ACHARYA NAGARJUNA UNIVERSITY
Nagarjuna Nagar, Guntur – 522 510
Andhra Pradesh, India.

REVISED REGULATIONS, SCHEME OF INSTRUCTION, EXAMINATION AND SYLLABII

FOR

CHEMICAL ENGINEERING

4-YEAR B.TECH., DEGREE COURSE
(Semester System)
w.e.f. 2011-2012.

ACHARYA NAGARJUNA UNIVERSITY: NAGARJUNA NAGAR

REVISED REGULATIONS FOR

FOUR - YEAR B.TECH. DEGREE COURSE
(CREDIT BASED SYSTEM)

(Effective from the batch of students admitted during the academic year 2011-2012).

1.0. MINIMUM QUALIFICATIONS FOR ADMISSION:

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

The selection is based on the rank secured by the candidate at the EAMCET / ECET (FDH) examination conducted by A.P. State Council of Higher Education.

The candidate shall also satisfy any other eligibility requirements stipulated by the University and / or the Government of Andhra Pradesh from time to time.

2.0. BRANCHES OF STUDY:

2.1. The B.Tech. Course is offered in the following branches of study at one or more of the affiliated colleges:

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

2.2 The first year of study is common to all branches of Engineering except for Chemical Engineering and Biotechnology.

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

3.0. DURATION OF THE COURSE AND MEDIUM OF INSTRUCTION:

3.1 The duration of the course is four academic years consisting of two semesters in each academic year where as annual pattern is followed for first year. The medium of instruction and examination is English.

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

4.0. MINIMUM INSTRUCTION DAYS:

The first year shall consist of a minimum number of 180 instruction days and each semester of 2nd, 3rd and 4th years shall consist of 90 days of instruction excluding the days allotted for tests, examinations and preparation holidays.

5.0 EVALUATION:

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

5.1. The distribution of marks between sessional work (based on internal assessment) and University Examination will be as follows:

Nature of the subject	Sessional Marks	University Exam. Marks
Theory subjects	30	70
Design and / or Drawing	30	70
Practicals	30	70
Mini Project / Seminar	100	---
Project work	50	150 (Viva voce)

5.2. In the First Year, there shall be three Mid Term Examinations and three Assignment Tests in theory subjects, conducted at approximate equal intervals in the academic year. Assignment questions shall be given at least one week in advance and the students shall answer the question(s) specified by the concerned teacher just before the commencement of the Assignment Test. A maximum of 18 Sessional marks (75 % approx) shall be awarded based on the best two performances out of the three Mid Term Exams and a maximum of 7 (25 % approx) marks for the best two Assignment Tests out of the three Assignment Tests conducted.

For Drawing subject (Engineering Graphics), 7 marks shall be awarded based on day-to-day class work and the remaining 18 marks based on the best two performances in the three Mid Term Exams. No separate Assignment Tests will be held for this subject.

The remaining 5 marks out of the 30 marks earmarked for the internal sessional marks are allotted for attendance in the respective theory and drawing subjects in a graded manner as indicated in *clause* 7.2 from I year to IV year.

Ineach of the Semesters of 2^{nd}, 3^{rd} and 4^{th} years, there shall be two Mid Term examinations and two Assignment Tests in every theory subject. The Sessional marks for the midterm examinations shall be awarded giving a weightage of 14 marks out of 18 marks (75% approx) to that midterm examination in which the student scores more marks and the remaining 4 marks (25% approx.) for other midterm examination in which the student scores less marks. Similarly a weightage of 5 marks (75% approx) out of 7 marks earmarked for assignment tests shall be given for the assignment in which the student scores more marks and remaining 2 marks (25% approx) shall be given for the assignment test in which the student scores less marks.

For Drawing subjects, there shall be only two Mid Term examinations in each semester with no Assignment Tests. In case of such subjects a maximum of seven marks shall be given for day-to-day class work and the remaining maximum 18 marks shall be awarded to the Mid Term examinations taking into account the performance of both the Mid Term examinations giving weightage of 14 marks for the Mid Term Examination in which the student scores more marks and the remaining 4 marks for the other midterm examination. A weightage of 5 marks will be given in the total sessional marks of 30 for attendance in all theory and drawing subjects as indicated in *clause* 7.2.

5.3. The evaluation for Laboratory class work consists of weightage of 20marks for day to day laboratory work including record work and 10 marks for internal laboratory examination including Viva-voce examination.

In the case of Project work, the sessional marks shall be awarded based on the weekly progress and based on the performance in a minimum of two Seminars and the Project Report submitted at the end of the semester. The allotment of sessional marks for Seminars and for day-to-day class work shall be20 and 30.

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

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

6.0. LABORATORY / PRACTICAL CLASSES:

In any year/semester, a minimum of 90 percent experiments / exercises specified in the syllabi for laboratory course shall be conducted by the students, who shall complete these in all respects and get the Record certified by the concerned Head of the Department for the student to be eligible to face the University Examination in that Practical subject.

7.0. ATTENDANCE REGULATIONS:

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

7.2 A Weightage in sessional marks upto a maximum of 5 marks out of 30 marks in each theory subject shall be given for those students who put in a minimum of 75% attendance in the respective theory in a graded manner as indicated below:

Attendance of 75% and above but less than 80%	- 1 mark
Attendance of 80% and above but less than 85%	- 2 marks
Attendance of 85% and above but less than 90%	- 3 marks
Attendance of 90% and above	- 5 marks

7.3 Condonation of shortage in attendance may be recommended on genuine medical grounds, up to a maximum of 10% provided the student puts in at least 65% attendance

as calculated in *clause* 7.1 above and provided the principal is satisfied with the genuineness of the reasons and the conduct of the student.

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

8.0 DETENTION:

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

9.0. UNIVERSITY EXAMINATION:

9.1. For each theory, design and/or drawing subject, there shall be a comprehensive University Examination of three hours duration at the end of First year / each Semester of 2^{nd}, 3^{rd} and 4^{th} years, except where stated otherwise in the detailed Scheme of Instruction.

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

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

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

10.0 AWARD OF CREDITS

Credits are awarded for each Theory/Practical Subjects. Each theory subject is awarded 4 credits and each practical subject is awarded 2 credits. Project work is awarded 10 credits. However for some important theory subjects more than 4 credits may be awarded by individual boards. The total number of credits for all the four years put together should be in the range of 218-224 for any branch.

10.1 AWARD OF GRADES

S.No.	Range of Marks	Grade	Grade Points
1	≥85%	S	10.0
2	75%-84%	A	9.0
3	65%-74%	B	8.0
4	55%-64%	C	7.0
5	45%-54%	D	6.0
6	40%-44%	E	5.0
7	≤39%	F(Fail)	0.0
8	The grade 'W' represents	W	0.0

	withdrawal/absent (subsequently changed into pass or E toS or F grade in the same semester)		

10.2 A Student securing 'F' grade in any subject there by securing 0 grade points has to reappear and secure at least 'E' grade at the subsequent examinations in that subject.

10.3 After Ist year/each semester, Grade sheet will be issued which will contain the following details:

- The list of subjects for the 1st year/each semester and corresponding credits and Grades obtained
- The Grade Point Average(GPA) for the 1st year/ each semester and
- The Cumulative Grade Point Average(CGPA) of all subjects put together up to that semester from first year onwards

GPA is calculated based on the following formula:

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

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

11.0 CONDITIONS FOR PROMOTION

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

11.2. A student shall be eligible for promotion to III B.Tech. Course if he / she secures a minimum of 70% of the total number of credits from one regular and one supplementary examinations of I B.Tech., (including practical subject) in addition to satisfying the minimum requirements of attendance and sessional marks stipulated in *Clauses 5 and 7* in II/IV B.Tech.

11.3. A student shall be eligible for promotion to IV B.Tech. course if he/she secures a minimum of 70% of the total number of credits from two regular & two supplementary examinations of I B.Tech. and two regular & one supplementary examinations of II B.Tech. 1st semester and one regular & one supplementary examinations of II B.Tech. 2nd semester (including practical subjects) in addition to satisfying the minimum requirements of attendance and sessional marks stipulated in *Clauses 5 and 7* in III B.Tech.

11.4. A student (Diploma Holder) admitted under lateral entry into II B.Tech. shall be eligible for promotion to IV B.Tech. course if he/she secures a minimum of 70% of the total number of credits from two regular & one supplementary examinations of II B.Tech. 1st semester and one regular & one supplementary examinations of II B.Tech. 2nd semester

(including practical subjects) in addition to satisfying the minimum requirements of attendance and sessional marks stipulated in *Clauses 5 and 7* in III B.Tech.

12.0 ELIGIBILITY FOR AWARD OF B.TECH. DEGREE

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

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

12.2. Maximum Time Limit for completion of B.Tech Degree

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

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

13.0 AWARD OF CLASS

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

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

14.0. IMPROVEMENT OF CLASS

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

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

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

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

15.0. AWARD OF RANK

The rank shall be awarded based on the following:

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

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

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

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

16.0 SUPPLEMENTARY EXAMINATIONS

In addition to the Regular University Examinations held at the end of 1st year / each semester, Supplementary University Examinations will be conducted during the academic year. Such of the candidates taking the Regular / Supplementary University examinations as Supplementary candidates may have to take more than one University Examination per day.

17.0 TRANSITORY REGULATIONS

17.1. Candidates who studied the four-year B.Tech. Degree Course under Revised Regulations (RR)/ Credit based Regulations(CR) but who got detained in any year for want of attendance / minimum aggregate sessional marks may join the appropriate year / semester in the Semester system applicable for the batch and be governed by the Regulations of that batch from then on.

17.2. University Examinations according to RR / CRshall be conducted in subjects of each year five times after the conduct of the last set of regular examinations under those Regulations.

17.3. Candidates who have gone through the entire course of four academic years and have satisfied the attendance and minimum aggregate sessional marks in 1st year/each semester under RR/CR, but who are yet to pass some subjects even after the five chances stated in *Clause 17.2*, shall appear for the equivalent subjects in the Semester system, specified by the University / Board of Studies concerned.

18. 0 AMENDMENTS TO REGULATIONS

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

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ACHARYA NAGARJUNA UNIVERSITY: NAGARJUNA NAGAR

SCHEME OF INSTRUCTION AND EXAMINATIONS
FOR
I/IV B.TECH. CHEMICAL ENGINEERING- ANNUAL PATTERN (For I/IV B.Tech. only)

(w.e.f. the batch of students admitted during the academic year 2011-2012)

S. No.	Code No. & Subject	Scheme of Instruction periods per week		Scheme of Examination			
		Theory + Tutorial	Practicals	Duration of University Exam. (hrs)	Sessional Marks	University Marks	Credits
1	ChE 101 Mathematics – I	3	-	3	30	70	4
2	ChE 102 Mathematics – II	3	-	3	30	70	4
3	ChE 103 Physics	3	-	3	30	70	4
4	ChE 104 Inorganic & Physical Chemistry	4	-	3	30	70	4
5	ChE 105 Professional Communication Skills	3	-	3	30	70	4
6	ChE 106 C Programming and Numerical Methods	3	-	3	30	70	4
7	ChE 107 Introduction to Chemical Engineering	3	-	3	30	70	4
8	ChE 108 Engineering Graphics	3+3	-	3	30	70	4
9	ChE 151 Physics Laboratory	-	3	3	30	70	2
10	ChE 152 Chemistry Laboratory	-	3	3	30	70	2
11	ChE 153 Workshop Practice	-	3	3	30	70	2
12	ChE 154 C-Programming Laboratory	-	3	3	30	70	2
Total		25+3	12	-	360	840	40

II / IV B.TECH. CHEMICAL ENGINEERING
SCHEME OF INSTRUCTION & EXAMINATIONS

THIRD SEMESTER

S. No	Code No. & Subject	Scheme of Instruction periods per week		Scheme of Examination			
		Theory + Tutorial	Practicals	Duration of University Examination (hrs)	Sessional Marks	University Marks	credits
01	ChE 211 Computational Techniques	4	-	3	30	70	4
02	ChE 212 Environmental Studies	4	-	3	30	70	4
03	ChE 213 Electrical & Electronics Engineering	4	-	3	30	70	4
04	ChE 214 Organic Chemistry	4	-	3	30	70	4
05	ChE 215 Chemical Process Calculations	4	-	3	30	70	4
06	ChE 216 Momentum Transfer	4+1	-	3	30	70	5
07	ChE 251 Electrical & Electronics Engineering Laboratory	-	3	3	30	70	2
08	ChE 252 Organic Chemistry Laboratory	-	3	3	30	70	2
09	ChE 253 Momentum Transfer Laboratory	-	3	3	30	70	2
	Total	24+1	9	-	270	630	31

