R-20

B.Tech. Program Regulations

Scheme of Instruction & Syllabus

(Effective from the Batch Admitted in 2020-2021)

DEPARTMENT OF CHEMICAL ENGINEERING

S V UNIVERSITY COLLEGE OF ENGINEERING

TIRUPATI- 517502

About the Department

Department is ranked 17 in top 20 National Universities in Chemical Engineering based on publication output (122 papers ,973 citations) as per "measures of performance of Universities in India: An Analysis of the Publication output in Science and Technology CSIR – National Institute of Science and Technology and Development Studies, New Delhi,2011. Department of Chemical Engineering, established in 1977, offers an undergraduate and a postgraduate course in chemical engineering, besides providing research guidance leading to a doctoral degree. The curriculum is regularly revised to incorporate newer subjects and the present curriculum is well balanced to meet the requirements of the industry and higher learning institutions. Three elective courses on advance topics are offered at the undergraduate level. One general and three electives in one of the following streams bioprocess engineering/high polymer engineering/energy engineering, are taught at postgraduate level. The laboratories of this department are well equipped with facilities to conduct about 100 experiments, at undergraduate and postgraduate level. Project work/dissertation on process analysis/design/core soft/experimental themes is to be submitted by undergraduates as a part of the curriculum. Postgraduate dissertations based on experimental or modeling and simulation study over a period of 1 year are prescribed. Students have been performing consistently well in GATE and recruitment tests conducted by various organizations. On an average 30% secure admission into M.Tech program of IIT's and IISc Bangalore, 45% are placed in the campus recruitments and the balance joins NIT's, other universities, civil services and higher education. All India first rank was bagged by a student of this department in GATE 2009.

THE VISION

- To be a world class department of chemical engineering in effective teaching and knowledge creation which is seamlessly integrated with bordering sciences and is committed to ignite and propel young minds with passion for originality, innovation and excellence.

THE MISSION

- To train technically competent and socially aware chemical engineers through innovative and rigorous educational programs to meet technological needs of the society
- To encourage self-learning, problem solving, inquisitiveness and team work among students.
- To enable students to develop capabilities needed to perform in multidisciplinary environment.
- To promote industry- institute interaction to nurture collaborative and applied research programs
- To help students develop a well-rounded personality with qualities of innovative thinking, leadership, entrepreneurship and ethical mind.
- To create amiable ambience of academics for intellectual pursuit and innovative research

SRI VENKATESWARA UNIVERSITY COLLEGE OF ENGINEERING
REGULATIONS – 2020 (R-20)

For B.Tech – Regular / Lateral Entry / Hons / Major-Minor

Henceforth, these shall be known as Regulations **R-20** and shall be applicable from the batch admitted in the academic year 2020-2021 through the State level EAMCET and ECET. They shall be applicable to B.Tech Lateral Entry admitted in 2021-2022 at the second year level (for Second, Third and Fourth years of study).

1 System

The system is a flexible Choice Based Credit System (CBCS) permitting students

a) To choose electives from a wide range of courses offered by the Institute or on-line platforms
b) To undergo additional courses
c) To adopt an inter-disciplinary approach

2 Programs

The University offers Regular B.Tech programs in

i) Chemical Engineering (ChE)
ii) Civil Engineering (CE)
iii) Electrical & Electronics Engineering(EEE)
iv) Electronics & Communication Engineering (ECE)
v) Mechanical Engineering (ME)
vi) Computer Science & Engineering (CSE)

In addition, meritorious students will have the option to choose B.Tech (Honours) or B.Tech (Major-Minor), both with extra courses and credits, in addition to those prescribed for B.Tech (Regular). Different Major-minor combinations are offered by the Institute subject to certain conditions specified herein this document

3 Duration

ALL PROGRAMS ARE OF FOUR YEARS DURATION, each academic year consisting of

two semesters, making a total of 8 semesters.

Each semester shall consist of 18 weeks with a typical academic work of 30 hours / week of instruction, equivalent to 90 instruction days. Number of instruction days may be reduced, when necessary, with an increased number of instruction hours per week per course

4 Instruction

Instruction is imparted in the following format

i) Basic Courses in Sciences and Basic Engineering to form the conceptual base
ii) Professional Core Courses intended knowledge development and enhancement in the chosen discipline of study.
iii) Elective Courses, both Professional and Open, intended to (a) to provide extended knowledge in the discipline of study, (b) to provide a broadened scope in the same discipline, (c) to enable an exposure to some other disciplines and (d) to enhance students' proficiency/skill.
iv) Audit Courses intended to provide awareness of the contemporary societal issues

5 Course Code

Each course shall be identified by an alpha-numeric course code, consisting of 2 alphabets followed by three numerals. XXxyy

XX denotes the department which offers the course.

x denotes the semester in which the course is offered

yy denotes a serial number assigned by the course offering department

CE : Civil Engineering	CO : Commerce
CH : Chemical Engineering	CY : Chemistry
CS : Computer Science and Engineering	EO : Economics
EC: Electronics and Communication Engineering	EN : English
EE : Electrical and Electronics Engineering	MA : Mathematics
ME : Mechanical Engineering	PH : Physics
	HU : Humanities
	BO: Biological Sciences

	MG : Management

6 Scheme of Instruction & Syllabus

6.1 A Board of Studies (Pass) of each department, constituted by the University, with experts from internal and external academic departments , industry, society, alumni and students shall formulate the Scheme of Instruction and Evaluation of a program and the detailed syllabus content of the courses.

6.2 All the Boards of Studies (Pass) shall together formulate the scheme of instruction and examinations, and detailed syllabi for all the courses of the First and Second Semesters which shall be mostly common for all the branches of study

7 Attendance Requirement

7.1 A student is required to complete the study of the Program satisfying the attendance requirements in all the Semesters within a maximum period of eight academic years from the year of admission to become eligible for the award of B.Tech degree, failing which he/she forfeits his/her admission.

7.2 A student shall be detained in a Semester if he/she fails to satisfy the attendance requirements given below:

i) Attendance in Audit Courses shall not be considered for calculation of academic requirements

ii) A student shall attend a minimum of 50 percent of the hours of instruction taken by the teacher, in each course (Theory + Tutorial)

iii) A student shall attend a minimum of 75 percent of total instruction hours conducted during that semester – Theory + Tutorial + Practical

iv) However, a committee, headed by the Principal, can condone shortage of attendance, due to ill health of the student, up to 10 percent (65 – 75 %) for those students, who attend a minimum of 65 percent of total instruction hours with a minimum 50 percent in each course.

v) A student who fails to satisfy the attendance requirements specified in clauses 7.2 (i, ii, iii) shall be detained and will have to repeat that Semester in the subsequent academic years with the written permission of the Principal subject to the clause 7.1

vi) A student shall not be permitted to study any semester more than three times during the entire Programme of study

vii) A student who satisfies the attendance requirements specified in either of the clauses 7.2 (ii or iii) in any semester may be permitted to repeat that semester

cancelling the previous attendance and sessional marks of that semester with the written permission of the Principal. However, this facility shall not be extended to any student more than twice during the entire Programme of study as specified in clause 7.1

8 **Credit -**

This is the unit by which the course work is measured. It determines the number of hours of instructions required per week. It is a weightage index, used in the computation of Grade Point Average, indicative of the student performance.

Theory / Tutorial …. 1 hr /week …. 1 credit
Practical … 2 hr/week …. 1 credit

Credit requirement for the Award of Degree : Successful performance in

B.Tech (Regular)	160 credits
B.Tech (Lateral Entry)	123 credits (II, III & IV years only)
B.Tech (Honors)	160 + 20 additional credits in the same discipline
B.Tech (Major-Minor)	160 (Major discipline) + 20 credits in another (Minor) discipline

9 **Examination – Evaluation**

9.1 Evaluation shall be carried out through Internal Tests and Semester End Examination.

9.2 For each theory course, there shall be two sessional tests. Each test is of two hours duration carrying 40 marks. Internal Test I will be conducted around the middle of the semester, on 50 % of the course content. Internal Test II will be at the end of the semester on the second 50% of the course syllabus.

It is mandatory for a student to attend both the sessional tests in each theory course. The weighted average of the marks secured in two tests is awarded as sessional marks. A weightage of 0.8 shall be assigned for the better performance of the two tests whereas for the other test it shall be 0.2. If a student is absent for any of the internal tests for whatsoever reason, the marks awarded for that test shall be zero.

Students are permitted to verify their internal test scripts after valuation.

The valuation and verification of answer scripts of Sessional Tests shall be completed within fifteen days after the conduct of the respective Sessional Tests.

9.3End-Semester Examination is of 3 hours duration carrying 60 marks. It shall be conducted after the last working day of the semester covering the entire syllabus prescribed for that course.

The question paper for end-semester examination shall be set by an external paper setter. The Chairman, BoS shall recommend a panel comprising at least six external paper setters for each theory course to the University. The University shall arrange for setting the question paper by appointing one external paper setter from that panel

Model Question Paper for each theory course shall be prepared by the concerned teacher within 30 days from the commencement of the Semester and the same shall be forwarded to the Controller of Examinations through the Chairman, BOS concerned.

Two questions shall be set from each unit of the syllabus, out of which one question shall be answered by the student. Each question of the unit carries a maximum of 12 marks.

However, the Chairman, BoS shall accord exception in question paper format, if necessary. The question papers shall assess the understanding of the concepts and their applications in solving problems and at least 50% of the questions shall be numerical. Further, the question papers of design-oriented courses shall assess the abilities of analysing and evaluating design alternatives

The valuation of End-Semester Examination answer scripts shall be arranged by the Controller of Examinations as per the University procedures in vogue.

9.4 For each practical course except project work, the sessional marks for a maximum of 40 shall be awarded based on the continuous assessment of practical work by the teacher concerned. An End-Semester Examination of 3 hours duration carrying 60 marks shall be conducted by two examiners, one external and one internal appointed by the Principal. The Principal shall appoint the external examiner from among the panel of examiners recommended by the Chairman, BoS concerned. He shall appoint the internal examiner nominated by the Head of the Department concerned

9.5 For Project work, the guide shall assess the progress of project work continuously and

award marks for a maximum of 40. A committee consisting of one external examiner and two internal examiners from the department shall value the project work and conduct viva-voce for a maximum of 60 marks. The Principal shall appoint the external examiner from among the panel of examiners recommended by the Chairman, BoS concerned. He shall appoint the internal examiner nominated by the Head of the Department concerned.

10 Course Performance

10.1 In each semester, every student who satisfies the attendance requirements has to register for the semester-end examination, failing which he/she shall not be promoted to the next semester. Any such student who has not registered for the semester-end examination in a semester shall repeat that semester in the next academic year with the written permission of the Principal.

10.2 To pass a course in the program, a student has to secure a minimum of 40% of maximum marks in the semester-end examination and a minimum Grade of P overall (both sessional and semester-end examination marks put together). A student obtaining Grade F shall be considered failed and shall be required to reappear for the semester-end examination. A student shall not be allowed to reappear for the semester-end examination in a course which he/she has already passed the course to improve the score

10.3 A student who has failed in a course shall be allowed to reappear for the semester-end examination as and when it is conducted in the normal course. The Sessional Marks obtained by the student shall be carried over for declaring the results

10.4 semester-end examination in any course of a particular regulation shall be conducted three times. Thereafter, the students who failed in that course shall take the semester-end examination in the equivalent papers of the subsequent regulation, suggested by the Chairman, BoS concerned.

10.5 Instant supplementary semester end examinations shall be conducted after announcement of IV year results for outgoing students in courses listed for IV year to save an year of time for outgoing students

11 Promotion Rules

11.1 A student shall be promoted from first year to second year if he fulfils the minimum attendance requirements.

11.2A student will be promoted from II year to III year if he fulfils the academic requirement of 40% of credits up to either II year I-Semester or II year II-Semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in II year II semester.

11.3 A student shall be promoted from III year to IV year if he fulfils the academic requirements of 40% of the credits up to either III year I semester or III year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in III year II semester

12 Student Performance - Grading and Grade Points

12.1 Letter Grade – Grade Point

Letter Grade is an index of the performance of students in a said course.

Grade Point is a numerical weight allotted to each letter grade on a 10-point

scale

Letter Grade	Range of Marks (Internal + End-Sem)	Grade Point
O (Outstanding)	**91 – 100**	**10**
A+ (Excellent)	**81 – 90**	**9**
A (Very Good)	**71 – 80**	**8**
B+ (Good)	**61 – 70**	**7**
B (Above Average)	**51 – 60**	**6**
C (Average)	**41 – 50**	**5**
P (Pass)	**40**	**4**
F (Fail)	**<40**	**0**
Ab (Absent)	**-**	**0**

A student obtaining Grade F or Absent for a semester end examination shall be considered failed in that course and he / she shall have to reappear in the Semester- end examination as and when it is conducted in the normal course. .

