer networks, including the types of monomers required and how their functionality affects gelatin
ii. To provide knowledge to compute molecular weight averages from the molecular weight distribution
iii. To provide knowledge to understand the major classes of step growth and chain growth polymerization
iv. To provide knowledge to understand the manufacture, properties and applications of addition and condensation polymers

Course Outcomes

1) Appraise the various monomers for manufacture of polymers
2) Estimate the optimum reaction conditions to control molecular weight and its distribution
3) Evaluate methods and equipment for polymer preparation
4) Compile the manufacturing processes and applications of addition and condensation polymers

UNIT - I **CO: 1**

Definitions: Monomer, polymer, functionality, homo and copolymers, hetero-chain and homo-chain polymers, polymer blends.
Classification of Polymers: Based on origin, applications, thermal behavior and polymerization.
Molecular Weights of polymers: Concept of average molecular weights; their measurement 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 **CO: 2**

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 **CO: 3**

Manufacture, properties and application of condensation polymers: a) phenolic resins, b) polyesters: unsaturated and saturated: PET & polycarbonate, d) Polyamides (nylon 6 & nylon 6,6)

e) polyurethanes - toluene diisocyanate , f) epoxy resins-epichlorohydrin with bisphenol A, g) silicone resins- Methyl silicone resin, h) cellulose and its derivatives-Diethylaminoethyl cellulose

CO: 4

UNIT – IV

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

LEARNING RESOURCES

TEXT BOOKS:

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)

CHEL19 ADVANCED SEPARATION PROCESSES

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To provide the principles of supercritical fluid extraction and short path distillation.
ii. To provide the fundamentals of the different membrane processes.
iii. To provide selection procedure for polymers to prepare membranes and characterization.
iv. To provide the suitable range of operating conditions for membrane processes and for a separation problem.

Course Outcomes

1) Design the super-critical fluid extractor.
2) Select suitable polymeric material & technique for the prepare the membrane modules.
3) Analyze the suitable membrane separation technique for particular separation.
4) Design the pervaporation and dialysis equipment.

UNIT - I **CO: 1**

Review of conventional processes, Supercritical fluid extraction: Supercritical fluids, phase equilibrium, industrial application, important supercritical processes- decaffeination of coffee, extraction of oil from seeds.

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 **CO: 2**

Synthetic membranes, characteristics of membrane materials, classification, methods of preparation, preparation technique for composite membranes

Membrane characterization, characterization of porous membranes, characterization of non-porous membranes, structural properties.

UNIT – III **CO: 3**

Pressure driven membrane processes: microfiltration: Introduction, membranes for microfiltration, industrial applications; Ultra filtration: membranes for ultra filtration, industrial applications, reverse osmosis and nanofiltration: membranes for reverse osmosis and nanofiltration, industrial applications.

Gas permeation, Dialysis, electro dialysis, Process parameters, membranes for electro dialysis, applications, Membrane electrolysis, Bipolar membranes, Fuel Cells. Liquid membranes, choice of the organic solvent and carrier, applications.

UNIT – IV **CO: 4**

Pervaporation, Transport in porous and non-porous membranes. Liquid membranes, choice of the organic solvent and carrier, applications.

Concentration polarization, Fouling, factors affecting fouling, methods to reduce fouling and flux enhancement, cleaning of membrane, membrane reactors, membrane distillation, membrane contactors.

LEARNING RESOURCES

TEXT BOOKS:

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

2) Principles of Mass Transfer and Separation Processes, Binay K. Dutta, PHI, New Delhi.

REFERENCE BOOKS:

1) Ultrafiltration and Microfiltration, MunirCheryan, 2nd Edition, Technomic Publishing Co (1998).

2) Separation process principles, J.D.Seader and Ernest J. Henley 2nd edition, Wiley-India.

3) Synthetic Polymeric membranes, R. E. Kesting, 2nd Edition, McGraw Hill (1985).

4) Membrane separation processes, KaushikNath, PHI, New Delhi (2008).

CHEL20 OPTIMIZATION OF CHEMICAL PROCESS

Lectures	*:*	*3 hrs*	*Sessional Marks*	*:*	*40*
Tutorial	*:*	*---hrs*	*Semester End Exam Marks*	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Course Objectives

i. To understand the maximizing and minimizing methods for single variable functions.
ii. To determine the maxima using linear programming and Simplex method for linear convex functions.
iii. To develop objective functions for optimizing design of flow and mass transfer equipment.
iv. To simplify and solves the optimization problems in chemical processes.