II / IV B.TECH. CHEMICAL ENGINEERING
SCHEME OF INSTRUCTION & EXAMINATIONS

FOURTH SEMESTER

S. No.	Code No. & Subject	Scheme of Instruction periods per week		Scheme of Examination			
		Theory + Tutorial	Practicals	Duration of University Exam. (hrs)	Sessional Marks	University Marks	Credits
01	ChE 221 Probability & Complex Analysis	4	-	3	30	70	4
02	ChE 222 Applied Mechanics & Mechanical Engineering	4	-	3	30	70	4
03	ChE 223 Professional Ethics & Human Values	4	-	3	30	70	4
04	ChE 224 Process Heat Transfer	4+1	-	3	30	70	5
05	ChE 225 Mechanical Operations	4	-	3	30	70	4
06	ChE 226 Chemical Engineering Thermodynamics-I	4	-	3	30	70	4
07	ChE 261 Mechanical Operations Laboratory	-	3	3	30	70	2
08	ChE 262 Computational Programming Laboratory	-	3	3	30	70	2
09	ChE 263 Communication & Soft Skills Laboratory	-	3	3	30	70	2
	Total	24+1	9	-	270	630	31

III/IV B.TECH. CHEMICAL ENGINEERING
SCHEME OF INSTRUCTION & EXAMINATIONS

FIFTH SEMESTER

S. No	Code No. & Subject	Scheme of Instruction periods per week		Scheme of Examination			
		Theory + Tutorial	Practicals	Duration of University Exam. (hrs)	Sessional Marks	University Marks	Credits
01	ChE 311 Material Technology	4	-	3	30	70	4
02	ChE 312 Mass Transfer operations-I	4	-	3	30	70	4
03	ChE 313 Inorganic Chemical Technology	4	-	3	30	70	4
04	ChE 314 Chemical Reaction Engineering-I	4	-	3	30	70	4
05	ChE315 Chemical Engineering Thermodynamics – II	4	-	3	30	70	4
06	ChE 316 Process Instrumentation	4	-	3	30	70	4
07	ChE 351 Process Heat Transfer Laboratory	-	3	3	30	70	2
08	ChE 352 Mass Transfer Operations Laboratory-I	-	3	3	30	70	2
09	ChE 353 Inorganic Chemical Technology Laboratory.	-	3	3	30	70	2
	Total	24	9	-	270	630	30

III / IV B.TECH. CHEMICAL ENGINEERING
SCHEME OF INSTRUCTION & EXAMINATIONS

SIXTH SEMESTER

S. No	Code No. & Subject	Scheme of Instruction periods per week		Scheme of Examination			
		Theory + Tutorial	Practicals	Duration of University Exam. (hrs)	Sessional Marks	University Marks	Credits
04	ChE 321 Industrial Pollution & Control	4	-	3	30	70	4
02	ChE 322 Mass Transfer Operations-II	4	-	3	30	70	4
03	ChE 323 Organic Chemical Technology	4	-	3	30	70	4
04	ChE 324 Chemical Reaction Engineering-II	4	-	3	30	70	4
05	ChE 325 Process Dynamics & Control	4	-	3	30	70	4
06	ChE 326 Elective-I	4	-	3	30	70	4
07	ChE 361 Instrumentation & Process control Laboratory	-	3	3	30	70	2
08	ChE 362 Mass Transfer Operations Laboratory-II	-	3	3	30	70	2
09	ChE 363 Organic Chemical Technology Laboratory	-	3	3	30	70	2
	Total	24	9	-	270	630	30

IV / IV B.TECH. CHEMICAL ENGINEERING
SCHEME OF INSTRUCTION & EXAMINATIONS

SEVENTH SEMESTER

S. No	Code No. & Subject	Scheme of Instruction periods per week		Scheme of Examination			
		Theory + Tutorial	Practicals	Duration of University Exam.(hrs)	Sessional Marks	University Marks	Total Marks
01	ChE 411 Computer Applications in Chemical Engineering	4	-	3	30	70	4
02	ChE 412 Chemical Process Equipment Design	4+1	-	3	30	70	5
03	ChE 413 Transport Phenomenon	4+1	-	3	30	70	5
02	ChE 414 Bio-Chemical Engineering	4	-	3	30	70	4
05	ChE 415 Elective-II (Open to other branches)	4	-	3	30	70	4
06	ChE 451 Mini Project	-	3	-	100	-	2
07	ChE 452 Chemical Reaction Engineering Laboratory	-	3	3	30	70	2
08	ChE 453 Computer Applications in Chemical Engineering Laboratory	-	3	3	30	70	2
09	ChE 454 Environmental Engineering Laboratory	-	3	3	30	70	2
	Total	20+2	12	-	340	560	30

IV/ IV B.TECH. CHEMICAL ENGINEERING
SCHEME OF INSTRUCTION & EXAMINATIONS

EIGHTH SEMESTER

S. No	Code No. & Subject	Scheme of Instruction periods per week		Scheme of Examination			
		Theory + Tutorial	Practicals	Duration of University Exam. (hrs)	Sessional Marks	University Marks	Total Marks
01	ChE 421 Process Economics & Industrial Management	4	-	3	30	70	4
03	ChE 422 Process Modeling and Simulation	4	-	3	30	70	4
04	ChE 423 Elective – III	4	-	3	30	70	4
04	ChE 424 Elective – IV	4	-	3	30	70	4
05	ChE 461 Computer Aided Process Equipment Design Laboratory	-	3	3	30	70	2
06	ChE 462 Project Work	-	9	3	50	150	10
	Total	16	12	-	200	500	28

ELECTIVE SUBJECTS:

Elective – I

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

Elective-II (open to other branches)

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

Elective – III

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

Elective – IV

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

ChE101 MATHEMATICS-I

(Common for all branches)

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

Unit-I

Differential Calculus:

Rolle's Theorem(without proof), Lagrange's Mean value theorem (without proof), Taylor's theorem (without proof), Maclaurin's series, Maxima and Minima of functions of two variables, Lagrange's method of undetermined multipliers.

Unit-II

Multiple Integrals :

Double integrals, Change of order of integration, Double integrals in polar coordinates, Area enclosed by plane curves, Triple integrals, Volume of solids, Change of variables.

Ordinary differential equations (first order):

Introduction, Linear and Bernoulli's equations, Exact equations, equations reducible to exact equations, Orthogonal trajectories, Newton's law of cooling, Heat flow, Rate of Decay of Radio-Active Materials

Unit-III

Ordinary differential equations (higher order):

Linear Differential equations: Definition, Theorem, Operator D, Rules for finding the complementary function, Inverse operator, Rules for finding the particular integral, Working procedure to solve the equation, Linear dependence of solutions, Method of variation of parameters, Equations reducible to linear equations, Cauchy's homogeneous linear equation, Legendre's linear equation, Simultaneous linear equations with constant coefficients.

Unit-IV

Fourier Series:

Introduction and Euler's formulae, Conditions for a Fourier expansion, Functions having points of discontinuity, Change of interval, Even and Odd functions, Half range series Typical wave forms and Parseval's formulae, Complex form of the Fourier series Practical harmonic analysis.

Text Book:

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

Reference Books:

1. Advanced Engineering Mathematics, ErwinKreyszig, 8th edition, Wiley India Pvt. Ltd.

2. Engineering Mathematics,Babu Ram, Pearson, New Delhi.

ChE102 MATHEMATICS-II

(Common for all branches)

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

Unit-I

Matrices:

Rank of a matrix, vectors, Consistency of linear system of equations, Linear transformations, Characteristic equations, Properties of eigen values, Cayley- Hamilton theorem (without proof), Reduction to diagonal form reduction of Quadratic forms to canonical form, Nature of a quadratic form, Complex matrices.

Unit-II

Beta Gamma functions, error function.

Statistics:

Method of least squares, Correlation, co-efficient of correlation (direct method only), lines of regression.

Vector Calculus:

Scalar and vector point functions, Del applied to scalar point functions. Gradient

Unit-III

Vector Calculus:

Del applied to vector point functions, Physical interpretation of divergence, Del applied twice to point functions, Del applied to products of point functions, Integration of vectors, Line integral, Surfaces, Green's theorem in the plane (without proof), Stoke' s theorem (without proof), Volume integral, Gauss divergence Theorem (without proof), Cylindrical Coordinates, Spherical polar coordinates.

Unit-IV

Laplace Transforms:

Introduction, Transforms of elementary functions, Properties of Laplace Transforms, existence conditions, Transforms of derivatives, Integrals, multiplication by t^n, division by t, Evaluation of integrals by Laplace Transforms, Inverse transforms, convolution theorem, Application to Differential equations with constant coefficients, transforms of unit step function, unit impulse function, periodic function.

Text Book:

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

Reference Books:

1. Advanced Engineering Mathematics, ErwinKreyszig, 8th edition, Wiley India Pvt. Ltd.
2. Engineering Mathematics,Babu Ram, Pearson, New Delhi.

ChE103 PHYSICS

(Common for all branches)

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT-I

Ultrasonics:

Production of Ultrasonics by Piezo electric oscillator method, Detection by Acoustic grating method, Applications - Pulse echo technique, ultrasonic imaging and some general applications.

Applied Optics:

Interference:

Stokes principle (Phase change on reflection), Interference in thin films due to reflected light (Cosine law), (uses of air films in wedge method and Newton's rings experiments - qualitative treatments only) Michelson's interferometer: Principle, construction working and applications (Determination of wavelength of monochromatic source & for resolution of two closely lying wavelengths).

Lasers:

Laser characteristics, Spontaneous and Stimulated emissions, Basic requirements of a laser, Population inversion – Solid state laser (Ruby laser), Gas (He-Ne) laser, Semiconductor (GaAs) laser, Applications of lasers.

Holography:

Principle, recording, reproduction and applications.

Fiber optics:

Structure of optical fiber, Types of optical fibers, Numerical aperture, Fiber optics in communications and advantages.

UNIT –II

Electromagnetism:

Gauss's law in electricity (statement & proof), Coulomb's law from Gauss law, Circulating charges and Cyclotron principle & working, Hall effect and its uses, Gauss law for magnetism, Faraday's law of electromagnetic induction, Lenz's law, induced electric fields, Inductance, energy stored in a magnetic field, Displacement current, Maxwell's equations (qualitative treatment), electromagnetic wave equation and Velocity, Electromagnetic oscillations(qualitative treatment)

Electron Theory of Solids:

Failure of classical free electron theory, quantum free electron theory, Fermi- dirac (analytical) distribution function and its temperature dependence, Fermi energy.

UNIT-III

Principles of Quantum Mechanics:

Dual nature of light, Matter waves & properties, de Broglie's concept of matter waves, Davisson and Germer experiment, Heisenberg's uncertainty principle and applications (non-existence of electron in nucleus, finite width of spectral lines). One dimensional time independent Schrodinger's wave equation, Physical significance of the wave function, Particle in a box (one dimensional).

Band theory of Solids:

Bloch theorem, Kronig-Penny model (Qualitative treatment), Origin of energy band formation in solids, effective mass of electron, concept of hole.

Dielectric and Magnetic Materials:
Electric dipole moment, polarization, dielectric constant, polarizability, types of polarizations, internal fields (qualitative), Clausius-Mossotti equation, Frequency dependence of polarization, Ferroelectrics and their applications.
Origin of magnetic moment of an atom, Bohr magneton, classification of dia, para and ferro magnetic materials on the basis of magnetic moment, Hysteresis curve, soft and hard magnetic materials, Ferrites and their applications.