12.2 Grade Point Average

Semester Grade Point Average **(SGPA)**: It is a measure of student's performance in a semester.

Cumulative Grade Point Average **(CGPA)**: It is a measure of overall performance of a student over all semesters.

Computation of SGPA and CGPA

SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses and the sum of the number of credits of all the courses in the semester.

SGPA $(S_i) = \sum_{i=1}^{N} (C_i \times G_i) / \sum_{i=1}^{N} C_i$

where C_i is the number of credits of the i^{th} course, G_i is the grade point scored in the i^{th} course and N is the number of courses in the semester

CGPA = $\sum_{i=1}^{M} (C_i \times S_i) / \sum_{i=1}^{M} C_i$

where S_i is the SGPA of the i^{th} semester, C_i is the total number of credits in that semester and M is the number of semesters.

SGPA and CGPA shall be rounded off to two decimal points and reported in the transcripts.

12.3 Award of Class:

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of B.Tech. degree, he/she shall be placed none of the following:

Class Awarded	CGPA Secured
First Class with Distinction	≥ 7.5
First Class	≥ 6.5 < 7.5
Second Class	≥ 5.5 < 6.5
Pass Class	≥ 4.0 < 5.5

Equivalent percentage is (CGPA – 0.5) multiplied by 10.

13 MOOCs (Online courses)

Certain prescribed courses will have to be pursued on Online platforms. This is recommended to encourage students to tap these resources and to prepare them for self-study.

1) **A**ll open elective courses are to be successfully completed on SWAYAM online portal of Government of India

2) Courses offered by the concerned Department as Program Core / Program Elective / Audit courses shall not be opted as open elective.

3) A student is free to opt for any course relating to (a) Domain Engineering (b) General Engineering (c) management and (d) functional / technical English, in consultation with his / her Department. It should not be a course offered by the Department.

4) Opted course shall carry 3 credits and of 12 or more weeks of duration

5) A student is free to enrol and complete an online course from III semester to VII semester of his / her B.Tech program, under permission of the concerned Head of the Department.

(6) Head of the Department concerned shall make arrangement for collection and consolidation of performance certificates in online courses for onward transmission to the University.

14 Summer Internship

All students shall have to undergo Internship during summer vacation breaks, of a duration of 6 weeks after 4th or 6th semester. They shall submit a certificate from the organization concerned and present a seminar on the internship in the beginning of seventh semester for its

assessment and inclusion in the 7th semester Marks Statement..

15 Gap Year

Gap year(s) shall be availed by the student himself/herself who wants to pursue entrepreneurship by taking a break of one year at any time after completing II year of study. A committee shall be constituted to evaluate the proposal submitted by the student and to decide on permitting the student to avail the Gap Year. Students shall be permitted to re-join the succeeding year from the date of commencement of class work and shall be under the academic regulations in force at that time

Gap year may be extended by another year (i.e. a total of two years) and shall not be counted for the maximum period of eight academic years for the completion of the program

16 Ranks & Awards

16.1 Ranks shall be awarded in each branch of study on the basis of Cumulative Grade Point Average (CGPA) for the top three students.

16.2 The students who have become eligible for the award of the degree by passing regularly all the eight Semesters shall only be considered for the award of ranks.

16.3 Award of prizes, scholarships and other honors shall be according to the rank secured by the student and in conformity with the desire of the Donor.

17 Grievance Redressal Committee

The Principal shall constitute a Grievance Redressal Committee of three Professors from the faculty of the college for a period of two years. The senior most among them shall be convener of the committee who receives the grievances from the students and places the same before the committee for its consideration. The committee shall submit its redressal recommendations to the Principal for his consideration

18 Amendment to Regulations

Sri Venkateswara University reserves the right to amend the regulations at any time in future without any notice. Further, the interpretation of any of the clauses of the regulations entirely rests with the University

B.Tech (Honors) Program

Additional Regulations for B.Tech (Honours) Program

H1 *Students of a Department/Discipline are eligible to opt for B.Tech (Honors) Program offered by the same Department/Discipline, to be completed within the stipulated period of 4 years.*

H2 A student shall be permitted to register for B.Tech (Honours) at the beginning of IV semester, provided that the student has acquired a minimum of 8.25 CGPA up to the end of II semester without any backlogs.

A student will have to consistently perform and at any later point of time, if his/her overall CGPA falls below 8.25, his/her registration for B.Tech (Honours) will be cancelled and such students will continue with the regular Program.

The credits earned in additional courses till that time will be treated as extra credits.

H3 *Students can select additional and advanced courses offered by their respective department in which they are pursuing the degree and get an honors degree in the same discipline.*

H4 In addition to fulfilling all the requisites of a Regular B.Tech Programme, a student shall learn 20 additional credits to be eligible for the award of B.Tech(Honours) degree. This is in addition to the credits essential for obtaining the Under-Graduate Degree in Major Discipline (i.e. 160credits).

H5 Of the 20 additional Credits to be acquired, 16 credits shall be earned by undergoing specified courses listed as pools, with four courses, each carrying 4 credits. The remaining 4 credits must be acquired through two MOOCs, which shall be discipline-specific, each with 2 credits and with a minimum duration of 8/12weeks as recommended by the Board of studies

H6 It is the responsibility of the student to acquire/complete prerequisite before taking the respective course. The courses offered in each pool shall be domain specific courses and advanced courses.

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B.Tech (Major-Minor) Program

Additional Regulations for B.Tech (Major-Minors) Program

MM1 *Students who are desirous of pursuing their special interest areas other than the chosen discipline of Engineering may opt for additional courses in another specified engineering discipline from among the combinations offered by the Institute.*

Such a program is referred to as B.Tech (Major) in discipline A and Minor in discipline B.

MM2 *Combinations will be decided, based on the compatibility, relevance, and the trend in technology, by the Boards of Studies of the participating Disciplines of Engineering. The list of combinations may alter from time to time.*

MM3 A student shall be permitted to register for B.Tech(Major-Minors)at the beginning of IV semester, provided the student has acquired a minimum of 8.25CGPA upto the end of II semester without any backlogs.

A student will have to consistently perform and at any later point of time, if his/her overall CGPA falls below 8.25, (both major and minor combined) his/her registration for B.Tech (Major-Minor) will be cancelled and such students will continue with the regular major program.

The credits earned in additional courses till that time will be treated as extra credits.

MM4 The students registered for B.Tech (Major-Minors) shall have to successfully complete 160 credits (in the major discipline) and 20 additional credits (in the minor discipline) subject to clause **MM3**.

MM5 *Scheme for 160 credits in the major discipline shall be the same as that of B.Tech regular program. For the additional 20 credits, BOS of the minor degree component shall prescribe the courses, in consultation with the Chairperson, BOS of the major discipline*

MM6 Of the 20 additional Credits to be acquired in the minor discipline, 16 credits shall be earned by undergoing specified four courses listed, each carrying 4 credits. The remaining 4 credits must be acquired through two MOOCs, which shall be minor discipline-specific, each with 2 credits and with a minimum duration of 8/12weeks as recommended by the Board of studies.

MM7 Minor must be completed simultaneously with a major degree program. A student cannot earn the Minor after he/she has already earned bachelor's degree.

PROGRAM OUTCOMES

A graduate of this Department after successful completion of B.Tech, will be able

- To integrate and apply concepts of mathematics, physics, chemistry and biology to real life situations.
- To apply principles of conservation, thermodynamics, transport processes, reaction engineering and process control to analyze and design process equipment.
- To develop mathematical models of chemical engineering systems.
- To demonstrate computational abilities and use of software tools in design & simulation of process and equipment.
- To apply techniques of optimization to improve the performance of chemical processes.
- To analyze equipment and processes for retrofitting and debottlenccking.
- To conduct energy audit and suggest strategies for its conservation.
- To incorporate effective measures for environmental protection and sustainability into chemical process design.
- To participate in laboratory scale process development and scale up or scale down of processes.
- To communicate effectively in both verbal and written forms.
- To adapt to changing scenario and circumstances, with self confidence.
- To succeed in competitive examinations like GATE, UPSC

PROGRAM EDUCATIONAL OBJECTIVES

The Department of Chemical Engineering offers B.Tech (Chemical Engineering) program with the following objectives of enabling its graduates.

- To seek career as Chemical engineers in traditional Chemical industries and also in areas of manufacture of newer materials, pharmaceuticals and biological, environmental remediation and development of renewable energy sources.

- To pursue higher qualification in Chemical Engineering or a related discipline, with a view to become a researcher or an academician.

- To be able to synthesize a chemical process from simple and even complex chemistry and to translate any chemical process from conceptual to commercial stage.

- To possess good breadth in scientific and engineering knowledge so as to understand, analyze and to offer novel solutions to problems arising in today's rapidly changing increasingly technological global society.

- To be socially conscious chemical engineers through their sensitivity towards impact on environment, energy, security and sustainability.

DEPARTMENT OF CHEMICAL ENGINEERING
SRI VENKATESWARA UNIVERSITY COLLEGE OF ENGINEERING
R-20- Scheme of Instruction effective from the academic year 2020-2021

I-Semester (First Year)

Course Code	Category	Course Title	Scheme of Instruction, Hrs/Week				Credits	Scheme of Evaluation, Marks		Total Marks
			L	T	P	Total		Internal	End Sem	
MA101	Basic Sci.	Mathematics – I	3	1	-	4	4	40	60	100
CY102	Basic Sci.	Chemistry for Chemical Engg.-1	3	1	-	4	4	40	60	100
EN103	Humanities	English	2	-	-	2	2	40	60	100
EE104	Basic Engg.	Basic Electrical and Electronics Engineering	3	1	-	4	4	40	60	100
ME105	Basic Engg.	Engineering Graphics and Design	2	-	3	3	3.5	40	60	100
EN106	Humanities Lab	English Communication Lab	-	-	3	3	1.5	40	60	100
		TOTAL	**13**	**3**	**6**	**2**	**19**	**360**	**640**	**1000**

DEPARTMENT OF CHEMICAL ENGINEERING
SRI VENKATESWARA UNIVERSITY COLLEGE OF ENGINEERING: TIRUPATI-517502

R-20 – Scheme of Instruction effective from the academic year 2020-2021
II Semester (First Year)

Course Code	Category	Course Title	Scheme of Instruction, Hrs/Week				Credits	Scheme of Evaluation, Marks		Total Marks
			L	T	P	Total		Internal	End Sem	
MA 201	Basic Sci.	Mathematics – II	3	1	-	4	4	40	60	100
PY 202	Basic Sci.	Engineering Physics	3	1	-	4	4	40	60	100
CS 203	Basic Engg.	Program for Problem Solving	2	1	-	3	3	40	60	100
CY 204	Basic Sci.	Chemistry for Chemical Engg.-II	3	1	-	4	4	40	60	100
ME 205	Basic Engg. Lab	Workshop/Manufacturing Practices	-	0	3	3	1.5	40	60	100
CS 206	Basic Engg. Lab	Program for Problem Solving Lab	-	0	3	3	1.5	40	60	100
CE 207	Audit	Environmental Science	4	0	-	4	0	40	60	100
		TOTAL	**15**	**4**	**6**	**25**	**18**	**360**	**540**	**900**

I Semester **MA101MATHEMATICS –I**

(I Semester-Common for all branches)

Instruction:3(L) +1(T) /week **Credits:4**
Assessment:40+60 UNIT I

Differential Equations: Linear differential equations of second and higher order with constant coefficients-particular integrals-homogeneous differential equations with variable coefficients- method of parameters-simulation equations.

UNIT II

Laplace Transforms I: Laplace transforms of standard functions-inverse transforms-transforms of derivatives and integrals-derivatives of transforms-integrals of transforms.

UNIT III

Laplace Transforms II: Transforms of periodic functions-convolution theorem-applications to solution of ordinary differential equations.

UNIT IV

Calculus: Roll's and Mean value theorems - Taylor's and Maclaurins's series-maxima and minima for functions of two variables - Infinite series - Convergence Tests series of positive terms - comparison, Ratio tests - Alternating series - Leibnitz's rule - Absolute and conditional convergence.

UNIT V

Multiple Integrals: Curve tracing (both Cartesian and polar coordinate) - Evaluations of double and Triple integrals-change of order of integrations-change of variables of integrations-simple applications to areas and volumes.