Course Outcomes

1) Fit data to linear and nonlinear functions.
2) Formulate chemical processes as optimization problems.
3) Solve linear convex objective functions.
4) Simplify and solve complex chemical engineering processes.

UNIT - I **CO: 1**

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 **CO: 2**

Optimization Techniques: Linear programming and applications, Simplex method and applications.

UNIT - III **CO: 3**

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 **CO: 4**

Chemical Engineering Examples: Optimal pipe diameter, optimal residence time for maximum yield in an ideal isothermal batch reactor, Chemo stat, optimization of a thermal cracker.

LEARNING RESOURCES

TEXT BOOKS:

1) Optimization of chemical process by T.F.Edgar, D.M.Himmelblau and L.S.Lasdon, 2nd edition, McGraw Hill (2001).

REFERENCE BOOKS:

1) Engineering Optimization: Theory and Practice by S.S.Rao, 3rd edition, New Age International (P) Ltd.(1996).

CHOL 01 ENERGY ENGINEERING

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To provide the knowledge about formation, classification, ranking, analysis, testing, carbonization, gasification and liquefaction of coal, manufacture of cock.
ii. To provide the knowledge about design, occurrence, composition, classification, exploration and production of petroleum, refining, testing and analysis of petroleum products.
iii. To provide knowledge about the non conventional energy courses and its storage.
iv. To provide knowledge about the energy related problems in the world and its solutions.

Course Outcomes

1) Understand the importance of environment and conservation of natural resources.
2) Succeed in the competitive exams of energy industry.
3) Utilize the non conventional energies in place of conventional energies and its manufacture.
4) Maintain the sustainability in the environment.

UNIT - I **CO: 1**

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 **CO: 2**

Petroleum: Origin, occurrence and reserves, composition, classification, characteristics, exploration and production.

UNIT - III **CO: 3**

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 **CO: 4**

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.

LEARNING RESOURCES

TEXT BOOKS:

1) Conventional Energy technology by S.B.Pandy, Tata McGraw Hill (1987) (Unit-1,2)
2) Non-Conventional Energy Sources, G. D. Rai, Khanna Publishers. (Unit-3,4
3) Principles of Energy conversion by Culp, Mc Graw Hill(1991) (Unit-3,4)

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).

CHOL 02 BIOFUELS

Lectures	*:*	*3 hrs*	*Sessional Marks*	*:*	*40*
Tutorial	*:*	*---hrs*	*Semester End Exam Marks*	*:*	*60*
Semester End Exam.	*:*	*3 hrs*	*Credits*	*:*	*3*

Course Objectives

i. To provide the knowledge about properties, composition, features of biofuels and uses of biomass and their environmental impacts.
ii. To provide the students a substantial knowledge of biofuel production technologies.
iii. To provide knowledge about the process of biogas production and methods of production of biodiesel and comparison of the standards to the conventional diesel.
iv. To provide knowledge about the production of lipids, bio hydrogen from different bacteria and algae.

Course Outcomes

1) Describe the functional principle of biofuel technologies in small and large scale.
2) Describe the main steps and components in bioethanol, biodiesel and biogas production.
3) Participate actively in teamwork and work with case related problem solving.
4) Work with professional problem solving in an industrial environment.

UNIT - I **CO: 1**

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 **CO: 2**

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. Biobutanol.

UNIT – III **CO: 3**

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 **CO: 4**

Bio hydrogen: Production of bio hydrogen from anaerobic bacteria, photosynthetic algae, photosynthetic–hydrogenase system.

Fuel cells: Enzymatic fuel cells, microbial fuel cells.

LEARNING RESOURCES

TEXT BOOKS:

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.

CHOL 03 ENVIRONMENTAL ENGINEERING

Lectures	:	*3 hrs*	*Sessional Marks*	:	*40*
Tutorial	:	*---hrs*	*Semester End Exam Marks*	:	*60*
Semester End Exam.	:	*3 hrs*	*Credits*	:	*3*

Course Objectives

i. To gain understanding of the basic concepts of air pollution and its effects on human and ecosystem health.
ii. To learn the concepts and strategies of control of gaseous pollutants, including adsorption, adsorption, condensation, and oxidation-reduction.
iii. To provide knowledge of the unit operations and unit processes which can be used for water pollution abatement.
iv. To provide knowledge on the sources, affects and control measures of solid waste.