UNIT –IV
Advanced Materials of Physics:
Optoelectronic devices:
Qualitative treatments of Photo diode, LED and LCD; Solar cell and its characteristics.Electro-optic and Magneto-optic effects (Kerr and Faraday effects).
Superconductivity:
First experiment, critical parameters (T_c, H_c, I_c), Meissner effect, types of superconductors, BCS Theory (in brief) and Applications of superconductors.
Nanotechnology:
Introduction to nano materials, nano scale, surface to volume ratio, fabrication of nanomaterials, sol-gel and chemical vapour deposition methods, Carbon nano tubes-preparation and properties (thermal, electrical and mechanical - in brief), some applications of nanomaterials.

Text Books:
1. Engineering Physics,M.R.Srinivasan, New Age International.
2. Physics Part I and II,Halliday and Resinck, John Wiley & sons (Asia).

Reference Books:

1. Concepts of Modern Physics,AurtherBeiser, TMG, New Delhi
2. Engineering Physics, Gaur & Gupta, DhanpatiRai Publications, New Delhi
3. Modern Engineering Physics,A.S.Vasudeva, S.Chand& Co., New Delhi
4. Materials science,M.Vijaya and G.Rangarajan, TMH, New Delhi

ChE 104 INORGANIC AND PHYSICAL CHEMISTRY

(Common for Chemical Engineering & Biotechnology Branches)

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT-I

Mole Concept:

Stoichiometry (Mass-Mass, Mass-Volume, Volume-Volume)

Chemical Bonding:

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

d-block elements:

Electronicconfiguration, General Characteristics, Oxidation states.

f-block elements:

General Properties, Atomic Size, Oxidation states.

UNIT-II

Transition metal Chemistry:

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

Titrimetric Analysis:

Introduction, Classification of reactions in Titrimetric Analysis, standard solutions, Normality, Calculation of Equivalent weight, Preparation of Standard solutions-Requirements of primary and secondary standards.Accuracy and precision with example, Classification of errors, Minimization of errors with examples.

UNIT-III

Thermodynamics:

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

Phase Rule:

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

Chemical Equilibria:

Reversible reactions, Law of mass action, Equilibrium constants-K_p, K_c, K_x for homogenous reactions. Effect of temperature on Equlibria-VantHoff equation, LeChateliar principle and applications.

UNIT-IV

Electrochemistry:

Electrical conductance, Specific conductance, Equivalentconductance, variation with dilution, kohlrausch's law, Half cell potentials, electrochemical series and its significance, Nernst equation, emf of cells, thermodynamics of cells, Electrochemistry of primary batteries(Lechlanche/dry cell), Secondary cells(Lead-acid cell, Ni-Cd cell), Lithium batteries and their advantages.

Chemical Kinetics:
Order, Molecularity, activation energy, Specific reaction rate, first order and second order reactions. Half life period, Effect of temperature on reaction rate, Kinetics of enzyme catalyzed reactions (Michaelis and Menten kinetics).

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

Text Books:
1. Principles of Inorganic Chemistry, Puri, Sarma and Kalia,Milestone (2008), (Unit I & II)
2. Essentials of Physical Chemistry, Bahl.B.S and Tuli, S.Chand& Co., Delhi, (Unit III & IV)

Reference Books:
1. A new concise Inorganic chemistry, J.D.Lee, ELBS and Van, 3rd edition, Nostrand Reinhold Co. Ltd., London.
2. Elements of Physical Chemistry, Samuel Glasstone and David Lewis, 2nd edition MacMillan & Co., London.
3. Physical Chemistry, P.W.Atkins, 3rdEdition, Oxford University Press.

ChE105 PROFESSIONAL COMMUNICATION SKILLS

(Common for all branches)

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT-I

Speech Building:

This arena refreshes the students in the usage of grammar and basics of communication in English. It also helps them start building up their vocabulary.

1. Speaking about oneself.
2. Sentence and its types
3. Positive, Negative and Interrogative Sentences, Speaking in formal and informal contexts, Asking for opinion, Asking for information, Requesting and Seeking permission; Emphasising a point
4. A list of 100 Basic Words
5. One word substitutes

UNIT- II

Basic Language Skills:

The emphasis is on Grammar and development of written and oral communication skills among students and equip them with the skills to overcome the cut throat competition in formal and informal situations in the present world.

1. Parts of speech
2. Tenses
3. Letter writing (Personal and Business)
4. Situational Dialogues
5. A list of 100 Basic Words

UNIT- III

Advanced Language Skills:

To develop two specific skills i.e. speaking and writing, using correct and good vocabulary to improve the communicative competence of learners in their discipline with glamour.

1. Antonyms
2. Paragraph Writing
3. Technical terms
4. Reading Comprehension
5. Correction of Sentences

UNIT - IV

Professional Communication Skills:

Professional communication skills aim at making students familiar with various aspects of corporate world and the importance of verbal communication. It also provides intensive instruction in the practice of professional writing.

1. Essay writing
2. Corporate Information
3. Idioms
4. E-mail etiquette

Text Books:

1. Communication Skills for Engineers, K. R. Lakminarayana and T. Murugavel, Scitech Publications.

Reference Books:

1. Communication Skills for Professionals, NiraKonar,PHI Publication.
2. Competitive English for Professional Courses, J.K.Gangal, S.Chand Publication.
3. English for Technical Communication: Volume 1&2, K.R. Lakminarayana ,Scitech Publications.
4. Effective Technical Communication, M.AshrafRizvi,TataMcGraw Hill.
5. Advanced Technical Communication, KavitaTyagi, Padma Misra, PHI Publication.
6. Word Power Made Handy, ShaliniVerma,S.Chand Publication.

ChE106 C PROGRAMMING AND NUMERICAL METHODS

(Common for all branches)

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT-I

Computer Basics: The Computer System, Generations of Computer, Classification of Computer, Block diagram of digital Computer, Inside the Computer-Processor, Memory, External Ports, PCI Card, Formatting Hard disk, Understanding BIOS, BIOS Commands, Networking Basics, Internet Basics, Basics of S/W-OS fundamentals, Algorithm, Flowchart, Programming Paradigms.

C-Basics: C-character set, Data types, Constants, Expressions, Structure of C program, Operators and their precedence & associativity, Basic input and output statements, Control Structures, Simple programs in C using all the operators and control structures.

UNIT-II

Functions: Concept of a function, passing the parameters, automatic variables, scope and extent of variables, storage classes, recursion, iteration vs. recursion, types of recursion, Simple recursive and non recursive programs, Towers of Hanoi problem.

Arrays: Single and multidimensional Arrays, Character array as a string, string functions, Programs using arrays and string manipulation.

UNIT-III

Pointers: Pointers declarations, Pointer expressions, Pointer parameters to functions. Pointers, Pointers and array, Pointer arithmetic.

Structures: Declaring and using structures, operations on structures, structures and arrays, user defined data types,, pointers to structures.

Files: Introduction, file structure, file handling functions, file types, file error handling, Programs using file functions.

UNIT-IV

Numerical Methods: Types of Errors, General formula, numerical method for finding roots of an algebraic equation of one variable, successive bisection method, false position method, Newton Raphson method, secant method. Guass elimination method, Guasssiedal method, Lagrange interpolation.

General Quadrature formula, Simpsons rule, Euler's method, general method for deriving differentiation formula, differentiation of Lagrange's polynomial, differentiation of Newton polynomial, Taylors Series, RangaKutta Method.

Text Books:

1. C Programming and Numerical Methods, Ajay Mithal, Pearson
2. Computer Oriented Numerical Methods, V.Raja Raman, PHI

ReferenceBooks :

1. Programming with C, Gottfried-Schaums Outline Series, TMH
2. C Programming,Behrouz A forouzan, CENGAGE Learning
3. Computer Programming,Kanthane, Pearson Education
4. Elementary Numerical Methods, C.D. Conte
5. Introduction to Numerical Methods,S.S.Sastry

ChE107 INTRODUCTION TO CHEMICAL ENGINEERING

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I:

Introduction: Definition of Chemical Engineering, unit operations, basic laws, units & dimensions.

Momentum Transfer:

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

UNIT – II:

Heat Transfer:

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

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

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

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

UNIT – III:

Mass Transfer:

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

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

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

UNIT – IV:

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

Text Book:

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

Reference Books:

1. Introduction to Chemical Engineering, Walter L. Badger & Julius T. Banchero, Tata-McGraw-Hill, New Delhi.
2. Unit Operations of Chemical Engineering, Warren L.McCabe, Julian C.Smith, Peter Harriot, 7^{th} edition, McGraw Hill, New Delhi.
3. Introduction to Chemical Engineering, Smith J. M., McGraw Hill, New Delhi.

ChE108 ENGINEERING GRAPHICS

(Common for all branches)

Lectures: 3+3 Periods / week
University Examination: 3 hours

Sessional Marks:30
University Examination Marks: 70
No. of credits : 4

Note: 1) Unit VI not to be included in the university theory examination. This unit is only for internal assessment
2) University Examination Question paper consists of FIVE questions, TWO questions from each unit with internal choice.
(To be taught & examined in First angle projection)

UNIT-I

General:

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

Curves :

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

UNIT-II

Method of Projections:

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

Projections of Planes:

Projections of planes, projections on auxiliary planes.

UNIT-III

Projections of Solids :

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

Sections of Solids:

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

UNIT-IV

Development of Surfaces:

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

Isometric Projections:

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

UNIT V

Orthographic Projections:

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

UNIT VI

(Demonstration only)

Computer Aided Drafting(Using any standard package):

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

Tool bars:
Draw tool bar, object snap tool bar, modify tool bar, dimension tool Bar
Practice of 2D Drawings:
Exercises of Orthographic views for simple solids using all commands in various tool bars.

Text Books:
1. Engineering Drawing, N.D. Bhatt & V.M. Panchal, Charotar Publishing House, Anand.
2. AutoCAD 14 for Engineering Drawing Made Easy(Features AutoCAD 200),P.NageswaraRao

Reference Books:
1. Engineering Drawing, K.L.Narayana&R.K.Kannaiah.
2. Engineering Graphics with AutoCAD 2002, James D. Bethune

ChE151 PHYSICS LABORATORY

(Common for all branches)

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

1. Compound pendulum –Determination of acceleration due to gravity (g)
2. Interference fringes - measurement of thickness of a foil / diameter of Wire using wedge method.
3. Sensitive galvanometer - Determination of figure of merit
4. Newton's rings – Measurement of radius of curvature of plano convex lens
5. Lissajous' figures –Calibration of an audio oscillator
6. Photo cell – I-V Characteristic curves and determination of stopping potential
7. Diffraction grating – Measurement of wavelengths
8. Torsional pendulum- Determination of rigidity modulus of the wire material.
9. Carey- Foster's bridge: Determination of specific resistance/Temperature coefficient of resistance.
10. Photo voltaic cell - Determination of fill-factor
11. Variation of magnetic field along the axis of a current carrying circular coil.
12. Series l LCR resonance circuit - Determination of "Q" factor.
13. Thomson's method - determination of e/m of an electron.
14. Determination of a.c. Frequency – Sonometer.
15. Prism/Grating - Determination of dispersive power.
16. To determine the wavelength of Laser source.
17. Hall effect – Determination of Hall coefficient.
18. Determination of energy band gap.
19. Determination of Numerical Aperture of an optical fiber.
20. Determination of Amplitude and Frequency of an AC signal using a CRO.

ChE 152 CHEMISTRY LABORATORY

(Common for all branches)

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

1. Estimation of total alkalinity of water sample
2. Determination of purity of washing soda
3. Estimation of Chlorides in water sample
4. Determination of Total Hardness of water sample:
5. Estimation of Magnesium
6. Estimation of Mohr's salt-permanganometry
7. Estimation of Mohr's salt –Dichrometry
8. Analysis of soil sample:
   a)Estimation of Ca and Mg
   b) Estimation of Organic matter
9. Determination of available chlorine in bleaching powder-Iodometry
10. Determination of iodine in iodized salt
11. Determination of iron (Ferrous and Ferric) in an iron ore by Permanganometry
12. Determination of Zn using Potassium ferrocyanide
13. Conductometric titration of an acid vs. base
14. pH metric titrations of an acid vs. base

Demonstration Experiments:

15. Potentiometric titrations: Ferrous vs. Dichromate
16. Spectrophotometry: Estimation of Mn/Fe

ChE 153 WORKSHOP PRACTICE

(Common for all branches)

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

Minimum four experiments should be conducted from each trade

1. Carpentry

To make the following jobs with hand tools

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

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

The following joints to be welded.