Text/Reference Books

1. BS Grewal ,Higher Engineering Mathematics, 40thEdition, Khanna Publications, 2007.
2. MK Venkataraman, Engineering Mathematics, National Publishing Company, Chennai.
3. BV Ramana, Higher Engineering Mathematics, 6th Reprint, Tata McGraw-Hill, 2008.
4. Bali and Iyengar, Engineering Mathematics, 6thEdition, Laxmi Publications, 2006.

Course Outcomes: At the end of the course,students will be able to

1. Analyze differential equations and solve them
2. Apply differential equations to engineering problems.
3. Use transformation to convert one type into another type presumablyeasierto solve.
4. Use shift theorems to compute the Laplac etransform, inverse Laplace transform and the solutions of second order, linear equations with constant coefficients.
5. Solve an initial value problem for an nth order ordinary differential equation using the Laplace transform.
6. Expand functions as power series using Maclaurin's and Talor's series.
7. Optimize the problems related to OR, Computer science, Probability and Statistics.
8. Draw an approximate shape by the study of some of its important characteristics such as

symmetry, tangents, regions enclosing curve tracing method to find length, area, volume.

9. Use multiple integral in evaluating area and volume of any region bounded by the given curves.

Mapping of Course Outcomes with Program Outcomes:

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

I & II Semesters CY101/CY202 ENGINEERING CHEMISTRY

(I Semester-CY101 for Civil & Mechanical Engg)

(II Semester -CY 202 for EEE, ECE & CSE)

Instruction:3(L) +1(T) /week Credits: 4 Assessment:40+60

UNIT I

Atomic and molecular structure (12lectures)

Postulates of quantum chemistry. Schrodinger equation. Particle in a box solutions, Molecular orbitals of diatomic molecules and plots of the multicenter orbitals, Equations for atomic and molecular orbitals, Energy level diagrams of diatomics, Pi-molecular orbitals of butadiene and benzene. Band structure of solids and the role of doping on band structures

UNIT II

Spectroscopic techniques and applications

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclearmagnetic resonance and magnetic resonance imaging, surface characterization techniques.

UNIT III

Chemical equilibria, Intermolecular forces and potential energy surfaces

Use of free energy in Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications.

Use of free energy considerations in metallurgy through Ellingham diagram. Equations of state of real gases and critical phenomena.

UNIT IV

Periodic properties

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atomsin the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular

geometries, Born- Haber cycle, The use of reduction potentials, Properties of ionic and covalent compounds.

UNIT V

Stereochemistry, **Organic reactions and synthesis of a drug molecule**

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, opticalactivity, absolute configurations and conformational analysis. Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings Synthesis of a commonly used drug molecule.

Reference/Textbooks

1. University chemistry, by B.H. Mahan
2. Chemistry: Principles and Applications, by M.J.Sienko and R.A.Plane 3.Fundamentals of Molecular Spectroscopy, by C. N. Banwell
4. Engineering Chemistry (NPTELWeb-book), by B.L.Tembe, Kamaluddin and M.S.Krishnan
5. Physical Chemistry by P.W.Atkins
6. Organic Chemistry: Structure and Function by K.P.C.Volhardt and N. E.Schore,5thEd.
7. Principles of physical chemistry, Puri, Sharma and Pattania

Course Outcomes: At the end of the course, students will be able to

1. Analyze microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.
2. Rationalize bulkproperties and processes using thermodynamic considerations.
3. Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
4. Rationalize periodic properties such as ionization potential, electronegativity, oxidationstates and electronegativity.
5. List major chemical reactions that are used in the synthesis of molecules.

Mapping of Course Outcomes with Program Outcomes:

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

I & II Semesters **EN103/EN203ENGLISH**

(I Semester - EN 103forChE,CE& ME)

(IISemester-EN203forEEE,ECE&CSE)

Instruction:2(L) **Credits: 2**

Assessment:40+60 UNIT I Ocabulary

Building

The concept of Word Formation- Root words from foreign languages and their use in English- Acquaintance with prefixes and suffixes from foreign languages in English form derivatives- Synonyms, antonyms, and standard abbreviations.

UNIT II Basic Writing Skills

Sentence Structures – Use of phrases and clauses in sentences –Importance of proper punctuation - Creating coherence – Organizing principles of paragraphs in documents -Techniques for writing precisely

UNIT III Identifying Common Errors in Writing

Subject-verb agreement -Noun-pronoun agreement -Misplaced modifiers -Article -Prepositions -Redundancies -Clichés

UNIT IV Nature and Style of sensible Writing

Describing - Defining - Classifying –Providing examples or evidence –Writing introduction and conclusion

UNIT V Writing Practices

Comprehension-Précis Writing–Essay Writing

Reference/Textbooks:

1. Practical English Usage. MichaelSwan. OUP.1995.
2. Remedial English Grammar. F.T.Wood. Macmillan.2007
3. OnWriting Well.William Zinsser. Harper Resource Book.2001
4. Study Writing. LizHamp-Lyons and BenHeasly. Cambridge University Press.2006.
5. Communication Skills. Sanjay Kumar and Pushpalata. Oxford University Press.2011.
6. Exercises in Spoken English. Parts.I-III. CIEFL, Hyderabad. Oxford University Press

Course Outcomes: At the end of the course, students will be able to

1. Learn the elements of grammar and composition of English Language.
2. Learn literary texts such as Short stories and prose passages.
3. Maintain linguistic competence through training in vocabulary, sentence structures and pronunciation.
4. Develop communication skills by cultivating the habit of reading comprehension passages.
5. Develop the language skills like listening, speaking, reading and writing.

Make use of self-instructed learner friendly modes of language learning through competence

Mapping of Course Outcomes with Program Outcomes:

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

CO4			2	2	3							
CO5		1	1	2								

I Semester **EE104 BASIC ELECTRICAL AND ELECTRONICS ENGG.**

(I Semester–for ChE, CE & ME)

Instruction:3(L) +1(T) /week **Credits: 4**
Assessment:40+60 UNIT-I

Electric DC Circuits: Kirchhoff's Voltage & Current laws, Superposition Theorem, Star –Delta Transformations.

AC Circuits: Complex representation of Impedance, Phasor diagrams, Power & PowerFactor, Solution of Single Phase Series & Parallel Circuits. Solution of Three Phase circuits and Measurement of Power in Three Phase circuits.

UNIT-II

Single Phase Transformers: Principle of Operation of a Single phase Transformer, EMFequation, regulation and Efficiency of a single phase transformer.

DCMachines: Principle of Operation, Classification, EMF and Torque equations, Characteristics of Generators and Motors

UNIT-III

Three Phase Induction Motor: Principle of Rotating Magnetic Field, Principle of Operation of 3- φI.M., Torque-Speed Characteristics of 3-φ I.M.

UNIT-IV

P-N junction operation, diode applications, Zenerdiodeas regulator.

Transistor and applications: Introduction to transistors, BJT Characteristics, biasing and applications

UNIT-V

Integrated Circuits: Operational amplifiers, Applications: adder, subtractor, Integrator and Differentiator.

Digital Circuits: logic gates, Combinational Logic circuits, Flip-Flops, counters and shift registers, Laboratory measuring instruments: digital multi-meters and Cathode Ray Oscilloscopes (CRO's).

Textbooks:

1. Electrical Technology by Edward Hughes
2. Basic Electrical Engineering by Nagrath and Kothari

Course Outcomes: At the end of the course, students will be able to

1. Understand the basic concepts of D.C.single phase and 3-phase supply and circuits and solve basic electrical circuit problems
2. Understand the basic concepts of transformers and motors used as various industrial drives

3. Understand the concept of powerfactor improvement for industrial installations and concepts of most economical power factor
4. Understand the operation and characteristics of diodes, transistors, integrated circuits and digital circuits.

Mapping of Course Outcomes with Program Outcomes:

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

I & II Semesters

ME105/ME205 ENGINEERING GRAPHICS AND DESIGN

(I Semester - ME105 for ChE, CE & ME)
(II Semester-ME205 for EEE, ECE & CSE)

Instruction: 2(L) +3 (Drg) /week **Credits: 3.5**

Assessment:40+60 UNIT I Introduction to Engineering Drawing

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epi-cycloid, Hypo- cycloid and Involutes.

UNIT II

Scales- Scales–construction of Plain & Diagonal Scales.
Projections of points, lines- Projections of Points and lines inclined to both planes, including traces;

UNIT III

Projections of planes

Projections of planes (Regular surfaces only) inclined Planes-Auxiliary Planes

Question Paper Modular– 4questionsfrom Units I t0 IV, 15 marks each

Projections of Regular Solids (Simple solids–cylinder, cone, prism& pyramid) those inclined to both the Planes-Auxiliary Views

UNIT IV

Isometric Projections & Orthographic projections

Principles of Ortho graphic Projections-Conventions Draw simple objects, dimensioning and scale. Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions.

UNIT V Introduction to CAD

CAD workstation and peripherals, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars Standard, Object Properties, Draw, Modify and Dimension, Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom used in CAD, Select and erase objects.;

Text/Reference Books:

1. Bhatt N.D., Panchal V.M. &Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
2. Shah, M.B. & Rana B.C.(2008), Engineering Drawing and Computer Graphics, Pearson Education.
3. Agrawal B. & Agrawal C.M.(2012), Engineering Graphics, TMH Publication
4. Narayana, K.L. & P Kannaiah (2008), Textbook on Engineering Drawing, Scitech Publishers
5. Corresponding set of) CAD Software Theory and User Manuals

Course Outcomes: At the end of the course, the student will be able to

1. Make adistinction between first angle projection and third angle projection of drawing.
2 draw hyperbola, parabola, Involutes and Cycloidal curves.
3. Draw sections of solids including cylinders, cones, prisms and pyramids.
4. Draw projections of lines, planes, solids and sections of solids.
   Draw orthographic projections of lines, planes, and solids.

Mapping of Course Outcomes with Program Outcomes:

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

I & II Semesters EN106/EN206 ENGLISH COMMUNICATION LAB

(I Semester - EN 106 for ChE, CE & ME)

(II Semester-EN 206 for EEE, ECE & CSE)

Instruction:0(L)+3(Lab)/week Credits:1.5 Assessment:40+60

Listening Comprehension -Pronunciation, Intonation, Stress and Rhythm -Common Everyday Situations: Conversations and Dialogues -Communication at Workplace -Interviews -Formal Presentations

Reference/Text Books:

1. Practical English Usage. Michael Swan. OUP.1995.
2. Remedial English Grammar. F.T.Wood. Macmillan.2007
3. On Writing Well. William Zinsser. Harper Resource Book. 2001
4. StudyWriting.LizHamp–LyonsandBenHeasly.CambridgeUniv.Press.2006
5. Communication Skills. Sanjay Kumar and Pushpalata. Oxford Univ. Press.2011
6.ExercisesinSpokenEnglish.PartsI-III.CIEFL,Hyderabad.OxfordUniv.Press

Course Outcomes:

The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

Mapping of Course Outcomes with Program Outcomes:

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

II Semester MA201MATHEMATICS II

(II Semester-for all branches)

Instruction:3(L) +1(T) /week Credits: 4 Assessment:40+60

UNIT I

Matrices: rank of a matrix-solution of system of linear equations-Eigen values, vectors –Canley-Hamilton theorem-quadratic forms-diagonalization.

UNIT II

Vector Calculus: Gradient, Divergence, Curl of a vector and related properties-line, surface, volume integrals- Green's, Stokes's and Gauss Divergence theorems and its applications.

UNIT III

Fourier Series: Fourier series-even and odd functions, periodic functions-half range sine and cosine series-harmonic analysis.

UNIT IV

Special Functions I: Gamma and Beta functions-series solutions of differential equations-ordinary points.

UNIT V

Special Functions II: Bessel function-recurrence formulae-generating function for $J_n(X)$-Lengender polynomials-recurrence formulae-generating function for $P_n(X)$ - Rodriguez's formula - orthogonality of Lengender polynomials.

Text/Reference Books

1. B.S Grewal, Higher Engineering Mathematics, 40thEdition, Khanna Publications, 2007.
2. M.K .Venkataraman, Engineering Mathematics, National Publishing Company, Chennai.
3. BV Ramana, Higher Engineering Mathematics, 6thReprint, Tata McGraw-Hill, 2008.
4. Bali and Iyengar, Engineering Mathematics, 6thEdition, Laxmi Publications, 2006.

Course Outcomes: At the end of the course, students will be able to

1. Use ranks of matrices to decide whether the system of linear equations is consistent or not
2. Use Cayley – Hamilton theorem to find inverses or powers of matrices.
3. Use Eigen values and vectors to reduce Quadratic forms to normal form.
4. to analyze motion problems from real lines to curves and surfaces in 3-D and use tools such as divergence and curl of vector and gradient, directional derivatives that play significant roles in many applications.
5. Use Green's theorem to evaluate line integrals along simple closed contours on the plane
6. Use Stokes' theorem to give a physical interpretation of the curl of a vector field
7. Use the divergence theorem to give a physical interpretation of the divergence of a

vector field.