Course Outcomes

1) Describe the sources, effects and analysis of Air pollutants
2) Select methods for control, and prevention of air pollution
3) Analyze the sources, effects and abatement of Water pollution
4) Analyze the sources of solid waste and their control measures

UNIT - I **CO: 1**

Air Pollution: Definition and scale of concentration, Classification and Properties of Air pollutants, Emission sources, Behaviour and fate of Air pollutants, effects of air pollution, Air pollution laws & standards, Temperature lapse rates and Stability, wind velocity and Turbulence and Plume behavior.

Air pollution Sampling and Measurement: Ambient air sampling, Stack sampling and Analysis of Sulphur Dioxide, Nitrogen Oxides and Particulate matter.

UNIT – II **CO: 2**

Air Pollution Control Methods and Equipment: Control methods, Source correction methods, Cleaning of gaseous effluents, Particulate emission control, Selection of a particulate collector and Control of Gaseous emissions.

Control of Specific Gaseous Pollutants: Control of Sulphur dioxide emission, Control of Nitrogen Oxides, Control of Carbon Monoxide and Hydrocarbons.

UNIT – III **CO: 3**

Water Pollution: Water resources, Origin of waste water, Types of Water Pollutants and their effects, Water Pollution Laws and Standards. Waste Water Sampling,

Analysis and Treatment: Sampling, Methods of Analysis, Determination of Organic Matter, Inorganic Matter and Physical Characteristics, Primary, Secondary, Advanced Waste Water Treatment and Recovery of Materials from Process Effluents.

UNIT – IV **CO: 4**

Solid waste Management: Sources and Classification, Public health aspects, Disposal methods and Potential methods of disposal.

Hazardous Waste Management: Definition, Sources, Classification, Hazardous Waste Management Strategy, treatment methods and Disposal methods.

LEARNING RESOURCES

TEXT BOOKS:

1) Environmental Pollution Control Engineering by C.S.Rao, 2nd edition, New Age International Ltd (2006)

REFERENCE BOOKS:

1) Air pollution by M.N.Rao, H.V.N. Rao, Tata McGraw Hill (2007)

CHOL04 NANOSCIENCE AND NANOTECHNOLOGY L T P C Int Ext

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 , catenanes, molecular Computers, Proteins, lipids and DNA
4. To provide the strong knowledge of the nano biometrics

COURSE OUTCOMES:

After successful completion of the course, the students are able to

1. Explain about molecular nanotechnology, nanolithography
2. Explain the concept of preparation of nanomaterials, sol-gels
3. Explain the applications of rotaxanes, catenanes Proteins, lipids and DNA
4. Explain about drug delivery systems and impact on environment

UNIT I [CO:1]

Introduction to nanotechnology and materials, Nano sizes, nano properties comparison with the bulk materials, different shapes, sizes and morphology, Nano tweezers, atom manipulation, nano dots, nano lithography

Nanomaterial's characterization: Microscopies SEM, TEM, Atomic Forced Microscopy, Scanning and Tunneling Microscopy

UNIT II [CO:2]

Nano powders and Nanomaterial's: Preparation, Plasma arcing, Chemical vapor deposition, Sol-gels, Electro deposition, Ball milling

Carbon nanotubes: Structure, Types, formation, assemblies, purification, properties and uses

UNIT III [CO:3]

Catenanes and rotaxanes, various molecular switches, synthesis of rotaxanes and catenanes, molecular computers, Properties of light in nanotechnology and interaction

Nano biometrics: Self-assembled monolayer's, Proteins, Lipids, Liposomes, DNA, DNA structure, using DNA to build Nano-cubes, switches, hinges, smart glue, wire template

UNIT IV [CO:4]

Nanobiology: Biological methods of synthesis. Applications in drug delivery, Nano containers and Responsive Release of active agents, Layer by Layer assembly for Nano spheres

Safety and health Issues of Nanomaterial, Environmental Impacts, Case Study for

Environmental and Societal Impacts

LEARNING RESOURCES:

TEXT BOOK:

Nanotechnology (Basic Science and Emerging Technologies) by Mick Wilson, K.K.Geoff Smith, Michella Simmons and BurkhardRaguge, Overseas Press