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

3. Sheet metal operations with hand tools.

a) Preparation of edges like Saw edge, wired edge, lap seam, grooved seam
b) Funnel
c) Rectangular Tray
d) Pipe joint
e) Electronic Component joining Techniques like use of crimping tool, soldering of electronic components, strain gauge, thermo couples, use of computer networking tools.

4. House wiring

a) One lamp by one switch
b) Two lamps by one switch
c) Wiring of tube light
d) Stair case wiring
e) Go-down wiring

ChE154 C-PROGRAMMING LABORATORY

(Common for all branches)

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

CYCLE-I:

Basics of Hardware and Software Exercises:

1. Explore Mother Board components and Layouts, identifying external ports and interfacing, identifying PCI cards and interfacing.
2. Partitioning and formatting Hard disks.
3. Install and Uninstall system and application software.
4. Understand BIOS configuration.
5. Connect computers in a network.
6. Assemble a Computer and troubleshoot a Computer.
7. Operating system commands
   a. Directory Related Utilities.
   b. File and Text Processing Utilities.
   c. Disk, Compress and Backup Utilities.
   d. Networking Utilities and
   e. Vi editor

CYCLE-II:

Programming Exercises:

1. Write a program to read x, y coordinates for 3 points and then calculate the area of a triangle formed by them and print the coordinates of the three points and the area of the triangle. What will be the output from your program if the three given points are in a straight line?
2. Write a program, which generates 100 random integers in the range of 1 to 100. Store them in an array and then print the arrays. Write 3 versions of the program using different loop constructs. (eg. For, while, and do write).
3. Write a set of string manipulation functions e.g. for getting a sub-string from a given position. Copying one string to another, reversing a string, adding one string to another.
4. Write a program which determines the largest and the smallest number that can be stored in different data types of like short, int., long, float and double. What happens when you add 1 to the largest possible integer number that can be stored?
5. Write a program, which generates 100 random real numbers in the range of 10.0 to 20.0, and sort them in descending order.
6. Write a function for transposing a square matrix in place (in place means that you are not allowed to have full temporary matrix).
7. First use an editor to create a file with some integer numbers. Now write a program, which reads these numbers and determines their means and standard deviation.
8. Write a program for implementing students management system(attendance, marks and fees reports) using structures and pointers.
9. Implement bisection method to find the square root of a given number to a given accuracy.
10. Implement Newton Raphson method to determine a root of polynomial equation.
11. Given a table of x and corresponding f(x) values, write a program which will determine f(x) value at an intermediate x value using Lagrange's interpolation.

ChE 211 COMPUTATIONAL TECHNIQUES

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT-I

Partial Differential Equations:

Introduction, Formation of partial differential equations. Solutions of partial differential equations, Equations solvable by direct integration, Linear equations of the first order, non-linear equations of the first order using Charpits method, Homogeneous linear equations with constant coefficients, Rules for finding the complementary function, Rules for finding the particular integral, Non-homogeneous linear equations.

UNIT–II

Applications of partial differential equations:

Introduction, Variable separable method, One dimensional wave equation, One dimensional heat equation-steady and unsteady states, Two dimensional heat flow-steady state heat flow-Laplace's equation in Cartesian coordinates.

UNIT–III

Numerical Methods:

Solution of Algebraic and Transcendental equations: Introduction, Newton-Raphson method, Solution of simultaneous linear equations: Gauss Siedal Iteration method.

Finite Differences & Interpolation:

Introduction, Finite difference operators, Symbolic relations, Differences of a polynomial, Factorial notation, Newton's forward and backward difference interpolation formula, Interpolation with unequal intervals – Lagrange's interpolation.

Numerical Integration:

Trapezoidal rule, Simpson's one-third rule.

UNIT–IV

Difference Equations:

Introduction, Formation, Linear difference equations – Rules for finding the complementary function, rules for finding the particular integral.

Numerical solution of ordinary and partial differential equations:

Euler's method, Picards method, Runge-Kutta method of fourth order (for first order equations only), Classification of partial differential equation of second order, Solutions of Laplace's and Poisson's equations by iteration method.

Text Book:

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

Reference Books:

1. Introductory Methods of Numerical Analysis, S. S. Sastry, PHI Pvt. Ltd.,
2. Numerical Analysis, James. B. B. Scarborough, Oxford & IBH.
3. Partial Differential Equations, Ian.N.Sneddon, McGraw-Hill.

ChE212 ENVIRONMENTAL STUDIES

(Common for all branches)

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT-I

Introduction:

Definition, Scope and Importance.

Natural Resources:

Forest Resources:

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

Water Resources:

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

Energy resources:

Energy needs, Renewable and non-renewable energy sources.

Land resources:

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

Ecosystems:

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

UNIT-II

Biodiversity and its Conservation:

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

Environmental Pollution:

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

UNIT-III

Social Issues and Environment:

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

Climate Changes:

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

UNIT-IV

Environmental Acts:

Prevention and Control of Water pollution & Air Pollution act, Environmental protection act, Wildlife protection act,ForestConservationact.

International Conventions:

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

Case Studies:

Chipko movement, Narmada BachaoAndolan, Silent Valley Project, Madhura Refinery and TajMahal, ChernobylNuclear Disaster, Ralegaon Siddhi, Florosis and Bhopal Tragedy.

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

Text Book:
1. Environmental Studies, Suresh K. Dhameja, S.K. Kataria& Sons, Ludhiana.

Reference Books
1. Environmental studies,AnubhaKaushik and C.P.Kaushik., New Age International Publishers, New Delhi.
2. Environmental Studies, T Benny Joseph, Tata McGraw-Hill Publishing Company Limited, New Delhi.

ChE213 ELECTRICAL& ELECTRONICS ENGINEERING

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT- I

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

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

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

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

UNIT- II

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

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

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

UNIT- III

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

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

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

UNIT- IV

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

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

Text Books:

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

References Books:

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

ChE214 ORGANIC CHEMISTRY

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT: I

Electron displacements in a molecule: Inductive, Mesomeric and electromeric effects, resonance, hyperconjugation, reaction mechanisms of SN_1, SN_2, E_1 and E_2 reactions, Generation, Stability and Structure of Carbocation, Carbanion, Carbenes and free radicals, Hydrogen bonding in organic molecules and its effects.

Stereo chemistry: Basics of Optical and geometrical isomerisms – Enantiomers, Diastereomers, meso compounds, Sequence rules, R and S,E and Z configuration, Keto-enoltautomerism, Conformations of Ethane and n- butane.

UNIT: II

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

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

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

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

UNIT: III

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

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

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

UNIT: IV

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

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

Synthesis of anti-bacterial drugs: Sulphanilamide, Sulphapyridine.

Synthesis of anti-malarial drugs: Isopentaquine, Chloroquine.

Text Books:

1. Text Book of Organic Chemistry, B.S.Bahl and ArunBahl, S.Chand& Co.,(Unit-I, II,III).
2. Text Book of Organic Chemistry, Vol.2, I.L.Finar, Longman group (Unit-IV)

Reference Books:

1. Text Book of Organic Chemistry, R.T.Morrison and R.N.Boyd, 6^{th} edition, PHI, Delhi.
2. Principles of Organic Chemistry, M.K.Jain, 9^{th} edition. S.Nagin& Co.

ChE 215 CHEMICAL PROCESS CALCULATIONS

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

Unit – I

Introduction to Chemical Engineering Calculations:

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

Unit – II

Vapour Pressures &Humidity :

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

Unit – III

Material Balances:

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

Unit – IV :

Energy Balances:

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

Text Books :

1. Basic Principles and Calculations in Chemical Engineering, David M.Himmelblau, 6th Edition, Prentice Hall India.

Reference Books:

1. Chemical process Principles Part–1, Material and Energy Balances, Hougen,O.A., Watson, K.M., and Ragatz, R.A., 2nd Edition, New Age International
2. Stoichiometry, B. I. Bhatt and Vora, Tata McGraw Hill
3. Stoichiometry and Process Calculations, K. V. Narayanan and B. Lakshmikutty, Prentice-Hall of India Private Limited, New Delhi.

ChE 216 MOMENTUM TRANSFER

Lectures/Tutorials: 4 + 1 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 5

UNIT – I

Basic Concepts:

Units and dimensions, dimensional analysis, similarity, equations of state, material and energy balances.

Fluid Statics:

Nature of fluids, pressure concept, hydrostatic equilibrium, manometers and decanters.

Fluid Flow Phenomena:

Concept of stream lines, stream tubes, velocity field, viscosity, types of fluids, turbulence and its nature, flow in boundary layers, its formation and growth in tubes and on plates.

UNIT – II

Basic Equations of Fluid Flow:

Continuity, momentum and Bernoulli's equations.

Flow of Incompressible Fluids:

Relation between skin friction and wall shear, laminar flow in pipes, Hagen-Poiseuille equation, turbulent flow in pipes, velocity distribution equations, friction factor, flow through channels of non-circular cross section, friction from changes in velocity or direction, flow of liquids in thin layers.

UNIT – III

Flow of Compressible Fluids:

Continuity equation, total energy balance, processes of compressible flow, isentropic flow, adiabatic frictional flow.

Flow Past Immersed Bodies:

Friction in flow through beds of solids, motion of particles through fluids, fluidization, mechanism of fluidization, pressure drop in fluidization, applications of fluidization.

UNIT – IV

Transportation of Fluids:

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

Metering of Fluids:

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

Text Book:

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

Reference Books:

1. Perry's Chemical Engineers Hand Book, Robert H. Perry, 7th edition, McGraw Hill
2. Coulson & Richardson's Chemical Engineering, Volume-1, J.F. Richardson, J. H. Harker and J. R. Backhurst, 4th edition, Elsevier.

CHE251 ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

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

ChE252 ORGANIC CHEMISTRY LABORATORY

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

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

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

ChE253 MOMENTUM TRANSFER LABORATORY

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

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

ChE221 PROBABILITY AND COMPLEX ANALYSIS

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT- I

Integral Transforms:

Introduction, Definition, Fourier integrals–Fourier sine and cosine integrals, Complex form of Fourier integrals, Fourier transforms, Fourier sine and cosine transforms, Properties of Fourier transforms.

UNIT-II

Probability and Distributions:

Probabilityand problems related to probability**-** addition theorem, multiplication theorem, Bayes theorem and its applications.Normal distribution, Normal approximation to binomial distribution, Some other distribution.

Sampling and Inference:

Sampling, Testing a Hypothesis, Simple sampling of attributes, Sampling of variables-large & small samples, Chi-square test.

UNIT-III

Complex Analysis:

Introduction, Continuity. Cauchy–Riemann's equation, Analytic functions. Harmonic functions, Orthogonal system.

Complex Integration:

Cauchy integral theorem, Cauchy's integral formula.

UNIT-IV

Series:

Taylor's series, Laurent's series, Zeroes and singularities

Calculation of residues:

Calculation of residues, Residue theorem, Evaluation of real definite integrals (by applying the residue theorem)

Text Book:

1. Higher Engineering Mathematics, B.S.Grewal, 40th edition, Khanna Publishers.

Reference Books:

1. Engineering Mathematics, M. K. Venkatraman, The National Publishing Company
2. Differential Equations, J. N. Sharma and Gupta, Krishna PrakasanMandir publishers
3. Functions of Complex Variable, M. L. Khanna, Meerut Publications.

ChE 222APPLIED MECHANICS & MECHANICAL ENGINEERING

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT I:

Forces:

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

Section Properties:

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

UNIT II:

Stress and Strain:

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

Thin and Thick Cylinders:

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

UNIT III:

Steam:

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

Steam Generators:

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

UNIT IV:

Drives:

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

Gears:

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

Bearings:

Purpose of bearings, slipper bearing, thrust bearing, ball and roller bearings.

Couplings:

Flange, flexible couplings, hooks joint, universal coupling.