8. Find the Fourier series to represent a function as a series of constants times sine and cosine functions of different frequencies in order to observe periodic phenomenon.
9. Evaluate certain improper integrals to make them simple with introduction of Gamma and Beta functions.
10. study certain special functions that arise in solving certain ordinary differential equations to model many physical phenomena.

Mapping of Course Outcomes with Program Outcomes:

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

II Semester **PY202 ENGINEERING PHYSICS**

(II Semester-for ChE, CE & ME)

Instruction:3(L) +1(T) /week **Credits: 4** **Assessment:40+60**

UNIT I

Wave Optics

Interference: Huygen`s Principle-Principle of Superposition-Interference of Light-Young`s double slit experiment- -Newton's Rings.

Diffraction: Fraunhofer Diffraction at a Single Slit and a Circular Aperture –Plane Diffraction grating –Resolving Power-Rayleigh`s Criterion-Resolving power of Grating and Microscope.

Lasers : Introduction – Spontaneous and Stimulated Emission of Radiation – Population Inversion – Types of Lasers – Ruby Laser – He-Ne Laser – Semiconductor Laser – Applications of Lasers.

UNIT II

Mechanics of Rigid Body

Rigid Body-Rotational Motion and Kinematics Relations-Kinetic Energy and Angular Momentum of a Rotating Body-Equation of Motion of a Rigid body (Torque of a Rigid Body)-Combined Translation and Rotational Motion of a Rigid Body- Body Rolling on an inclined Plane.

Mechanics of Continuous Media

Elasticity, Stress and Strain- Hook`s Law and Behavior of Wire Under Load- Elastic Constants- Relation Between Elastic Modulii-Types of Supports, Beams and Loads-Different types of Bending- Cantilever with an End Load. Ultrasonic Waves - Sound Absorption and Reverberation -Sabine Formula - Acoustics of Buildings.

UNIT III

Electromagnetism and magnetic properties of Materials

Laws of Electro statistics- Electric Current- Laws of Magnetism- Ampere`s, Faraday`s laws- Max wells Equations – Polarization - Permeability and dielectric constant- Polar and non-polar Dielectrics, Clausius-Mossotti equation, Applications of Dielectrics.

Magnetization - Permeability and Susceptibility- Classification of Magnetic Materials, Ferromagnetism-Magnetic Domains and Hysteresis, Applications of ferromagnetic materials.

UNIT IV

Quantum Mechanics

Wave – Particle duality – de Broglie Concept of Matter Waves – Properties of Matter Waves – Davison and Germer Experiment –G.P.Thomson Experiment –Heisenberg's Uncertainty Principle– Schrödinger's Time Independent and Time Dependent Wave equation–Significance of Wave

Function –Electron in an Infinite Square Potential Well–Probability Densities and Energy Levels.

UNIT V

Nano Physics and Nanotechnology

Introduction to Nanomaterials –Properties: Optical Properties – Quantum Confinement – Electrical properties. Synthesis of Nanomaterials: Ball milling, Arc deposition method – Chemical Vapor Deposition-Pulsed laser deposition. Characteristics of C^{60} (Zero dimensional), Carbon Nano tubes (One Dimensional) and Graphene (Two Dimensional). Applications of Nano materials.

Text Books /Reference Books:

1. R.K.Gaur andS.L.Gupta``Engineering Physics"Sultan and Chand Pub., New Delhi
2. S.L. Gupta and Sanjeev Gupta`Unified Physics`Vol. I JaiPrakash Nath& Co., Meerut.
3. Hitendra K.Malik andA.K.Singh``Engineering Physics"Tata MC Graw Hill Education Pvt.Ltd., New Delhi
4. M.N.Avadhanulu and P.G.Kshirsagar``A Text book of Engineering Physics``S.Chandand Company Pvt.Ltd., New Delhi
5. B.LTheraja,"Modern physics",S.Chand& Company.
6. V.Raghavan "Material Science",Tata Mc Graw Hill Publications.
7. M.S.RamachandraRao and Shubra Singh,``Nanoscience and Nanotechnology`` Wiley India Pvt.Ltd, New Delhi

Course Outcomes: At the end of the course, students will be able to

1. Develop appropriate competence and working knowledge of laws of modern Physics in understanding advanced technical engineering courses
2. understand the quantum mechanics and ultimately the quantum behavior of charged particles when they are in motion.
3. identify and apply appropriate analytical and mathematical tools of Physics in solving Engineering problems
4. apply the basic principles of Mechanics of rigid body and continuous media and their applications understand the principles in electrostatics and electromagnetic and magnetic properties of materials.
5. Understand size depended properties of Nano-dimensional materials and their effective utilization in making Nano- and micro-devices for further microminiaturization of electronic devices.
6. Think and participate deeply, creatively, and analytically in emerging areas of engineering technology.
7. Learn the basics of instrumentation, design of laboratory techniques, measurement, data acquisition, interpretation, and analysis.
8. Provide multidisciplinary experiences throughout the curriculum.

OUTCOMES WITH PROGRAM OUTCOMES:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3									2		
CO 2	2									3		
CO 3	1			3								
CO 4		3								3		
CO 5					2							3

I & II Semesters

CS103/CS203 PROGRAMMING FOR PROBLEM SOLVING
(I Semester–CS103 for EEE, ECE & CSE)
(II Semester –CS 203 for ChE, CE & ME)

Instruction:3(L) +1(T) /week Credits: 4 Assessment:40+60

Course Objectives:

1. To acquire problem solving skills
2. To be able to develop flowcharts and algorithms for the given problem
3. To learn how to write modular programs in C
4. To enable to use arrays, pointers, strings and structures in solving problems.
5. To explain the difference between object-oriented programming and procedural programming.
6. To understand principles of object-oriented programming.

UNIT-I

Problem Solving : Problem solving techniques, Computer as a problem solving tool, Programming Languages – Machine Language, Assembly Language, Low and High-Level Languages, Procedural and Object-Oriented Languages. Algorithm definition, Features, Criteria, Flowchart definition, Basic symbols, Sample flowcharts, Problem solving aspects, Efficiency of algorithms.

Basics of C: Structure of a C program, C tokens, Keywords, Identifiers, Basic data types and sizes, Constants, Variables, Operators in C, Operator Precedence and Associativity, Expressions, Type conversions, Basic input/output statement, Sample programs.

UNIT-II

Conditional Statements: Selection statements, Decision making within a program, Simple if statement, if-else statement, Nested if-else, if-else ladder and switch-case. Iterative statements: while-loop, do-while loop, for loop, Nested loops, Infinite loops, go to, break and continue statements, Sample programs.

Functions: Introduction to modular programming and functions, Basics, Standard Library of C functions, Prototype of a function, Parameter passing, User defined functions, Recursive functions, Passing arguments to a function: Call by reference, Call by value, Storage Classes in a single source file, Scope rules, Header files, C Pre-processor.

UNIT-III

Arrays: Introduction to arrays, Definition, Declaration, Storing elements, Accessing elements, One dimensional arrays: Array manipulation; Searching, Insertion, Deletion of an element from an array, Two dimensional arrays, Addition/Multiplication of two matrices, Transpose of a square matrix, Passing array to functions, String fundamentals, String manipulations, Standard library string functions.

Pointers: Definition of pointer, pointer type declaration, pointer assignment, pointer initialization, Pointer arithmetic, Functions and Pointers, Dangling memory, Character pointers and functions, Pointers to pointers, Arrays and Pointers, Pointer arrays, Pointers and structures, Dynamic memory management functions.

UNIT-IV

Structures: Structures declaration, Structure variables, Initialization of structures, Accessing structures, Nested structures, Arrays of structures, Structures containing arrays, Structures and functions, Pointers to structures, Self-referential structures, Unions, Type def, Bit-fields.

File Processing: Concept of Files, Text files and binary files, File opening in various modes and closing of a file, Reading from a file, Writing onto a file.

UNITV

Introduction to Object-Oriented Programming (OOP): Need for OOP, Principles of OOP, Basics of C++ Programming, Operator Overloading, Function Overloading, Inheritance: Derived classes, Protected access specifier, Derived class constructors, Overriding member functions, Class hierarchies, Public and Private inheritance, Multiple inheritance.

Course Outcomes: At the end of the course, student will be able to

1. Develop and test programs in C and correct syntax and logical errors.
2. Implement conditional branching, iteration and recursion.
3. Decompose a problem into functions and synthesize a complete program.
4. Use arrays, pointers, strings and structures to formulate algorithms and programs
5. Use files to perform read and write operations.
6. Handle programming assignments based on class, abstraction, encapsulation, overloading and inheritance.

TextBooks

1. Ashok N Kamthane, Amit Ashok Kamthane, Programming in C, 3rdEdition,Pearson Education, 2019.
2. ScheldtH, C: The Complete Reference, 4thEdition, Tata McGraw-Hill,2002.
3. R.G.Dromey, How to solve it by Computer, Pearson Education, 2019.
4. Hanly J R & Koffman E.B, “Problem Solving and Program design in C”, Pearson Education, 2019.
5. Herbert Schildt, The Complete Reference C++, 4thEdition, Tata McGraw-Hill.

Reference Books

1. C Programming-A Problem Solving Approach, Forouzan, Gilberg, Cengage.
2. Programming with C, Bichkar, Universities Press.
3. Programming in C, Reema Thareja, OXFORD.
4. C by Example, NoelKalicharan, Cambridge.
5. The C++ Programming Language, B jarneStroustrup, 3rdEdition, PearsonEducation.
6. Problem solving with C++: The Object of Programming, 9th Edition, Walter Savitch, Pearson Education.

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	2	1		3			2			2		2
CO 2	2	3	2		3					2		
CO 3		2	1								3	
CO 4		3										
CO 5			3									

I & II Semesters CE104/CE204 ENGINEERING MECHANICS

(I Semester –CE 104 for EEE) (IISemester–CE204forCE&ME)

Instruction:3(L)+1(T)/week Credits:4 Assessment:40+60

UNIT I

STATICS: Basic concepts – System of force, Concurrent and non-concurrent coplanar and non-coplanar forces – Resultant – Moment of force and its application – Couples and resultant of force systems – Equilibrium of systems of forces – Free body diagrams, Equations of equilibrium of coplanar systems and spatial systems.

UNIT II

Analysis of plane trusses: Types of supports – Types of trusses – Analysis of trusses using method of joints and method of sections.

UNIT III

CENTRE OF GRAVITY AND MOMENTS OF INERTIA: Theory of Pappus – Centroids of composite figures – Areas of gravity of bodies – Moment of inertia – Parallel and perpendicular axis theorems – Moments of inertia of composite areas (rolled and built up sections) – Radius of gyration of areas.

UNIT IV

SIMPLE STRESES AND STRAINS: Elasticity and plasticity – Types of stresses and strains – Hooke's law – Stress-strain diagram for mild steel – Working stress – Factor of safety.

Lateral strain – Poisson's ratio and volumetric strain – Elastic moduli and relationship between elastic constants – Bars of varying section – Composite bars – Temperature stresses.

UNIT V

STRAIN ENERGY: Gradual, sudden and impact loading – Endurance limit principles of virtual work and its applications.

TEXTBOOKS:

1. Ghose D.N.–Applied Mechanics and Strength of Materials.
2. Timoshenko &Young–Engineering Mechanics.
3. Junarkar SB–Mechanics of Structures–Vol. I.
4. Junarkar SB–Elements of Applied Mechanics.

Course Outcomes: At the end of the course, student will be able to

1. Apply the basic knowledge of force system.
2. Know the types of supports occur in civil engineering structures
3. Know the geometrical properties of different cross sections.
4. Understand different types of stresses and strains, elastic constants.
5. Understand the behavior of different internal forces under different types of loading.

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO 1		3										
CO 2		3										
CO 3		3							2			1
CO 4									3			1
CO 5			3						1			

I & II Semesters ME105/ME205 WORKSHOP/MANUFACTURING PRACTICE

(ME105 for EEE, ECE & CSE) (ME 205 for ChE, CE & ME)

Instruction:0(L) +3 (lab)/week Credits: 1.5 Assessment:40+60

Workshop Practice: Five practices among

1.Machineshop 2.Fittingshop 3.Carpentry 4.Electricalwiring
5. Welding shop 6.Casting 7.Smithy 8.Plasticmoulding&GlassCutting

Examinations could involve the actual fabrication of simple components, utilizing one or More of the techniques covered above.

Detailed Contents

1. Manufacturing Methods-casting, forming, machining, joining, advanced manufacturing methods
2. CNC machining, Additive manufacturing
3. Fitting operations & power tools.
4. Electrical & Electronics
5. Carpentry
6. Plastic moulding. Glass cutting
7. Metal casting.
8. Welding (arc welding & gas welding), brazing

The above course content is learnt by online videos/ppt presentations.

Text/Reference Books:

1. Hajra ChoudhuryS.K., Hajra ChoudhuryA.K. and NirjharRoyS.K.,Elements of Workshop Technology", Vol. I 2008and Vol. II 2010, Media promoters and Publishers private limited, Mumbai.
2. KalpakjianS.and StevenS.Schmid Manufacturing Engineering andTechnology", 4th edition, Pearson Education India Edition, 2002.
3. GowriP. Hariharan and A.SureshBabu, Manufacturing Technology–I"Pearson Education,2008.
4. RoyA.Lindberg, Processes and Materials of Manufacture",4 th edition, PrenticeHall India,1998.

5. Rao P.N.,“ManufacturingTechnology”,Vol.I&II,Tata Mc Graw Hill House,2017

Laboratory Outcomes

- Upon completion of this laboratory course, students will be able to fabricate components with their own hands.
- They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
- By assembling different components, they will be able to produce small devices of their interest.

Course Outcomes : Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry to fabricate components using different materials.

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2		3									2
CO 2	2		3									
CO 3	2		3									
CO 4	2		3									
CO 5	2		3									

I & II Semesters CS106/CS206 PROGRAMMING FOR PROBLEM SOLVING LAB

(CS106 for EEE, ECE & CSE) (CS 206 for ChE, CE & ME)

Instruction: 0(L)+3(Lab))/week Credits: 1.5 Assessment:40+60

Course Objectives:

1. To provide exposure to problem-solving through programming
2. To train the student on the concepts of the C-Programming language

The following programs shall be developed and executed in Programming Language C.

1. Programs on conditional control constructs.
2. Programs on iterative statements (while, do-while, for).
3. Programs on recursive procedures
4. Programs on arrays, matrices(single and multi-dimensional arrays).
5. Programs using user defined functions, demonstrating parameter passing methods viz. callby value and call by reference.
6. Programs using different library functions viz. c type.h, math.h, stdio.h, stdlib.h, string.h, conio.h and pre-processor directives.
7. Programs using pointers (int pointers, char pointers)and pointer arrays.
8. Programs on structures and unions
9. Programs on File Processing.
10. Programs on Pointers to structures and Self-referential structures

Course Outcomes: After Completion of this course the student would be able to

1. Develop the C code for the given algorithm.
2. Understand, debug and trace the execution of programs written in C language.

Reference Books:

1. ScheldtH,C:The Complete Reference, 4thEdition, Tata McGraw-Hill,2002.
2. HanlyJR &KoffmanE.B,"ProblemSolving and Program design in C",Pearson Education,2019.
3. R.G.Dromey, How to solve it by Computer, Pearson Education, 2019.
4. BehrouzA .Forouzan&RichardF.Gilberg, Computer Science: A Structured Programming Approach Using C, Third Edition, Cengage Learning

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	2	3										
CO 2	2		3									
CO 3	2	3	2									
CO 4	2		3									
CO 5	2	3										

CE107/CE207 ENVIRONMENTAL SCIENCE *Audit Course*

(CE107 for EEE, ECE & CSE) *No Univ.Exam* (CE207 for ChE, CE & ME)

Instruction:4(L) Credits: 0(Zero) ssessment:40+60

UNIT I

Environmental Studies and Natural Resources

Definition, Scope and importance of Environment, Environmental studies, Need for public awareness

Components of Environment-Atmosphere, Hydrosphere, Lithosphere.

Renewable and **Non-Renewable Resources and associated problems**

Water resources: Use and over utilization of surface and groundwater, floods, drought, conflicts over water, dam benefits and problems.

Forest resources: Use and over exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.

Land resources: Land as a resource, land degradation, Man induced landslides, soil erosion and desertification.

Mineral resources: Use and overexploitation, Environmental effects of extracting and using mineral resources, case studies.

Food resources: World food problems, changes caused agriculture and overgrazing, effects of modern agriculture, fertilizer – pesticide problems, water logging, salinity, Case studies.

Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies.

Role of an individual in conservation of natural resources.

UNIT II

Ecosystem and Biodiversity

Ecosystem - Concept of an ecosystem, Structure and functions of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids.

Introduction, types, characteristic features, structure and function of the following ecosystem.

(a) Forest ecosystem. (b) Grassland ecosystem

(c) Desert ecosystem. (d) Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and its conservation:

Definition, genetic species and ecosystem diversity, Biogeographically classification of India.

Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation.

Hot-spots of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man – wildlife conflicts, Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

UNIT–III

Environmental pollution and Global Effects

Definition, Causes, Effects, and control measures of (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards
Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.
Pollution case studies.

Disaster management: Floods, earthquakes, cyclone, landslides, Tsunami. Climate change- Global warming, Acid rain, Ozone depletion.

UNIT–IV

Environment Issues and Management

- Environment and Human health – Epidemic diseases, HIV/AIDS, Aviation Flue, Water Borne Diseases.
- Environmental Impact Assessment, Sustainable Development, Clean Production and Clean Development Mechanisms
- Environment Legislation: Environmental Protection Act, Water Act, Air Act, Wild Life Protection Act, Forest Conservation Act, Public Liability & Insurance Act, Issues involved in Enforcement of Environmental legislation.

UNIT–V

Social Issues and the Environment

- Population growth, Population Explosion, Population Control, Women and Child welfare.
- Urbanization, Industrialization, Development projects, Resettlement and Rehabilitation of people – Problems concerned, Case studies.
- Consumerism and Waste Products Conservation, Public Awareness, Water Conservation, Rain water harvesting, water shed management, Waste land reclamation, Human Rights, Value education, Environmental ethics- Issues and possible solution.
- Role of information Technology in Environment and Human Health.

Text Books /Reference Books:

1. Anubha Kaushik & CP Kaushik, Environmental studies, New age International Publishers, 2008
2. BennyJoseph, Environmental studies, Tata McGraw-HillPublishers,2005
3. M Chandra Sekhar, Environmental Scie nce, Hi-Tech Publishers, 2004
4. Keerthinarayana and Daniel Yesudian, Principles of Environmental Sciences and Engineering , Hi-Tech Publishers, 2005
5. AmalK.Datta, Introduction to Environmental Science and Engineering, Oxford & IBH Publishing Co. Pvt. Ltd, 2000
6. SanthoshkumarGarg, RajeshawriGarg and RajniGarg, Ecological and Environmental studies, Khanna publishers, 2006
7. GilbertM, Introduction to Environmental Engineering and Science, Masters Publication by Prentice –Hall of India Private Ltd., 1991
8. William PCunningham and MaryAnn Cunningham, Principles of Environmental Science,Tata McGraw Hill Publishing Co.Ltd, 2002

Course Outcomes:

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

1. Acquire knowledge in
    - Diverse components of environment and natural resources
    - Ecosystem and biodiversity & its conservation methods
    - Population growth and human health
    - Green technology
2. Identify and resolve the issues related to sources of different types of pollutions
3. Provide solutions to individuals, industries and government for sustainable development of natural resources
4. Apply environmental ethics in protection of diversified ecosystems.

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MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2						3					2
CO 2	3						2					1
CO 3	1						3					
CO 4							3					
CO 5	2						2					

B. Tech. III semester Chemical Engineering

MA 301 B **MATHEMATICS – III** III semester

Instruction Hours/Week: 3(L) Credits: 3 Assessment : 40 + 60

Course Objectives:

1. This course aims at providing the student to acquire the knowledge on the calculus of functions of complex variables.
2. To understand power series and expansion of analytic function.
3. To understand Laurent Series, poles, singular points, Residue theorem and its applications.
4. The aim is to analyze the solutions of partial differential equations.
5. To discuss the boundary value problems, one dimensional wave equation, heat equation and Laplace Equation.

UNIT - I

Complex analysis - I: Analytical functions - Cauchy-Reimann equations – Construction of Analytic functions- Complex integration - Cauchy's theorem - Integral formula - Evaluation of integrals.

UNIT - II

Complex analysis - II**:** Taylor's and Laurents' series- Transformations- Conformal mapping - Bilinear transformations - Transformation of 1/z, z^2, sin z and cos z.

UNIT - III

Complex Analysis –III: Singularities - Poles - Residues - Residue theorem – Contour integration- Evaluation of real integrals

UNIT - IV

Partial differential equations - I : Formation of differential equations - Classification - First order linear partial differential equations – Legranges' linear equation - Method of multipliers - first order non-linear partial differential equations - Charpits method.

UNIT- V

Partial differential equations - II: Method of separation of variables - One dimensional wave equation - Heat equation – Laplace's equation.

Text Books:

1. Grewal B S, Higher Engineering Mathematics, 40th Edition, Khanna Publications, 2007.
2. Venkataraman M K, Engineering Mathematics, Vol. I & II, National Publishing Company, 1993.
3. Venkataraman M K, Engineering Mathematics, National Publishing Company, 1995.
4. Grewal B S, Engineering Mathematics, 13th Edition, Khanna Publications.
5. Kreyszig E, Advanced Engineering Mathematics, 8th edition, Wiley, 1998.

Course Outcomes: At the end of the course, students will be able to

a) After the completion of course, students will be able to Understand the analyticity of complex functions and conformal mappings.
b) Apply Cauchy's integral formula and Cauchy's integral theorem to evaluate improper integrals along contours.
c) Describe basic properties of complex integration and having the ability to compute such integrals.
d) Describe conformal mappings between various plane regions.
e) Apply the concepts of Complex Analysis in many branches of Engineering, including the branches of hydrodynamics, thermodynamics, and particularly quantum mechanics.
f) Compute the residue of a function and use the Residue Theory to evaluate a contour integral or an integral over the real line.
g) Formulate/solve/classify the solutions of Partial differential equations.
h) Identify linear and nonlinear PDE and solve nonlinear PDE by Charpit's method.
i) Apply Variables separable methods to solve boundary value problems.
j) Find the solution of one dimensional wave equation, heat equation and Laplace equation.

CH302E ENGINEERING AND SOLID MECHANICS III semester

Instruction Hours/Week: 3(L) Credits: 3 Assessment : 40 + 60

Objectives:

1. The course is designed to give fundamental knowledge of mechanics of deformable solids including stress, strain, stress – strain relations.
2. Theories of failure and energy methods.

Unit I :
Introduction, Point Kinematics: Moving point in various coordinate systems (Cartesian,Cylindrical, Path)

Rigid body kinematics: Translation and rotation, relative motion, angular velocity, General motion of a rigid body, General relative motion
Unit II :
Equivalent force systems, Resultant forces, Linear and Angular Momentum, Laws of motion(Euler's Axioms), Free Body Diagrams, Dynamics of point mass models of bodies. Equilibrium of rigid bodies, distributed forces, Analysis of structures: Trusses, Forces in
Unit III :
Beams: Shear Force and Bending Moment
Unit IV :
Frictional forces, Laws of Coulomb friction, impending motion
Inertia tensor, Principal Moments of Inertia, Moment of momentum relations for rigid bodies,Euler's Equations of Motion
Unit V :
State of stress at a point, equations of motion, principal stress, maximum shear stress, Concept of strain, strain displacement relations, compatibility conditions, principal strains, transformation of stress/strain tensor, state of plane stress/strain.
Uniaxial stress and strain analysis of bars, thermal stresses, Torsion of circular bars and thinwalled members, Bending of straight/curves beams, transverse shear stresses, deflection of beams, Buckling of columns

Course Outcomes (COs):

At the end of this course students will be able to

a) Learn about the elastic and plastic behavior of material and evaluate stress invariants, principal stresses and their directions.
b) Determine strain invariants, principal strains and their directions.
c) Develop constitutive relationships between stress and strain for linearly elastic solid.
d) Analyze theories of failure and design components for safe operation.
e) Examine the properties of ideally plastic solid and apply the concepts of energy methods in solving structural problems.

TEXT BOOKS :

1. Engineering Mechanics, Strength of Materials and Elements of Structural Analysis – C.Venkataramaiah &A.V.NarasimhaRao

REFERENCES :

1. Strength of Materials – I.B.Prasad.
2. Strength of Materials – S.S.Bhavikatti.
3. Mechanics of Structures Vol. I --- S.B. Junnarkar
4. Strength of Materials part - I ----Stephen Timoshenko.