Text Books:

1. Strength of Materials, Ramamrutham, DhanpathRai Publishers, Delhi (Unit – I, II)
2. Elements of Mechanical Engineering, Mathur, and Mehta Jain Brothers, Delhi (Unit – III, IV)

Reference Books:

1. Applied Mechanics & Strength of Materials, R. S. Khurmi, S. Chand & Co.
2. Basic Mechanical Engineering, T.J.Prabhu& Others, Scitech Publishers,

ChE223 PROFESSIONAL ETHICS AND HUMAN VALUES

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT-I

Human Values:

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

UNIT-II

Engineering Ethics:

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

UNIT-III

Engineering as Social Experimentation:

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

Safety, Responsibility and Rights:

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

Workplace rights and responsibilities:

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

UNIT-IV

Global Issues:

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

Text Book:

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

Reference Books:

1. Ethics in Engineering Practice & Research, Caroline Whitbeck, Elsevier.
2. Mike Martin and Roland Schinzinger, Ethics in Engineering, McGraw Hill. New York 1996.
3. Professional Ethics & Human Values, R.S. Naagarazan, New Age International Publishers

ChE224 PROCESS HEAT TRANSFER

Lectures/Tutorials: 4 + 1 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 5

UNIT – I:

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

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

UNIT – II:

Convection: Heat exchange equipment, heat flux and heat transfer coefficients, thermal boundary layer, dimensionless numbers in heat transfer and their significance.

Forced Convection: Heat transfer by forced convection inside tubes and ducts in laminar, transition & turbulent flow.Analogy between heat and momentum transfer, Reynold's, Prandtl and Colburn analogies.

Natural convection: Grashoff number, natural convection from vertical and horizontal surfaces.

Heat transfer to liquid metals: Forced convection over exterior surfaces. Heat transfer for tubes in cross flow.

UNIT – III:

Heat transfer to fluids with phase change: Heat transfer from condensing vapours; film wise and drop wise condensation,derivation and practical use of Nusselt equation,condensation of super heatedvapours, Effect of non-condensable gases on rate of condensation.Heat transfer to boiling liquids; Boiling of saturated liquid,maximum flux and critical temperature drop, minimum flux and film boiling,sub-cooled boiling.

Radiation: Thermal radiation, emission of radiation, absorption of radiation by opaque solids, radiation between surfaces, radiation to semitransparent materials, combined heat transfer by conduction, convection and radiation.

UNIT – IV:

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

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

Text Book:

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

Reference Books:

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

ChE 225 MECHANICAL OPERATIONS

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I:

Properties and Handling of Particulate Solids:

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

Size Reduction:

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

UNIT – II:

MechanicalSeparations:

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

Materials Separation:

Magnetic separators, Electro- static separators and froth flotation.

UNIT – III:

Filtration:

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

UNIT – IV:

Gravity Sedimentation Processes:

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

Agitation and Mixing Liquids:

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

Mixing of Solids:

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

Text Book:

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

Reference Books:

1. Chemical Engineering, vol. – II, Coulson, J.H., and Richardson, Paragon Press and ELBS.
2. Mechanical Operations for Chemical Engineers, C. M. Narayana and B.C.Bhattacharyya, Khanna Publishers.
3. Perry's Chemical Engineers Hand Book, Perry Rober H, 7th edition,McGraw Hill

ChE226 CHEMICAL ENGINEERING THERMODYNAMICS–I

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I:

The First Law and other Basic Concepts:

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

UNIT – II:

Volumetric Properties of Pure Fluids:

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

The Second Law of Thermodynamics:

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

UNIT – III:

Thermodynamic Properties of Fluids:

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

Applications of Thermodynamics to Flow Processes:

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

UNIT – IV:

Refrigeration and Liquefaction:

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

Text Book:

1. Introduction to Chemical Engineering Thermodynamics, Smith, J.M., Van Ness,H.C., and Abbott,M.M., 6th Edition (In SI units), Tata McGraw Hill.

Reference Books:

1. Chemical Engineering Thermodynamics, Dauber, McGraw Hill
2. Chemical Engineering Thermodynamics, Y.V.C.Rao, Universities press.
3. A textbook of Chemical Engineering Thermodynamics, K.V. Narayana, PHI

ChE 261 MECHANICAL OPERATIONS LABORATORY

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

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

ChE262 COMPUTATIONAL PROGRAMMING LABORATORY

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

Part 1: Fortran 90

1. Introduction to programming; variables; program structure and loops. Truncated Taylor's series & errors
2. Iterative computational methods
3. Using commercial (or open-source) numerical packages
4. Using commercial (or open-source) numerical packages
5. Linear Equations and their solution

Part II MATLAB

1. Introduction to MATLAB; data structures; functions/scripts
2. Linear / Nonlinear Equations
3. Regression / Curve fitting
4. Function Approximation / Integration
5. Differential equations – 1 (coding for numerical method)
6. Differential equations – 2 (solving an engineering problem)

Part III Aspen-Plus

1. Introduction to Aspen Plus
2. Aspen Properties

ChE263 COMMUNICATION& SOFT SKILLS LABORATORY

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

1 Introduction to Communication:

1.1 Elements of Communication 1.2 Theories of Communication
1.3 Barriers to Communication 1.4 Successful Communications
1.5 Types of Communication

2 Introduction to Skills:

2.1 Listening skills 2.2 Speaking skills 2.3 Reading skills
2.4 Writing Skills 2.5 Study skill

3Accent Training:

3.1 Phonetics 3.2 Intonation 3.3 British English
3.4. American English 3.5 Indian English

4 Career English:

4.1 Resumes 4.2 Letters 4.3 Reports 4.5 Writing with a purpose

5 Conversational English:

5.1 Conversational styles 5.2 Face – to – Face interaction
5.3 Telephonic interaction 5.4 Group Interaction

6 Performance:

6.1 Elocution 6.2 Debates 6.3 Group Discussion
6.4 Presentation 6.5 Brainstorming 6.7 Extempore

7Softskills:

7.1 dress code & Interview skills 7.2 Body language
7.3 Self awareness and motivation

ChE 311 MATERIAL TECHNOLOGY

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I:

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

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

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

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

Crystal imperfections: point, line and surface imperfections.

UNIT – II:

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

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

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

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

UNIT – III:

Elastic behavior of materials Plastic deformation: Mechanism of slip and twinning.

Creep: Mechanism and methods to reduce Creep in materials.

Fracture: Fracture in ductile and brittle materials, Fatigue-Mechanism and preventive methods

Oxidation and corrosion: Basic principle, types of corrosion, various combating methods.

UNIT – IV:

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

Text Book:

1. Material Science and Engineering, V.Raghavan, Prentice Hall of India Pvt.Ltd.

Reference Books:

1. Material Science and Engineering, R.K.Rajput, S.K.Kataria& Sons, Delhi.
2. Material Science and Engineering, D.CallistersJr,Weily& Sons.
3. Elements of Material Science and Engineering, Van Vlock, L.H.,Wesely

ChE 312 MASS TRANSFER OPERATIONS – I

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

Unit I

Molecular Diffusion:

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

Unit II

Mass transfer coefficient:

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

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

Unit III

Equipment for Gas-Liquid Operations:

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

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

Humidification:

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

Unit IV

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

Crystallization: Crystal geometry, nucleation, crystal growth, equipment– vacuum crystallizer & draft tube crystallizer.

Ion Exchange: Types of ion exchange, mechanism for rate of ion exchange

Membrane Separations: Mechanism, Membrane modules, dialysis, pervaporation

Text Book:

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

Reference Books:

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

ChE313 INORGANIC CHEMICAL TECHNOLOGY

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

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

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

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

UNIT – IV:
Sulfur and sulfuric acid:
manufacture of sulfur and sulfuric acid.
Hydrochloric acid:
Manufacture of Hydrochloric acid
Aluminum Industries:
Aluminum sulfate and alum
Nuclear industries: Uranium and thorium fission, nuclear fuels

Text Book:
1. Dryden's Outlines of chemical technology, M.GopalRao and M.Sittig, 3rd edition, East West Press.

Reference Books:
1. Shreve's Chemical Process Industries, Austin,G.T., McGraw Hill, 5th edition, 1985
2. Text Book of Chemical Technology (Inorganic), G.N.Panday, Vikas Publishers
3. Chemical Process Technology, Jacob A.Moulijin, MIchie**l** Maker and Annelies Van Diepen, John Wiley & Sons Ltd

ChE314 CHEMICAL REACTION ENGINEERING – I

sLectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I:

Overview of Chemical Reaction Engineering:

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

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

UNIT – II:

Interpretation of Batch Reactor Data:

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

UNIT – III:

Introduction to Reactor design:

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

UNIT – IV:

Design for Single Reactions:

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

Design for multiple reactions:

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

Text Book:

1. Chemical Reaction Engineering, Octave Levenspiel, 3rd edition, 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.

ChE315 CHEMICAL ENGINEERING THERMODYNAMICS–II

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I:

Heat effects:

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

UNIT – II:

Solution thermodynamics:

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

Solution Thermodynamics Applications:

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

UNIT – III:

Vapor-Liquid Equilibrium:

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

Phase Equilibrium:

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

UNIT – IV:

Chemical Reaction Equilibrium:

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

Text Book:

1. Introduction to Chemical Engineering Thermodynamics, Smith, J.M., Van Ness, H.C., and Abbott, M.M., 6^{th} Edition (In SI units), Tata McGraw Hill.

Reference Books:

1. Chemical Engineering Thermodynamics, Daubert, McGraw Hill.
2. Chemical Engineering Thermodynamics, Y.V.C.Rao, University Press.
3. A textbook of Chemical Engineering Thermodynamics, K.V. Narayana, PHI

ChE316 PROCESS INSTRUMENTATION

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Qualities of Measurement:

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

Process Instrumentation:

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

UNIT – II

Temperature measurement:

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

UNIT – III

Pressure, Level and flow measuring instruments:

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

UNIT – IV

Methods for composition analysis:

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

Text Book:

1. Industrial Instrumentation, Donald P. Eckman, Wiley Eastern Ltd.,

Reference Books:

1. Principles of Industrial Instruments, Patrenabis, Tata McGraw Hill
2. Instrumental Methods of Chemical Analysis, Gurudeep R. Chatwal& Sham K. Anand, Himalaya Publishing house.
3. Introduction to Chemical Analysis, Robert D. Braun, McGraw Hill.

ChE351 PROCESS HEAT TRANSFER LABORATORY

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

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

ChE352 MASS TRANSFER OPERATIONS LABORATORY-I

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

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

ChE353 INORGANIC CHEMICAL TECHNOLOGY LABORATORY

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

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

ChE 321 INDUSTRIAL POLLUTION & CONTROL

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Introduction:

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

Industrial Pollution emissions & Indian Standards:

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

UNIT – II

Water Pollution:

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

UNIT – III

Air Pollution:

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

UNIT – IV

Pollution control in selected process Industries:

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

Text Book:

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

Reference Books:

1. Environmental Pollution Control Engineering, C.S.Rao, Wiley Eastern Ltd., New Age International Ltd.,
2. Air pollution, M.N.Rao, H.V.N.Rao, Tata McGrawhill.
3. Water Pollution control, W.Wesley Eckenfelder Jr.Industrial, Tata McGrawHill.

ChE322 MASS TRANSFER OPERATIONS–II

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Distillation:

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

UNIT – II

Liquid-Liquid Extraction:

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

UNIT – III

Gas Absorption:

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

UNIT – IV

Leaching:

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

Adsorption:

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

Text Book:

1. Mass Transfer Operations, Robert E. Treybal, 3rd Edition , International Edition, McGraw Hill.

Reference Books:

1. Transport process and separation process principles, Christie John Geankoplis, 4th edition, PHI
2. Separation Process Principles, J D Seader and E J Henly, John Wiley & sons, NY 1998.
3. Principles of Mass Transfer and Separation Process, Binay K. Dutta, PHI, New Delhi.

ChE323 ORGANIC CHEMICAL TECHNOLOGY

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Rubbers:

Classification, natural rubber, monomers of synthetic rubber, manufacture of SBR.

Synthetic Fibers:

Classification, manufacture of nylon 6,6, polyester fiber, viscose rayon fiber.

Petroleum Refining:

Constituents of petroleum, Products of Refining, petroleum refining process- Cracking, reforming, polymerization, alkylation, isomerization, hydro-cracking, esterification and hydration.

UNIT – II

Plastic industry:

Classification of plastics, outlines and manufacture of phenols, formaldehyde, vinyl chloride and vinyl acetate, manufacture of phenol-formaldehyde resin and polyvinyl resins.