HS303C MANAGERIAL ECONOMICS AND ACCOUNTANCY

Instruction Hours/Week: 3(L) Credits: 3 Assessment : 40 + 60

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

CO1	Understand Macro Economic environment of the business and its impact on enterprise.
CO2	Identify various cost elements of the product and its effect on decision making.
CO3	Understand the concepts of financial management and smart investment.
CO4	Prepare the Accounting records and interpret the data for Managerial Decisions.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO 3	PO4	PO5	PO 6	PO7	PO8	PO 9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-		2	-	-
CO2	-	-	-	-	-	-	-	-	3	-	3	-
CO3	-	1	-	-	-	-	-	-	-	-	3	-
CO4	2	-	-	-	-	-	-	-	-	-	3	-

Detailed Syllabus:

UNIT -I

Introduction to Engineering Economics, Fundamental concepts, Time value of money, Cash flow and Time Diagrams, choosing between alternative investment proposals, Methods of Economic analysis (pay back, ARR,NPV,IRR and B/C ratio), The effect of borrowing on investment, Equity vs Debt Financing, concept of leverage, Income tax leverage.

UNIT -II

Depreciation and methods of calculating depreciation (straight line, sum of the years digit method, Declining balance method, Annuity method, Sinking fund method), National income accounting Methods of estimation, Various concepts of National Income, Significance of National income Estimation and its limitations.

UNIT -III

Inflation: Definition, Process and Theories of inflation and Measure of control. New Economic Policy 1991(Industrial Policy, Trade Policy, Fiscal Policy), Impact on Industry.

UNIT -IV

Accounting Principles, procedure, Double entry system, Journal, ledger, Trial balance, Cashbook, preparation of Trading and Profit and Loss account, Balance sheet.

Unit -V

Cost Accounting: Introduction, Classification of costs, Methods of costing, Techniques of costing, Cost sheet and preparation of cost sheet, Break-even Analysis, Meaning and its application, Limitation.

Reading Text Books:

1. Henry Malcom Steiner, Engineering Economics Principles, 2nd Edition, McGraw Hill Education, 1996.
2. Dewett. K.K., Modern Economic Theory, Sultan Chand and Co., 2006.
3. A.N.Agarwal, Indian Economy, Wiley Eastern Limited, New Delhi.
4. Jain and Narang, Accounting Part-I, Kalyani Publishers, 2011.
5. Arora, M.N. Cost Accounting: Principles and Practice, 12th Edition, Vikas Publication, 2012.

CH304C CHEMICAL PROCESS CALCULATIONS

Instruction Hours/Week: 3(L) Credits: 3 Assessment : 40 + 60

Course Educational Objectives:

1. To understand different representations of mixture compositions and reaction stoichiometry.
2. To understand the ideal gas law and its applications.
3. To learn the concepts of vapor pressure and different representations of vapor presence in gas mixtures.
4. To understand and to apply the law of conservation of mass.
5. To understand and to apply the law of conservation of energy.
6. To analyze combustion operations, from material and energy perspective.

UNIT – I:
Basic concepts – Units & Dimensions - Graphical integration and differentiation - use of log-log, semi-log and triangular graphs, conversion of units.

Stoichiometric and composition relations - Stoichiometric relation, basis of calculation, method of expressing composition of mixture and solutions, density and specific gravity.
Behavior of ideal gases: Ideal gas law and applications, gaseous mixtures, gases in chemical reactions.
UNIT - II:
Mass balance without chemical reaction – Formulation – Mass balance calculations for unit operations like distillation, absorption, extraction, crystallization (single solute systems), drying, evaporation
UNIT - III:
Mass balance with chemical reaction – Mass balance calculations for processes involving reactions – Mass balance calculations for systems involving recycle, purge and bypass
UNIT - IV :
Vapor pressure - Concept of vapor pressure, liquefaction and liquid state, vaporization, boiling point, effect of temperature on vapor pressure, vapor pressure plots, vapor pressure of immiscible liquids and solutions, Raoult's law and its limitations.
Humidity and saturation: Relative and percent saturation, dew point, wet and dry bulb temperatures, Humidity charts
UNIT - V:
Energy balance
Thermophysics - Concepts of energy, energy balance equation, heat capacity of gases, liquids and mixtures in energy balance problems, Kopp's rule, latent heat - heats of fusion and vaporization, Trouton's ratio, Kistyakowski equation.
Thermo chemistry - Heats of formation, combustion and reaction, Hess law, Calculation of heat of reaction from heat of formation / combustion data, Effect of temperature and pressure on heat of reaction, Adiabatic reaction temperature

fuels & combustion - Heating value, Theoretical and actual flame temperatures

TEXT BOOK:

1. Chemical Process Principles part - I, Material and Energy Balances by Hougen, O.A., Watson, K.M. and Ragatz, R.A. John Wiley and sons, 2nd ed.
2. Chemical Process Calculations - David Himmelblau

REFERENCES:

1. Stoichiometry (3 rd edition) - Bhatt and Vora , tata-McGraw-Hill Publication.
2. Elementary Principles of Chemical Process , 3 rd edition – Richard M.Felder & Ronald W.Rousseau, Wiley – Eastern
3. Process Calculations by K.V.Narayanan and Lakshmi Kutty.

Course Outcomes:

a) To understand the dimension-unit systems and their inter relationships.
b) To be able to represent mixture compositions in different forms.
c) To be able to make calculations using reaction stoichiometry.
d) To be able to apply ideal gas law equation and to calculate volume, pressure, mass temperature, as the case may be.
e) To have learnt the significance of vapor pressure and its dependence.
f) To have learnt different representations of partial saturation and to apply ideal gas law in conjunction with variation in levels of saturation.
g) To have acquired a perfect understanding of law of conservation of mass, its mathematical form and its application to different operations and reactions.
h) To have acquired a thorough understanding of law of conservation of energy.
i) To be able to make mass and energy balance calculations for different operations, with and without reaction.
j) To be able to estimate parameters like oxygen requirement, flue gas analysis, energy released and flame temperatures.

	OUTCOMES										
		a	b	c	d	e	f	g	h	i	j
OBJECTIVES	1	*	*	*							
	2				*						
	3					*					
	4		*	*	*	*	*	*	*	*	*
	5		*	*	*	*	*	*	*	*	*
	6							*	*	*	*

CH305C **MOMENTUM TRANSFER**

Instruction Hours/Week: 3(L) Credits: 3 Assessment : 40 + 60

Course Educational Objectives :

To learn dimensional analysis, fluid statics and its applications.

1. To learn dimensional analysis, fluid statics and its applications.
2. To understand the important phenomena observed in flowing fluids, basic quantitative laws and equations of fluid flow.
3. To form a firm idea of the flow of incompressible and compressible fluid flow through pipes and in thin layers.
4. To understand the flow past solid surfaces, through packed bed and in fluidized beds.
5. To learn the settling characteristics of particles through fluids.
6. To learn the working and performance of pumps and compressors, valves.
7. To understand the construction and operation of flow measuring devices.

UNIT - I:
Introduction: Units, Dimensions and Dimensional analysis, Fluid statics and its applications.
UNIT - II:
Fluid flow phenomena, kinematics, of flow, velocity field - streamlines - irrotational flow - Newton's law of viscosity - Non-Newtonian fluids - Laminar and turbulent flows,
Basic equations of fluid flow - continuity equation - Bernoulli's equation and its applications.
UNIT - III:
Flow of incompressible fluids in conduits and thin layers - Laminar and turbulent flows in pipes and closed channels - Universal velocity distribution - friction factor, effect of fittings and valves. Flow of compressible fluids - continuity equation, mechanical and total energy balances, velocity of sound, ideal gas equation, stagnant temperature.
UNIT - IV:
Flow pas immersed bodies, drag force and drag coefficient, friction in flow through bed of solids - motion of particles through fluids - free and hindered settling - Mechanism and pressure drop of fluidization and its applications - fundamental concepts of two – phase, gas liquid flow.
UNIT - V:
Transportation and metering of fluids, fluid moving machinery - classification and performance of pumps and compressors - selection and specifications - measurement of flowing fluids, storage and handling.

TEXT BOOKS:

1. Unit operations of Chemical Engineering (7th ed) Warren L.McCabe, Juliane Smith and Peter Harriott, McGraw Hill.

REFERENCES:

1. 1. Chemical Engineering Vol.I by Coulson and Richardson, Pergamon Press.
2. Solved Examples in Chemical Engineering by G.K.Roy
3. "Fluid Mechanics" 2nd edition by Noel de Nevers, Mc Graw Hill

Course Outcomes:

a) To be able to perform dimensional analysis of fluid flow problems.

b) To develop pressure drop equations for fluid static equipments in which fluid is at rest.

c) To have the knowledge on different types of flow regions in fluid flow, rheological properties of fluids, turbulence and boundary layers.

d) To be able to carry out macroscopic mass, momentum and energy balance to solve engineering problems related to fluid flow.

e) Educate about the formation and calculation of fluid friction in pipes and conduits.

f) Analyze flow past solid surface, through packed bed and in fluidized beds.

g) Determine the minimum fluidization velocity and terminal velocity of the fluid in Stokes and Newton's law regions.

h) The analysis of fluid flow measuring devices like Orifice meter, Venturimeter, Rotameter and Pitot tube.

i) The construction and working of Centrifugal and reciprocating pumps. And also give the knowledge on different types of valve, selection of pipe and fittings.

	OUTCOMES									
		a	b	C	d	e	f	g	h	i
OBJECTIVES	1	*	*							
	2		*	*	*	*				
	3			*	*	*				
	4						*	*		
	5							*		
	6									*
	7								*	

CH306C CHEMICAL ENGINEERING THERMODYNAMICS –I

Instruction Hours/Week: 3(L) Credits: 3 Assessment : 40 + 60

Course Educational Objectives:

1. To understand the concepts of energy, forms of energy, equilibrium and reversibility
2. To learn and apply the first law of thermodynamics
3. To understand the P-V-T behavior of pure fluids
4. To learn the concept of entropy and to apply second law of thermodynamics
5. To study the feasibility of processes
6. To learn thermodynamic analysis of refrigeration and different flow processes

UNIT - I:
Introduction – Scope, Dimensions and Units – Mass, mole, volume, force, temperature, pressure, work, energy, heat, internal energy.

The first law of thermodynamics, Energy balance for closed systems, Thermodynamic state and state functions, equilibrium, The phase rule, The reversible process, enthalpy, heat capacity, Mass and energy balances for open systems, Energy balances for steady state flow processes

UNIT - II:

Volumetric properties of pure substances: P-V-T behaviour, Virial expressions, The ideal gas, Applications of Virial equations , Cubic equations of state - vander walls and Redlich - Kwongg equations, Theorem of corresponding states, generalized correlation – Pitzer correlation.

UNIT - III:
Heat effects – Sensible and latent heat effects, Heats of formation , combustion and reaction, Temperature dependence, heat effects of industrial reactions .

UNIT - IV:
Second law – Statement, Heat engine, Thermodynamic Temperature scale, concept of entropy, mathematical statement of second law, Entropy changes of an ideal gas, Calculation of ideal work and lost work The Third Law of Thermodynamics

UNIT - V:

Refrigeration: The Carnot refrigerator, The vapor compression cycle, choice of refrigerant, cascade systems, absorption refrigeration, Heat pump, Liquefaction process. Thermodynamics of flow processes - Duct flow of Compressible fluids – turbines – compression process.

Production of power from heat – The steam power plant, Internal combustion engines, Jet engines

TEXT BOOK:

1. J.M.Smith , H C Van Ness and M.M.Abbott - Introduction to Chemical Engineering Thermodynamics 6 th ed. Tata McGraw-Hill Publishing Company .

REFERENCES:

1. Chemical Engineering Thermodynamics by Thomas E.Daubert
2. Chemical Engineering Thermodynamics, YVC Rao, University publications.

Course Outcomes:

a. To have learnt the fundamental ideas about energy, equilibrium and reversibility.
b. To be able to apply first law to estimate heat and work effects in closed, open and flow systems.
c. To understand PV and PT phase diagrams, ideal gas law and its applications.
d. To be able to estimate heat and work effects for different processes – isothermal, isobaric, isometric, and adiabatic processes.
e. To have understood the concept of entropy and its estimation.
f. To be to apply second law of thermodynamics to estimate efficiency of a cycle.
g. To have learnt to comment on the feasibility of a process.
h. To have learnt different refrigeration cycles and also to be able to calculate their COP.
i. To have learnt the thermodynamic analysis of flow processes.

	OUTCOMES									
		a	b	C	d	e	f	g	h	i
OBJECTIVES	1	*	*	*	*	*	*	*		
	2	*	*		*					
	3			*	*					
	4					*	*	*		
	5					*		*		
	6								*	*

CH307L MOMENTUM TRANSFER LABORATORY

Instruction Hours/Week: 3(P) Credits: 1.5 Assessment : 40 + 60

Any 10/12 experiments on

Flow Through Straight Pipe, Frictional losses Due To Fittings, Venturi meter , Orifice meter, Flow Through Helical Coil, Characteristics Of Centrifugal Pump, Flow Through Annulus, Frictional Loss Due To Sudden Expansion, Bernoulli's Experiment, Flow Through Packed Bed, Fluidization.

CH308L ANALYSIS LABORATORY

Instruction Hours/Week: 3(P) Credits: 1.5 Assessment : 40 + 60

10 / 12 experiments from

Chemical Analysis - Water (Hardness & total chlorides), Estimation Of Chromium, Analysis of Bleaching Powder, Estimation Of Phenol, Estimation Of Sugars, Analysis Of Vegetable Oils, Analysis Of Soda Ash, Analysis Of Pyrolusite, Analysis of Urea

Instrumental Analysis - .Flurometer, Refractometer, Polarimeter, Conductometric Titration, Viscosity And Flash Point Determination, .Measurement Of pH, Colourimeter, Potentiometric Titration, Fuel Characterization-Calorific Value, Flash And Cloud Points.

CH309S **COMPUTER SKILLS**

Instruction Hours/week: 1(L) + 2(P) Credits :2 Assessment : 40 + 60

Course Educational Objective (CEOs)

1. Identify basic terms, concepts, and functions of computer system components.
2. To enable the student to use MSWORD.
3. To acquaint with MSEXCEL and MSPOWERPOINT
4. To familiarize with browsing the INTERNET and EMAIL

- MS WORD: Text Basics, Text Formatting and saving file, working with Objects.
- MS WORD: Header & Footers, Working with bullets and numbered lists, Tables.
- MS WORD: Styles and Content, Merging Documents, Sharing and Maintaining Document
- MS WORD: Sharing and Maintaining Document, : Proofing the document, Printing
- MS EXCEL: Introduction to Excel, Formatting excel work book
- MS EXCEL: Perform Calculations with Functions, Sort and Filter Data with Excel
- MS EXCEL: Create Effective Charts to Present Data Visually, Analyze Data Using PivotTables and Pivot Charts, Protecting and Sharing the work book
- MS EXCEL: Use Macros to Automate Tasks, Proofing and Printing, Preparation of various data collection forms, Mathematical Calculations using Spreadsheet
- MS POWER POINT: Setting Up PowerPoint Environment, Creating slides and applying themes, Working with bullets and numbering, Working with Objects, Slide show option and print
- INTERNET AND EMAIL: What is Internet, Types of internet networks , Receiving Incoming Messages , Sending Outgoing Messages, Email addressing , Email attachments, Browsing, Search engines , Text chatting, Job Searching.

Course Outcomes (COs)

After completion of the course the student will:

a) The study and use of MS WORD, MS EXCEL , POWER POINT AND Google Forms with their utilization in Chemical engineering project works and personal works

MC310A **CONSTITUTION OF INDIA**

Instruction Hours/Week: 2(L) Credits: 0 Assessment: 100 + 0

Course Objectives: Students will be able to

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution

UNIT-I

History of Making of the Indian Constitution: History
Drafting Committee, (Composition & Working)

Philosophy of the Indian Constitution: Preamble
Salient Features

UNIT-II

- **Contours of Constitutional Rights & Duties:**
- Fundamental Rights
- Right to Equality
- Right to Freedom
- Right against Exploitation
- Right to Freedom of Religion
- Cultural and Educational Rights
- Right to Constitutional Remedies
- Directive Principles of State Policy
- Fundamental Duties.

Unit-III

- **Organs of Governance:**
- Parliament
- Composition
- Qualifications and Disqualifications
- Powers and Functions
- Executive
- President
- Governor
- Council of Ministers

- Judiciary, Appointment and Transfer of Judges, Qualifications
- Powers and Functions

Unit-IV

- **Local Administration:**
- District's Administration head: Role and Importance,
- Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation.
- Pachayati raj: Introduction, PRI: ZilaPachayat.
- Elected officials and their roles, CEO ZilaPachayat: Position and role.
- Block level: Organizational Hierarchy (Different departments),
- Village level: Role of Elected and Appointed officials,
- Importance of grass root democracy

Unit-V

- **Election Commission:**
- Election Commission: Role and Functioning.
- Chief Election Commissioner and Election Commissioners.
- State Election Commission: Role and Functioning.

Institute and Bodies for the welfare of SC/ST/OBC and women

Text Books/References:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

Students will be able to:

a) Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
b) Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
c) Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.

Discuss the passage of the Hindu Code Bill of 1956.

B. Tech. IV semester Chemical Engineering

CH401B MATHEMATICS – IV

Instruction Hours/Week: 3(L) Credits: 3 Assessment : 40 + 60

Course Objectives:

1. This course aims at providing the student with the knowledge on various numerical methods for solving equations, interpolating the polynomials.
2. To acquaint the students with different types of numerical methods to solve transcendental equations, derivatives and integrals.
3. To provide suitable and effective methods called Numerical Methods, for differential equations. Evaluation of iterative methods and Finite Difference approximation to derivatives, solutions of Laplace, Poisson equations by iterative methods.
4. To provide knowledge of discrete and continuous distributions and problems on Binomial, Poisson, Normal Distributions. Interpret the association of characteristics and through correlation and regression tools.
5. To acquaint the students with different types of large and small sample tests

UNIT I : Curve fitting by the method of least squares, Fitting of (i) Straight line (ii) Second degree parabola (iii) Exponential curves, Solutions of Algebraic & Transcendental Equations: Determination of roots of non - linear equations by iterative methods - Falsi position method - bisection method - Newton Raphson method - Multiple roots by Newton Raphson method - Complex roots by Mueller's method. Solution Of Linear And Non-Linear Algebraic Equations - iterative methods - Gauss elimination with pivotal condensation - Gauss Seidal & Jacobi iterative methods.

UNIT-II : Numerical Interpolation, Integration & Differentiation - Newton's forward & backward interpolation formula - Lagrange's interpolation formula. Numerical differentiation with forward and backward differences, Numerical Integration with Trapezoidal rule, Simpson's 1/3 rule and Simpson's 3/8 rule and Romberg method.

UNIT - III: Solution Of Ordinary & Partial Differential Equations - Taylor series method - Euler's method - Euler's modified method - Runge Kutta second & fourth order methods - Runge Kutta Gill method - Milne's predictor and corrector methods for first order equations. Finite Difference approximation to derivatives, solutions of Laplace, Poisson equations by iterative methods.

UNIT - IV: Random variables, Discrete and Continuous distributions, expectation, variance. Distributions: Binomial, Poisson, Normal and Exponential Properties and applications. Correlation: curve fitting by method of least squares - Linear, Quadratic and Exponential fitting – Correlation – Rank, Correlation - Regression analysis - Multiple correlation.

UNIT - V: Testing of Hypothesis –Null and alternate hypothesis, level of significance and critical region-Z-test for single mean and difference of means, single proportion and difference of proportions - t-test for single mean and difference of means - F-test for comparison of variances, Chi-square test for goodness of fit .

TEXT BOOK:

1. Higher Engineering Mathematics – B.S.Grewal.

2. Numerical methods by E. Balagurusamy, Tata McGraw-Hill Publishing Co.

3. Numerical Methods for Scientific and Engineering Computation 3 rd edition by Jain, New Age International.

4. S P Gupta, Statistical Methods, 38th Edition, Sultan Chand & Sons Educational Publishers, 2009.

5. K V Iyengar et al, Probability and Statistics 2nd Edition, S. Chand & Company Ltd, 2010.

6. S. C. Gupta and V K Kapur, Fundamentals of Applied Statistics, 3rd Edition, Sultan Chand & Sons Educational Publishers.

Course Outcomes: At the end of the course, students will be able to

1. To apply numerical methods to solve the Solution of Linear And Non-Linear Algebraic Equations and curve fitting problems iterative methods.
2. Derive interpolating polynomials using interpolation formulae Test and evaluate the accuracy of Differentiation and integral equations numerically.
3. Derive numerical methods solution of Ordinary differential equations and Partial differential equations.
4. Evaluate discrete and continuous probability distributions and able to solve problems on Binomial, Poisson, Normal Distributions. Interpret the association of characteristics and through correlation and regression tools.
5. Design the components of a classical hypothesis test. Infer the statistical inferential methods based on small and large sampling tests.

CH402C PARTICLE AND FLUID PROCESSING

Instruction Hours/Week: 3(L) Credits: 3 Assessment : 40 + 60

Course Educational Objectives :

1. To develop understanding of solids, their characterization, solid handling and mixing.
2. To develop understanding of the principles of communition, milling and size reduction operations.
3. To understand separation of solid mixtures.
4. To understand the different techniques of separation of solid-liquid mixtures.
5. To understand on methods and effect of agitation and mixing of liquids.

Syllabus:

UNIT - I: Characterization of particulate masses

Properties, handling and mixing of particulate solids: characterization of solid particles, properties of particulate masses, storage, transportation and mixing of solids, types of mixers, mixers for cohesive solids, mixers for free flowing solids.

UNIT - II: Size reduction

Principles of comminution, computer simulation of milling, Operations size reduction equipment -crushers, grinders, ultra fine grinders, cutting machines, equipment and operation.

UNIT - III: Mechanical separations -I

Screening, screening equipment, Separations based on motion of particles through fluids, gravity settling processes and centrifugal settling processes, Gas cleaning. Flotation

UNIT – IV: Mechanical separations-II

Filtration – Cake filters - Centrifugal filters, principles of cake filtration and clarifying filters, liquid clarification, principles of clarification, cross flow filtration,

UNIT - V:

Agitation and mixing of liquids: agitation of liquids, circulation velocities, power consumption in agitated vessel, blending and mixing - suspension of solid particles, dispersion operation.

TEXT BOOK:

1. Unit operations of Chemical Engineering (5th ed) Warren L.McCabe, Juliane Smith and Peter Harriott, McGraw Hill.

REFERENCE:

1. Chemical Engineering Vol.I & II, Coulson and Richardson , Pergamon Press.

2. Mechanical Operations for Chemical Engineers by Narayanan & Bhattacharya, Khanna Publishers

Course Outcomes :

a) To be able to determine the Volume surface mean diameter, mass mean diameter, number of particles and types of mixers.
b) To be able to calculate the screening effectiveness.
c) To be able to find the power requirement using three crushing laws.
d) To have the knowledge of different types of Crushers, grinders, ultrafine grinders, cutters.
e) To have understood settling processes and flotation technique.
f) To develop the rate equations for constant pressure and constant volume filtration techniques and also to solve the problems related to these techniques.
g) To have acquired the construction and operation of different filtration, settling and clarifying equipment.
h) To understand the functioning of agitated vessels and to calculate the power consumption.
i) To have the knowledge on different types of turbines, blending and mixing.

	OUTCOMES									
		a	b	c	d	e	f	g	h	i
OBJECTIVES	1	*								*
	2		*			*		*	*	
	3		*	*						
	4				*	*				
	5						*	*		

CH403C CHEMICAL ENGINEERING THERMODYNAMICS - II

Instruction Hours/Week: 3(L) Credits: 3 Assessment : 40 + 60

Course Educational Objectives :

1. To develop frame work to estimate thermodynamic properties of fluids

2. To systematize the synthesis of mixture properties from pure component properties

3. To develop equilibrium criterion and examine its various forms

4. To study phase equilibria

5. To study chemical reaction equilibria

Syllabus

UNIT I :
Thermodynamic properties of fluids
Property relations for homogeneous phases - Residual properties - Two phase systems - Thermodynamic diagrams - Tables - Properties from virial equations - Properties from equations of state - Properties from Pitzer-type correlations

UNIT – II :
Solution thermodynamics
Fundamental property relations - Chemical potential as a criterion for phase equilibrium - Partial properties -Ideal gas mixtures - Fugacity and fugacity coefficient for pure species and component in solutions - Ideal solutions - Excess properties, Liquid phase properties from VLE data, models for excess Gibb's energy, property changes of mixing.

UNIT – III
VLE at low to moderate pressures
Nature of equilibrium - Phase rule, Duhem's theorem, qualitative behavior, the gamma/phi formulation of VLE, Dew point and bubble point calculations, flash calculations.

UNIT – IV
Topics in Phase Equilibria:
VLE from cubic equations of state, VLE from k-value correlations - Equilibrium and stability - liquid-liquid equilibrium (LLE), vapor-liquid-liquid equilibrium (VLLE)

UNIT - V:
Chemical reaction equilibria

Reaction coordinate - application of equilibrium criterion to chemical reactions - standard Gibb's energy change and the equilibrium constant - effect of temperature on equilibrium constant - Evaluation of equilibrium constant - relation to composition - equilibrium conversion for single reactions - phase rule and Duhem's theorem for reacting systems.