Paints and Varnishes:

Constituents of paints and varnishes and their manufacturing procedures.

UNIT – III

Sugar and starch industry:

Manufacture of cane sugar, production of starch from maize.

Fermentation industry:

manufacture of alcohol from molasses, manufacture of penicillin.

Pulp and paper industry:

Methods of pulping, production of sulphate and sulphite pulp, production of paper–wet process. Cellulose and its derivatives.

UNIT – IV

Oils, soaps and detergents:

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

Text Book:

1. Dryden's Outlines of chemical technology, M.GopalRao and M.Sitting, 3rd edition, East West Press.

Reference Books:

1. Shreve's Chemical Process Industries, Austin, G.T., McGraw Hill, 5th edition, 1985
2. Text Book of Chemical Technology (Organic), G.N.Panday, Vikas Publishers

ChE324 CHEMICAL REACTION ENGINEERING – II

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Temperature and pressure effects:

Single reaction and multiple reactions

Thermal characteristics and design of reactors:

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

UNIT – II

Non-ideal reactors:

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

UNIT – III

Introduction to design for heterogeneous reacting systems:

Rate equations for heterogeneous reactions, contacting patterns for two phase systems.
Fluid particle reactions: Selection of a model, un-reacted core model for spherical particles, rate of reaction for shrinking spherical particles, determination of rate controlling steps.

UNIT – IV

Heterogeneous catalysis:

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

Text Books:

1. Chemical Reaction Engineering, Levenspiel, Octave, 3rd edition, Wiley Eastern (UNIT-I - III)
2. Chemical Engineering Kinetics, Smith J.M. McGraw Hill.(UNIT-IV)

Reference Book:

1. Elements of Chemical Reaction Engineering, Fogler, H.S., 2nd edition, PHI

ChE325 PROCESS DYNAMICS AND CONTROL

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Basic Principles and problems of process control:

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

Linear open loop systems:

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

UNIT – II

Linear closed loop systems:

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

UNIT – III

Frequency response:

Introduction, substitution rule, Bode diagrams.

Control system design by frequency response:

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

UNIT – IV

Advanced control strategies:

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

Controller tuning and process identification:

Tuning, tuning rules, process identification.

Control Valves:

Valve construction, sizing, characteristics, positioner.

Text Book:

1. Process systems analysis and control, Coughanour, D.R. &Koppel, 2nd edition, McGraw Hill.

Reference Books:

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

ELECTIVE – I:

ChE 326 (A) ELECTRO - CHEMICAL ENGINEERING

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Review of basics of Electro - Chemistry:

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

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

UNIT – II

Mass transfer in Electro-Chemical systems:

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

UNIT – III

Primary and Secondary batteries:

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

UNIT – IV

Electrodes used in different electrochemical industries:

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

Text Book:

1. Electrochemical Engineering, Picket, Prentice Hall Inc.

Reference Books:

1. An Introduction to Electrochemistry by Samuel Glasstone, EWP.
2. Electrochemical Power sources Primary and Secondary Batteries, M.Barak (ed.) and L.K.Steverge.
3. Electro Chemical Engineering Science and Technology in Chemical and other industries by H.Wendt and G.Kreysa, Springer

ChE 326 (B) TEXTILE ENGINEERING

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

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

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

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

UNIT – IV
Wool Processing:
Wool setting and milling, Mildew, rot and moth proofing.
Silk Processing:
Degumming, Silk Dyeing, Silk Printing, Silk Finishing, Weighting of silk and scroop finish.
Printing:
Printing with kerosene and transfer printing.
Finishing:
Emerisingbiopolishing, water proofing and water repellency, flame proofing.

Text Book
1.A text book of Fiber science and technology, S.P.Mishra, New Age International

Reference Book:
1. Scouring, bleaching, Mercerizing and Dyeing of Cellulose Fibre, R.S. Prayag, TMH

ChE 326(C) MEMBRANE TECHNOLOGY

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

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

UNIT – II
Membranes:
Synthetic membranes, characteristics of membrane materials, classification, methods of preparation, membrane characterization, structural properties.

UNIT – III
Processes:
Microfiltration, ultrafiltration, nanofiltration, reverse osmosis, dialysis, electrodialysis, gas permeation, liquid membrane separations and their Industrial applications.

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

Text Book:
1. Basic principles of membrane technology, Marcal Mulder, Springer India.

Reference Books:
1. Ultrafiltration and Microfiltration, MunirCheryan, Technomic Publishing Co.,
2. Synthetic Polymeric membranes, R. E. Kesting, McGraw Hill.
3. Membrane separation processes, KaushikNath, PHI, New Delhi.

ChE 326 (D) CORROSION ENGINEERING

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Introduction and Scope:

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

UNIT – II

Polarization and Corrosion potentials:

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

UNIT – III

Oxidation:

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

UNIT – IV

Control:

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

Text Book:

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

Reference Books:

1. Electrochemistry, Samuel Glasstone, John Wiley.
2. Corrosion engineering, Fontana and Greene, John Wiley.

ChE 326(E) NUCLEAR CHEMICAL ENGINEERING

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I
Introduction:
The atomic nucleus, Nuclear forces and Nuclear binding. The compound nucleus and nuclear reactions.

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

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

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

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

Reference Book:
1. Perry's Chemical Engineers Hand Book, Perry Rober H, 7th edition, McGraw Hill

ChE 326 (F) FLUIDIZATION ENGINEERING

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Introduction:

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

Fixed beds:

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

UNIT – II

Minimum fluidization:

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

Fluidization:

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

UNIT – III

Bubble phenomena:

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

Terminal Velocity:

Derivation for terminal velocity.

Entrainment and Elutriation:

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

UNIT – IV

Flow of High Bulk Density and Low Bulk Density Mixtures:

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

Spouted bed:

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

Text Book:

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

Reference Book:

1. Fluidization, Max Leva, McGraw Hill
2. Perry's Chemical Engineers Hand Book, Perry Rober H, 7th edition, McGraw Hill

ChE 361 INSTRUMENTATION & PROCESS CONTROL LABORATORY

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

1. Response of Hg –Glass bare thermometer
2. Two tank non interacting system
3. Two tank interacting system
4. Control valve characteristics
5. Response of thermocouples
6. Response of thermometers
7. Response of temperature control trainer for step input forcing function
8. Response of level control trainer for step input forcing function
9. Response of flow control trainer for step input forcing function
10. Response of pressure control trainer for step input forcing function
11. Response of temperature control trainer for sinusoidal input forcing function
12. Response of level control trainer for sinusoidal input forcing function
13. Response of flow control trainer for sinusoidal input forcing function
14. Response of pressure control trainer for sinusoidal input forcing function
15. Pneumatic P+I controller

ChE 362 MASS TRANSFER OPERATIONS LABORATORY – II

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

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

ChE 363 ORGANIC CHEMICAL TECHNOLOGY LABORATORY

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

1. Active matter in detergents
2. Total fatty matter in soaps
3. Determination of adulteration in edible oils
4. Analysis of glucose-Estimation of total reducing sugars
5. Analysis of sawdust-Estimation of total cellulose
6. Preparation of soap by semi boiled process
7. Preparation of phenol formaldehyde resin
8. ASTM distillation of crude
9. Estimation of Urea
10. Preparation of ester
11. Preparation of Linear Alkyl Benzene Sulfonate
12. Preparation of Metallic salts
13. Iodine value
14. Acid value
15. Saponification value

ChE 411 COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Treatment and interpretation of engineering data:

Roots of algebraic and transcendental equations

Iteration methods:

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

UNIT – II

Ordinary differential equations:

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

UNIT – III

Regression Analysis:

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

UNIT – IV

Application of law of conservation of mass:

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

Application of law of conservation of energy:

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

Application of finite difference method:

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

Text Books:

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

Reference Books:

1. Applied Mathematical methods for Chemical Engineers, Norman W Loney, 2nd edition, CRC Press.
2. Numerical methods for Engineers, Chapra, McGraw Hill.
3. Applied Mathematics in Chemical Engineering, Mickley, H.S., Sherwood, T.S., and Reed, C.E., Tata McGraw Hill

ChE 412 CHEMICAL PROCESS EQUIPMENT DESIGN

Lectures/Tutorials: 4 + 1 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 5

UNIT – I

Introduction: Overall design considerations, Optimum design, Practical considerations in design.

Process Design Development: Design-project procedure, Design information from literature, Flow diagrams, Preliminary Design, Comparison of different processes, Equipment design specifications.

UNIT – II

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

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

UNIT – III

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

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

Text Books:

1. Plant Design and Economics for Chemical Engineers, Peters. M. S. and Timmerhaus, K.D., 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.

ChE 413 TRANSPORT PHENOMENA

Lectures/Tutorials: 4 + 1 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 5

UNIT – I

Momentum Transport:

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

Equations of continuity and motion:

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

UNIT – II

Turbulent Flow:

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

Friction Factors & Macroscopic Balance:

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

UNIT – III

Energy Transport:

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

UNIT – IV

Mass Transport:

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

Text Book:

1. Transport Phenomena, R.B.Bird, Warrin.E, Stewat and Edwin N.Light Foot, Wiley International Edition.

Reference Book:

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

ChE 414 BIO-CHEMICAL ENGINEERING

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Introduction:

An overview of industrial bio chemical processes, comparing with chemical processes.

A little Microbiology:

Biophysics and cell doctrine, Structure of cells, types of cells.

Chemicals of life:

Lipids, proteins, building blocks of DNA and RNA.

UNIT – II

The kinetics of enzyme–catalyzed reactions:

The enzyme-substrate complex & enzyme action, simple enzyme kinetics with one and two substrates, substrate activation & inhibition, modulation & regulation of enzyme activity, other influences on enzyme activity.

Applied enzyme catalysis:

Applications of enzymes, enzyme immobilization, medical & analytical applications of immobilized enzymes, effect of external mass transfer resistances, analysis of intra particle diffusion & reaction.

UNIT – III

The kinetics of cell growth:

Ideal reactors for kinetics measurements, Monod growth kinetics, growth cycle phases for batch cultivation.

Biological reactors:

Fed batch reactors, enzyme–catalyzed reactions in CSTRs, CSTR reactors with recycle and wall growth, the ideal plug flow tubular reactor, sterilization reactors, packed bed reactors, fluidized bed reactors and trickle-bed reactors.

UNIT – IV

Product recovery operations:

Recovery of particulates - Filtration, centrifugation, sedimentation.

Production Isolation:

Extraction, precipitation, Chromatographic techniques, membrane separations, drying and crystallization.

Text Book:

1. Biochemical Engineering fundamentals, J.B.Bailey and D.F.Ollis, McGraw Hill

Reference Books:

1. Bio process Engineering Basic Concepts, 2nd edition, Michel L. Shuler, FikeetKargi, PHI
2. Biochemical Engineering, James M Lee, PHI.

Elective-II

ChE 415(A) ENERGY ENGINEERING

(Open to other branches)

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Introduction:

Conventional energy resources, the present scenario, scope for future development.

Coal:

Origin, occurrence and reserves, classification, ranking, analysis and testing, coal carbonization, manufacture of coke, coal gasification, coal liquefaction.

UNIT – II

Petroleum:

Origin, occurrence and reserves, composition, classification, characteristics, exploration and production.

Petroleum Refining:

Refinery processes, petroleum products, testing and analysis of petroleum products.

UNIT – III

Non conventional energy sources:

Solar energy, solar radiation, principles of heating and cooling, photo voltaic cells.Bio gas products, bio-mass, wind energy, hydrogen energy, geothermal and ocean thermal energy, fuel cells.

UNIT – IV

Energy storage:

mechanical energy storage, water storage, solar pond, phase change storage, chemical storage.

Energy Conservation:

Conservation methods in process industries, Theoretical analysis, practical limitations, equipment for energy saving / recovery.

Text Books:

1. Energy Technology, S. Rao, B. B. Parulekar, KhannaPublishers, Delhi. (Unit I -II)
2. Non-Conventional Energy Sources, G.D. Roy, 4th edition,KhannaPublishers, Delhi (UnitIII - IV)

Reference Books:

1. Conventional Energy Technology, S.B.Pandy, Tata McGraw Hill
2. Fuels and energy, Harker and Backhusst, Academic press,London 1981

ChE 415 (B) BIOFUELS

(Open to other branches)

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Introduction:

Sources of energy, introduction of biofuels, availability of bio mass, composition of biomass, terrestrial biomass, aquatic biomass.Physical and chemical properties of biomass.useful features of biofuels, undesirable features of biofuels, energy crops, modes of utilization of biomass and their environmental impacts.

UNIT – II

Biogas:

The substrate, the digester, the microorganisms, the process of bio gas production, factors affecting bio gas yields, advantages, disadvantages.

Bioethanol:

Bioethanol vs. Petrol, production of bio ethanol, ethanol recovery.Bio butanol.

UNIT –III

Bio diesel:

Sources of lipids, production of lipids, methods of production of bio diesel, comparison of bio diesel with conventional diesel.Standards of bio diesel.

UNIT – IV

Bio hydrogen:

Production of bio hydrogen from anaerobic bacteria, photosynthetic algae, photosynthetic–hydrogenase system.

Fuel cells:

Enzymatic fuel cells, microbial fuel cells.

Text Book:

1. Bio Technology – Expanding horizons, B.D.Sing, Kalyani Publishers, Ludhiana.

Reference Books:

1. Fundamentals of Renewable Energy Systems, D.Mukherjee, S.Chakrabarti, New Age International Publishers.
2. A Text Book of Biotechnology, R.C.Dubey, S.Chand& Company Ltd., New Delhi.
3. Non-Conventional Energy Sources, G.D.Rai, Khanna Publishers.

ChE451 MINI PROJECT

Lectures: 3 Periods / week

Sessional Marks: 100
No. of credits : 2

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.,)

ChE452 CHEMICAL REACTION ENGINEERING LABORATORY

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

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

ChE453 COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING LABORATORY

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

1. **Roots of nonlinear equations iterative methods:**
   a. Bisection method
   b. False position method
   c. Newton Raphson method
   d. Secant method

2. **Direct solution for set of linear equations:**
   a. Gauss Elimination Method
   b. Gauss-Jordan method
   c. Matrix inversion method
   d. Triangular Factorization (L.U.Decomposition method)

3. **Iterative solution for set of linear equations:**
   a. Jacobi's method
   b. Gauss Seidel method

4. **Regretion analysis:**
   a. Fitting Linear equation
   b. Fitting Transdental equations
   c. Fitting a polynomial function

5. **Numerical differentiation:**
   a. Forward difference quotient
   b. Central difference quotient
   c. Backward difference quotient

6. **Numerical integration:**
   a. Trapezoidal rule
   b. Simpson's 1/3 Rule
   c. Simpson's 3/8th rule

7. **Numerical solution of ordinary differentialequations:**
   a. Taylor series method
   b. Euler's method
   c. Heun's method
   d. Polygon method
   e. Runga-Kutta method

8. **Predictor and corrector methods:**
   a. Milne-Simpson method
   b. Adam Bash forth method
9. Rating of shell and tube heat exchanger using Aspen Plus software.
10. Rating of Distillation column using Aspen Plus software.
11. Simulation of Recycle Processes.
12. Simulation of PFR and CSTR.

ChE 454 ENVIRONMENTAL ENGINEERING LABORATORY

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

1. Suspended solids in air sample using high volume sampler.
2. CO_2 and CO concentrations in a given sample.
3. SO_2 concentrations in a given sample.
4. Hardness
5. pH value
6. Dissolved oxygen content.
7. BOD.
8. COD.
9. Iron content in a given industrial effluent sample.
10. Determination of Fluoride content in a given sample.
11. Determination of Chloride content in a given sample.
12. Nitrates
13. Determination of optimum dose of coagulant.
14. Determination of MLSS and MLVSS in a given industrial effluent sample.
15. Noise Measurement

ChE421 PROCESS ECONOMICS & INDUSTRIAL MANAGEMENT

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Interest &Depreciation:

Time value of money, interest discrete and continuous, Depreciation and depletion.

Cost:

Cost concepts, capital costs for process plants, estimation of production cost, cost indices, cost accounting and process costing –profit and loss account and balance sheet. Break even analysis.

Profitability:

Profitability analysis, comparison of alternative investments and replacements: Accounting for inflation and technological advancement.

UNIT – II

Production system:

Operation Manager's activities, types of operations, classification of production system, manufacturing and service units, mass production and batch production systems.

Work:

Work study, motion study and work measurement.

Production:

Production Planning and control, forecasting, controlling and intermediate production system, functions under PPC.

UNIT – III

Management:

Principles and functions of management

Forms of Business Organizations:

Sole trader, partnership, company form of business organization.

Organization:

Organization chart, principles of organization, types of organization, line and staff functions.

UNIT – IV

Inventory control:

Reasons for inventory control, analytical treatment and Inventory control techniques

Operations Research:

Problem formulation, linear programming, simplex and graphical solutions.Introduction to Marketing Management.

Text Books:

1. Plant Design and Economics for Chemical Engineers, Peters. M. S. and Timmerhaus, K.D., 5th edition, McGraw Hill, (Unit - I)
2. Industrial Management and Operations Research, K. K. Ahuja, Khanna Publishers, New Delhi (Unit II – IV)

Reference Books:

1. Engineering Economics, Paneerselvam, PHI
2. Essentials of Management, Koontz and O'Donnel, McGraw Hill.
3. Works Organization and Management, K.C. Sahu, N.K.Dutta, Oxford publications

ChE422 PROCESS MODELLING AND SIMULATION

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Mathematical models for chemical engineering systems:

Introduction, Use of mathematical models, Scope of coverage, Principles of formation, Fundamental laws, Continuity equation, Energy equation, Equations of motions, Transport equations, Equations of state, Equilibrium, Chemical kinetics.

UNIT – II

Examples of mathematical models of chemical engineering systems:

Introduction, Series of isothermal, constant hold up CSTRs, CSTRs with variable hold-ups, Two heated tanks, Gas phase pressurized CSTR, Non-isothermal CSTR, Single component vaporizer, Multi-component flash drum, Batch reactor, Reactor with mass transfer, Ideal binary distillation: Batch distillation with holdup.

UNIT – III

General Concepts of Simulation for Process Design:

Introduction, Process simulation models, Methods for solving non-linear equations, Simulation examples.

UNIT – IV

Computer simulation:

Simulation examples, Gravity flow tank, Three CSTRs in series, Non-isothermal CSTR, Binary distillation column, Multi-component distillation column, Batch reactor.

Text Book:

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

Reference Books:

1. Process Modelling and Simulation, R.W.Gaikwad, Dr. Dhirendra, Central Techno Publications.
2. Chemical Process Modelling and Computer Simulation, Amiya K. Jana, PHI
3. Computational methods for process simulation, W. FrednRamirez, Betterworthus series in Chemical Engineering

ELECTIVE – III:

ChE 423(A) POLYMER TECHNOLOGY

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT –I

Definitions: Monomer, polymer, functionality, homo and copolymers, heterochain and homochain polymers, polymer blends.

Classification of Polymers: Based on origin, applications, thermal behavior and polymerization.

Measurement of Molecular Weights: By end group analysis, colligative properties, intrinsic viscosity, Gel permeation chromatography and light scattering methods.

Chemical structure and physical states of polymers: Configuration & conformations, crystalline and amorphous states.

General properties of polymers: Mechanical, chemical, thermal, electrical and optical properties.

UNIT – II

Mechanism and kinetics: (I) step growth or condensation polymerization, (II) addition or chain growth a) free radical, b) anionic, c) cationic and d) coordination polymerizations.

Copolymerization of binary monomer system: Kinetics and relation of copolymer composition to monomer ratio.

Role of Chemicals: Initiator, catalyst, solvents, inhibitors, chain transfer agents in polymerization.

Methods of polymerization: Bulk or mass, solution, suspension and emulsion polymerization techniques.

Polymer chemical reactions: Degradation, curing or cross linking and vulcanization

UNIT – III

Compounding of polymers: Role of various additives such as fillers, reinforcing agents, stabilizers, antioxidants, lubricants, fire retardants, coupling agents.

Processing methods: a) Extrusion, b) moulding, c) injection moulding, d) calendaring, e) fibre spinning.

Manufacture, properties and applications of addition polymers:

a) polyethylene, b) polypropylene, c) polyvinyl chloride, d) polystyrene, e) polymethyl methacrylate, f) polytetrafluoroethylene and g) natural rubber.

UNIT – IV

Manufacture, properties and application of condensation polymers:

a) phenolic resins, b) polyesters c) unsaturated and saturated: PET & polycarbonate, d) Polyamides (nylon 6 & nylon 6,6) e) polyurethanes, f) epoxy resins, g) silicone resins, h) cellulose and its derivatives.

Text Book:

1. Polymer science, Gowarikar R.A., New Age publishers.

Reference Books:

1. Polymer science and technology, Joel R. Fried, PHI publishers.
2. Polymer science and technology of plastics and rubbers, PremamoyGhosh, Tata McGraw Hills, New Delhi

ChE 423(B) FERTILIZER TECHNOLOGY

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Introduction:

Details about indigenous fertilizer production, raw materials, details of the various nutrients with their importance.

Raw Materials:

Source of nitrogen and hydrogen.steam reforming of hydrocarbons. Partial oxidation of Fuel oils with gas purification, CO_2 removal processes and methanation.

UNIT – II

Nitrogen Fertilizers:

Coal gasification, ammonia synthesis, thermodynamic principles associated with ammonia synthesis, ammonia reactors. Nitric acid and sulfuric acid.

Urea, total recycle and stripping processes, process details, ammonium sulfate, ammonium chloride, ammonium nitrate, calcium ammonium nitrate.

UNIT – III

Phosphorous Fertilizers:

Phosphate rock availability and benefaction methods, upgradation, bone-meal, basic slag single super phosphate, triple super phosphate, phosphoric acid by wet process and furnace process. AMI process with HCL.Complex fertilizer like Mono and Di-ammonium phosphates, urea-ammonium phosphates.

UNIT – IV

Potassium Fertilizers:

Nitrophosphates, Ores for the potassic fertilizers, potassium chlorides, potassium sulfate, potassium nitrite liquid fertilizers, pollution abatement methods, controlled release fertilizers.

Text Book:

1. Hand book on Fertilizers, published, Fertilizer Association of India, New Delhi

Reference Books:

1. Chemistry and Technology of Fertilizers, V. Sauchelli, Reinhold Publications.
2. Fertilizer manual, A UNIDO Publication from International Fertilizer Development Centre, Albania, USA.

ChE 423(C) TECHNOLOGY OF EDIBLE FATS

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I
Refining:
Processes and plants employed for refining, bleaching and deodorization.

UNIT – II
Modification:
Hydrogenation and Winterization of oils for edible purposes, manufacture and evaluation of auxiliary materials such as nickel catalysts and hydrogen.

UNIT – III
Specialty Fats:
Manufacture of butter, margarine, ghee, vanaspati, bakery and confectionery fats and fatty foods, composition and properties of products.

UNIT – IV
Storage, Stability and Packing:
Spoilage during storage of fats and fat products, storage, handling and stabilization of edible fats and oils, pollution problems in oil industry, packaging of fats and oils.

Text Book:
1. Bailey's Industrial Oil and Fat products, volume 2 and 3, SwernDaneil E, 4th edition, John Wiley Publishers.

Reference Book:
1. Technology and Refining of oils and fats, Small Business Publications

ChE 423 (D) NANOTECHNOLOGY

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT-I

Introduction to nanotechnology:

Importance of nanotechnology and nanoscale, molecular and atomic size, surface and dimensional spaces.

Molecular nanotechnology:

Atoms by inference, electron microscopes (SEM) nanomanipulator, nanotweezers, atom manipulation, nanodots, nanolithography.

UNIT-II

Nanopowders and nanomaterials:

Concepts of nanomaterials, preparation, plasma arcing, chemical vapor deposition, sol-gels, electrodeposition, ball milling, applications.

Carbon nanotubes:

Structure, Types, formation, assemblies, purification, properties and uses.

UNIT-III

Molecular mimics:

Catenanes and rotaxanes, various molecular switches, synthesis of rotaxanes and catenanes, molecular computers, chemical rotors, prodders, flippers, atom shuttles, actuators, contacts.

Optics, photomics and solar energy:

Properties of light and nanotechnology, interaction.

UNIT-IV

Nanobiometrics:

Lipids as nano-bricks and mortar, self-assembled monolayers, proteins, 3-D structures arising from amines acids, nanoscale motors, biological computing, ion channels as sensors, information in DNA structure, using DNA to build nano-cubes, hinges, smart glue, wire template.

Text Book:

1. Nanotechnology (Basic Science and Engineering technologies) Mick Wilson, KKGeoffSmithj, Michella Simmons, BurkhardRaguge, Overseas Press.

Reference Book:

1. Introduction to Nanotechnology, Charles P. Poole, Jrl and Frank J Owens, Wiley – Interscience.

ChE 423(E) COMPUTER AIDED DESIGN

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT-I

Introduction:

Tracing the Historical Development, Task of the process engineer, what is mathematical modeling and simulation, Scope and structure.

Estimation of Gas and liquid properties:

Volumetric properties of gases, Volumetric properties of liquids, Fugacity of gases and liquids, Estimation of Enthalpy.

CAD of flow of fluids in Pipes:

Flow of Newtonian fluids in pipes, Sizing of pipes for Newtonian and Non-Newtonian flow, Pressure drop in compressible fluid flow, Flow of Non –Newtonian fluids in pipes, Pipe network calculations, Two-Phase flow systems.

UNIT – II

CAD of heat transfer equipment:

Introduction, Shell and Tube Exchangers without phase change, Condensers, Reboilers, Applications to furnaces.

UNIT – III

CAD of mass transfer equipment:

Introduction, Distillation, Gas Absorption, Liquid extraction

CAD of chemical reactors:

Introduction, Extent of reaction, analysis of rate data, Ideal reactor models, Temperature effects in homogeneous reactors.

UNIT – IV

Chemical Process Simulation:

Introduction, Process simulation Techniques, Partitioning and Tearing, The Flow sheet Simulator.

Text Book:

1. Chemical Process Computations, Raghu Raman, Elsevier Applied Science Publishers

Reference Books:

1. Computer Applications in chemical Engineering: Process Design & simulation, Robert G. Squires.
2. Computer Aided Process Plant Design, M.E.Leesley, Gulf Publishing Co.,
3. Chemical Engineering Vol.6, Sinnot, Pergamon Press.

ChE 423(F) PETROLEUM REFINERY ENGINEERING

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I
Origin and formation:
Origin and formation of petroleum, reserves and deposits of the World, Indian petroleum industry, composition of crudes. Refinery products and test methods. Evaluation of crudes. Crude pretreatment, dehydration and desalting, pipe still heater, atmospheric and vacuum distillation of crude oil.

UNIT – II
Gasoline Treatment:
Treatment of products, additives, blending of gasoline, treatment of gasoline, kerosene, lubes and lubricating oil, wax.

UNIT – III
Cracking:
Thermal and catalytic cracking, hydrocracking and hydrotreating, catalytic reforming.

UNIT – IV
Reforming and Asphalt Technology:
Coking, visbreaking, alkylation, isomerization, polymerization, asphalt and air blown asphalt.

Text Book:
1. Modern petroleum Refining Processes, B.K.B.Rao, Oxford IBH.

Reference Book:
1. Petroleum Refining Engineering, Nelson, McGraw Hill

ELECTIVE- IV

ChE 424 (A) CATALYST SCIENCE AND TECHNOLOGY

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

Unit-I

Introduction of catalysis: Definition, Catalyst properties, Heterogeneous & Homogeneous Catalysis, Nature of catalytic reactions, Adsorption &Chemisorptions

Unit-II

Mechanism: Steps in Catalytic reactions, Synthesizing the rate law, mechanism and rate limiting step, reforming catalyst, geometric electric factor in catalysis, adsorption isotherms.

Unit-III

Process: Production, testing & characterization of industrial catalysts

Solid Catalyst: Determination of surface area, void volume & solid density, pore volume distribution, theories of heterogeneous catalyst.

Unit-IV

Catalyst deactivation: Types & mechanism of catalyst deactivation, Decay reactions, determination of rate from experimental data from independent deactivation, effect of pore diffusion resistance on the kinetics of reaction with deactivating catalysts.Temperature-time trajectories, moving bed reactors, straight through transport reactors (STTR).

Text Books:

1. Elements of chemical reaction engineering, H. Scott Fogler, 4th edition, Pearson Prentice Hall. (Unit - I, II & IV)
2. Chemical Engineering Kinetics, J. M. Smith, 3rd edition, McGraw Hill Publishers. (Unit - III)

Reference Books:

1. Heterogeneous catalysis – Principles and applications, G. Bond, 2nd edition, Oxford University Press.
2. Catalytic processes with prover catalysis, C. C. Thomas, Academic press.

ChE 424(B) FOOD TECHNOLOGY

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT-1
General aspects of Food Industry, Constituents of Food, Quality & nutritive aspects, Food additives, Standards.

UNIT-II
Deteriorative factors and their control, Preliminary methods, Conversion and preservation operations, Preservation by Heat and Cold, Concentration, Drying, Irradiation, Microwave heating.

UNIT-III
Sterilization &Pasteuterisation, Fermentation & Pickling, Packing methods, Cereal grains, Pulses, Vegetables, Fruits, Spices, Fats & Oils.

UNIT-IV
Bakery, Confectionery & Chocolate Products, Soft & Alcoholic beverages, Dairy products, Meat, Poultry & Fish products.

Text Book:
1. Food Science, Norman N. Potter Joseph H. Hatchkiss, 5th edition, CSB Publishers & Distributors, New Delhi

Reference Books:
1. Fundamentals of Food processing operations, J.L.Heid and K.A Joslyn, the AVL Publishing Co., Westport
2. Food Process Engineering, D.R. Heldman, The AVL Publishing Co., Westport
3. The Fundamentals of Food Engineering, S.E. Charm, The AVL Publishing Co., Westport.

ChE 424(C) OPTIMIZATION OF CHEMICAL PROCESS

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I
Fundamentals of Optimization:
Nature and Organization of optimization problems, fitting models to data, formulation of objective functions, obstacles to optimization.Basic concepts of optimization, optimization of unconstrained function – single and two variables, one dimensional search - numerical methods

UNIT – II
Optimization Techniques:
Linear programming and applications, Simplex method and applications.

UNIT – III
Chemical Engineering Examples:
Optimization of recovery of waste heat, shell and tube heat exchanger, evaporator design, liquid-liquid extraction process, optimal design of staged distillation column.

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

Text Book:
1. Optimization of chemical process, T.F.Edgar and Himmelblau.D.M., 1st Edition, McGraw Hill.

Reference Book:
1. Optimization: Theory and Applications, S.S.Rao, Wiley Eastern Ltd.

ChE424 (D) Fuel Cell Technology

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Introduction:

Fuel Cell relevance and importance, historical highlights, classification of fuel cells

Alkaline fuel cells:

Description of alkaline fuel cell, working principle, components of alkaline fuel cell, modules, fuel cell stacks, ammonia as AFC fuel, general performance characteristics

UNIT – II

Phosphoric acid fuel cells:

Electrodes, materials and manufacturing, stacks and systems

Solid oxide fuel cells:

Benefits and limitations, cell components, cathode materials, anode materials, configurations and performance

UNIT – III

Molting carbonate fuel cells:

Cell components, mechanism of electrode reactions, status of MCFCs

Direct Methanol Fuel cells:

Mile stones in direct methanol fuel cell technology, eletro oxidation of methanol, the electrolyte, non-catalytic aspects, state of art of methanol crossover in DMFC

UNIT – IV

Proton Exchange Membrane Fuel Cells:

Scientific challenges, technology development, fuel processing, modeling studies of PEMFC performance

Fuel Processing:

Processing hydrogen from alcohols, producing hydrogen from hydro carbons, hydrogen from other sources

Hydrogen Storage:

Hydrogen storage, hydrogen production, hydrogen as an engine fuel, methods of hydrogen storage

Text Book:

1. Fuel Cell Principles and Applications, B.Viswanathan, M.AuliceScibioh, Universities Press

Reference Book:

1. Constructional features and operating characteristics of fuel cells, Weidlich Erhard

ChE 424(E) INDUSTRIAL BIOTECHNOLOGY

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I

Introduction to Fermentation Processes:
The range of fermentation processes, microbial biomass, microbial enzymes microbial metabolites, recombinant products, transformation processes, the chronological development of the fermentation industry.
Media for industrial fermentations: Typical media, medium formulation, energy sources, carbon sources, nitrogen sources, minerals, growth factors, nutrient recycle.
Sterilization: Medium sterilization, sterilization of the fermentor and feeds.

UNIT – II

Organic acids: Production of citric acid, acetic acid and lactic acid
Amino acids: Commercial uses of amino acids, strains for amino acid production, production of glutamic acid.
Vitamins & Antibiotics : Production of vitamin B_{12}, production of β-lactam, antibiotics, amino acid & peptide antibiotics and macro cyclic lactone antibiotics.

UNIT – III

Enzymes: Production of amylases, proteases, pectinases and lipases
Organic feed stocks: production of Ethanol, acetone / butanol
Ergot alkaloids: Occurrence and significance, structure, biosynthesis, production of ergot alkaloids, regulation of alkaloid production in cultures, strain development

UNIT – IV

Microbial transformations: Types of bioconversion reactions, procedures for bio transformation, transformation of steroids & sterols, non steroid compounds, antibiotics and pesticides.
Single Cell Protein (SCP) : Production of SCP form alkanes, methanol fermentations, SCP from wood, carbohydrates and sewage.

Newer Approaches to sewage treatment: Starter cultures for treatment processes, aerobic, sewage treatment-air lift process, aeration with pure oxygen, methane production.

Text Books :

1. Principles of Fermentation Technology P.F. Stanbury, A Whitaker and S.J.Hall, 2nd Edition, Elsevier (Unit – I)
2. A Text book of Industrial Microbiology, Wulf.Cruger&AnnelieseCruger, 2nd Edition, Panima Publishing Corporation (Units-II,III,IV)

Reference Books :

1. Industrial Microbiology, J.E.Casida, New Age
2. Industrial Microbiology, Prescott & Dunn, Agrobios, Jodhpur
3. Industrial Microbiology, A.H.patel, McMillan

ChE 424(F) INDUSTRIAL HAZARDS AND SAFETY ANALYSIS

Lectures: 4 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 4

UNIT – I
Introduction:
Definition of safety.The basis for safety.Chemical hazards and worker safety.Hazards of commercial chemical reactions and operations.Hazop studies, Fault Tree analysis, Event Tree Analysis.

UNIT – II
Safety:
Process design, instrumentation for safe operations, safety education and training.

UNIT – III
Risk:
Effect of toxic agents, flammable materials, Risk assessment, Work permit systems.

UNIT – IV
Protection:
Personnel protective equipment, fire extinguishing agents and their applications, measuring safety effectiveness.

Text Book:
1. Safety and accident prevention in chemical operations, Fewcett H.H. and W.S.Wood, John Wiley and Sons Inc.

Reference Book:
1. Safety Handling of Hazardous Chemicals Enterprises, R.Pjatgo.A.K
2. Industrial safety practices, Bob skeltor
3. Chemical process safety – Learning from case histories, Roy E Sanders, 3rd edition, Elsevier Butterworth Heinemann

ChE 461 COMPUTER AIDED PROCESS EQUIPMENT DESIGN LABORATORY

Lectures: 3 Periods / week
University Examination: 3 hours

Sessional Marks: 30
University Examination Marks: 70
No. of credits : 2

1. Flow chart symbols
2. Engineering drawings

Simulation using Aspen

3. Properties estimation
4. Material & Energy balances
5. Sensitivity Analysis
6. Design Specification
7. Mixers & Splitters
8. Pumps
9. Heat Exchangers
10. Columns
11. Reactors

ChE462 PROJECT WORK

Lectures: 9 Periods / week
University Examination: 3 hours

Sessional Marks: 50
University Examination Marks: 150
No. of credits : 10

The project work should consist of a comprehensive design project of a chemical plant in the form of a report with 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.