TEXT BOOK:

1. J.M.Smith and H C Van Ness, Introduction to Chemical Engineering Thermodynamics 5th ed. McGraw Hill 1996.

REFERENCES:

1. Chemical Engineering Thermodynamics by Thomas E. Daubert

2. Chemical Engineering Thermodynamics, YVC Rao, University publication

Course Outcomes :

a. To be able to develop and use expressions for property estimation

b. To be able to calculate property values from equations of state

c. To have learnt the concepts of residual, excess, partial molar properties and property changes of mixing

d. To have understood concepts of ideal solutions, fagacity and activity coefficient

e. To be able to make phase equilibrium calculations using Raoult's law

f To be able to use modified forms of Raoult's law for non-ideal systems

g. To have learnt the concepts of LLE and VLLE

h. To have learnt the concept of equilibrium constant and its calculation

i. To be able to estimate equilibrium conversion of single and simple multiple reactions

	OUTCOMES									
		a	b	c	d	e	f	g	h	i
OBJECTIVES	1	*	*							
	2			*	*					
	3				*			*		

	4				*	*	*	*		
	5								*	*

CH404C HEAT TRANSFER

Instruction Hours/Week: 3(L) Credits: 3 Assessment : 40 + 60

Course Educational Objectives :

1. To understand different modes of heat transfer and their characterization
2. To understand the transfer mechanism of heat in fluids with and without phase change
3. To learn the principles of radiation heat transfer
4.. To design heat exchange equipment
5. To understand the principles of evaporation and the working of equipment
6. To learn the principles of crystallization

Syllabus

UNIT I : Heat transfer by conduction

Fourier's law - one dimensional steady state conduction- compound resistances in series - plain wall, cylinder, sphere - critical thickness of insulation - Unsteady state heat conduction - one dimensional, semi infinite solid, infinite slab – lumped hat capacity systems

UNIT II : Principles of Heat Flow

Principles of heat flow in fluids – heat exchange equipment – parallel and countercurrent flow – energy balances – calculation of overall heat transfer coefficient – log mean temperature difference – single and multiple heat exchangers – correction for LMTD – Fouling Factors – Effective Coefficients for Unsteady State conduction – NTU & Effectiveness Methods.

UNIT III : Heat transfer to fluids with out phase change

Concept of hydrodynamic and thermal boundary layers – Forced Convection in laminar flow over plates and in tubes – correlations for heat transfer in turbulent flow – Dimensional Analysis – Heat Transfer at High velocities

Analogy between heat and momentum transfer – Reynold's, Prandtl and Colburn analogies – Transfer in Transition region

Transfer to liquid metals - Natural Convection – Heat transfer over vertical plates and tubes, horizontal plates and tubes

UNIT IV : Heat transfer to Fluids With Phase Change & Radiation

Heat transfer from condensing vapors - drop wise and film wise condensation - Nusselt assumptions and derivation of Nusselt equation – Condensation of superheated vapors - effect of non-condensable gases on rate of condensation - heat transfer to boiling liquids

Fundamentals of Radiation heat transfer – laws of black body radiation – radiation between surfaces – view factors – radiant heat exchange between black and non-black surfaces – combined heat transfer by conduction, convection and radiation – radiation shields

UNIT V : Condensers & Evaporators

Condensers - boiler and calandria - heat transfer in agitated vessels, heat transfer in packed beds - scraped surface exchangers – Plate Type Heat exchangers – Extended Surfaces
Evaporation : types of evaporators – capacity and economy of evaporators - material and energy balances in single effect evaporators - multiple effect evaporators – methods of feeding

Text book

1. Unit Operations of Chemical Engineering by Warren L.McCabe and Julian C.Smith

Reference Book

1. Heat Transfer by J.P.Holman, McGraw-Hill Publications

Course Outcomes :

a) To be able to calculate the heat transfer flux in one-dimensional heat conduction
b) To have learnt the concepts of turbulence, boundary layer and analogies
c) To be able to calculate heat flux in natural convection
d) To be able to estimate heat flux in forced convection
e) To have understood the concepts of black body, view factors and to be able to calculate radiation heat flux
f) To be able to handle conduction-convection conduction-convection-radiation heat transfer
g) To have understood the phenomena of boiling and condensation
h) To have understood the construction and flow patterns in heat exchange equipment
i) To be able to design heat exchangers and condensers
j) To have understood the functioning of evaporators
k) To have learnt the mechanism of crystallization and the general features of crystallizers

	OUTCOMES											
		a	b	c	d	e	f	g	h	i	j	k
OBJECTIVES	1	*	*	*	*	*	*					
	2		*	*	*		*	*				
	3					*	*					
	4				*				*	*		
	5										*	

	6											*

CH405C MASS TRANSFER OPERATIONS – I

Instruction Hours/Week: 3(L) Credits: 3 Assessment : 40 + 60

Course Educational Objectives:

1. To understand the mechanisms of mass transfer – diffusive and convective transport
2. To synthesize the overall resistance for transfer from individual phase resistances
3. To develop the frame work for the design of equipment for staged and continuous contacting devices
4. To learn the construction, operation and inoperable conditions in gas-liquid contacting devices
5. To understand the equilibrium considerations in the operations – absorption/drying/ humidification

UNIT - I:

Introduction: Scope of Mass Transfer Operations - Classification of Mass Transfer Operations - Choice of Separation method - Methods of conducting Mass Transfer Operations - design principles.

Diffusion In Fluids : Molecular diffusion - The equation of continuity - Steady state molecular diffusion of Fluids at rest and in laminar flow - Diffusivity of gases and liquids - Applications of molecular diffusion.

Eddy Diffusion - Mass transfer coefficients - Mass transfer coefficients in laminar flow and turbulent flow - mass transfer theories - Mass, Heat and Momentum Transfer Analogies - Mass Transfer data for simple situations.

UNIT - II:

Inter Phase Mass Transfer: Equilibrium – Overall mass transfer coefficients – gas phase & liquid phase controlled situations

Equipment for gas-liquid contact – Description of continuous and stage wise contact equipment – packing for packed columns liquid distribution – mass transfer coefficients in packed columns - inoperable conditions – stage , ideal stage, Point, plate and column efficiency – comparison of plate and packed columns

UNIT - III

Gas Absorption: Equilibrium solubility of gases in liquids - choice of solvent for absorption- Co-current and Counter current flow (one component transferred) – material balance, Minimum liquid - gas ratio for absorbers, Dilute gas mixtures, Absorption factor – Kremser-Brown equations - Determination of number of transfer units and height of transfer unit

UNIT - IV:

Humidification Operations: Vapor - liquid Equilibrium and Enthalpy for a pure substance - vapor gas mixtures, Air-water system - Adiabatic saturation curves, wet bulb temperature – Psychometric charts – humidification and dehumidification – Operating lines and design of packed humidifiers, dehumidifiers - cooling towers - spray chamber - Evaporative cooling.

UNIT - V:

Drying : Equilibrium - Insoluble solids - Soluble solids - Drying Operations - Batch Drying - Mechanisms of Batch Drying-Thorough Circulation Drying - Continuous Drying - Equipment - Rate of drying

TEXT BOOK:

1. Mass Transfer Operations - Robert E.Treybal (3rd Ed.) McGraw Hill, Kogakusha.

REFERENCE :

1. Principles of Mass transfer and Separation Processes – B. K.Datta - PHI

Course Outcomes :

a) To be able to calculate the flux in cases involving diffusive transfer
b) To appreciate the contribution of turbulence to transfer and to calculate coefficients and flux
c) To be able to differentiate different representations of resistances and to properly integrate them to obtain the overall resistance
d) To be able to write mass balance equations for different contacting patterns
e) To learn the concept of transfer units
f) To be able to estimate the process parameters like solvent requirement, number of theoretical stages, height and diameter of columns
g) To understand the working of gas continuous-liquid-dispersed and gas –dispersed liquid – continuous contacting equipment
h) To understand equilibrium relevant to absorption and to calculate the number of stages, number and height of transfer units
i) To understand the equilibrium concerned to humidification, various methods of conducting the operation and to design a cooling tower
j) To understand the mechanism of drying operation and to calculate the time of drying.

	OUTCOMES										
		a	b	c	d	e	f	g	h	i	j
OBJECTIVES	1	*	*	*							
	2		*	*							
	3				*	*	*		*	*	*
	4							*			
	5						*		*	*	*

CH406C **CHEMICAL TECHNOLOGY**

Instruction Hours/Week: 3(L) Credits: 3 Assessment : 40 + 60

Course Educational Objectives:

1. To know the difference between unit operations and unit processes.
2. To learn principles of different unit operations like screening, filtration, size reduction, mixing.
3. To learn how to draw flow sheet for a process.
4. To know the industrial production of cements, industrial gases, nitrogen, sulphur phosphorous, glass and ceramic industries.
5. To learn the thermodynamic considerations, engineering problems and economic factors in the production.

UNIT - I

Water Technology: Sources of water - methods of treating fresh water - Desalination - Activated Sludge Process

Fuel and Industrial gases: Natural gas, LPG, Carbon dioxide, Hydrogen, Nitrogen and Synthesis gas.

Chlor-Alkali Industry: Manufacture of Soda Ash , Caustic Soda & Chlorine

UNIT - II

Nitrogen Industries - Synthetic Ammonia, Urea, Nitric acid . Phosphorous Industries: Super Phosphate & Triple Super Phosphate, Phosphoric acid

Sulfur and Sulfuric acid

UNIT - III

Cement - Types and manufacture. Pulp And Paper Industry - Methods of pulping, Production of sulphate and sulphite pulp, production of paper - wet process.

Sugar And Starch Industry - Manufacture Of Cane Sugar, Production Of Starch From Maize

UNIT IV

Oils, fats and waxes: Edible oil - extraction of vegetable oils- Hydrogenation of oils - Methods of production of essential oils .

Soaps and detergents - manufacture of soaps, detergents and glycerin

Manufacture of Industrial alcohol, acetone and butanol, acetic acid, vinegar, Penicillin.

UNIT - V

Synthetic fibers: Manufacture of Rayon, Nylon and polyester fibers.

Plastics: Classification-types of synthetic resins and plastics and their manufacture - Thermosetting resins-thermoplastic resins, oil soluble and modified resins-laminated Plastics.
Rubbers: Classification, natural rubber, monomers for synthetic rubber, manufacture of SBR.

TEXT BOOK:

1. Chemical Process Industries by R.N.Shreve and J.A.Brink Jr. McGraw Hill 5th ed.

REFERENCE:

1. Dryden's Outlines of Chemical Technology by Gopal Rao and Marshall sitting. – Boca Raton

Course Outcomes:

a) Able to differentiate between unit operations and unit processes in industrial processes.
b) Know various equipments used for chemical processes in different industries.
c) Can understand the sources of water and different water treatment methods.
d) Know types of cements and raw materials, production of different types of cements.
e) Able to know the raw materials used , reactions involved and different methods for the production nitrogen, phosphorous, sulphur.
f) Knows different types of glasses, raw materials and production process.
g) Understand about basic raw materials, production process of different ceramic products and about refractories.
h) Able to understand temperature, pressure effects of process, about the materials for construction of equipments, furnaces and economic problems in process industries.

	OUTCOMES								
		a	b	c	d	e	f	g	h
OBJECTIVES	1	*	*	*	*	*	*		
	2	*	*	*	*	*	*		
	3	*	*	*	*	*	*		
	4	*	*	*	*	*	*	*	
	5								*

CH407L PARTICLE AND FLUID PROCESSING LAB

Instruction : 3 hr/ week Credits : 1.5 Assessment 40 + 60

EXPERIMENTS:

1.Sieve Analysis	2.Roll Crusher
3.Ball Mill	4.Rod Mill
5.Pulverizer	6.Cyclone Separator
7.Crystallizer	8.Plate And Frame Filter Press
9.Leaf Filter	10.Hydro Classifier
11.Motion Of Particles Through A Fluid	12.Disk Grinder

CH408L HEAT TRANSFER LABORATORY

Instruction Hours/Week: 3 hr/week Credits: 1.5 Assessment: 40 + 60

Any 8/10 experiments on Double Pipe Heat Exchanger, Heat Transfer through Composite Wall, Thermal Conductivity of Insulating Powder, Heat Transfer from Pin Fin Apparatus, Heat Transfer through Natural Convection, Heat Transfer through Forced Convection, Critical Heat Flux Apparatus, Heat Transfer in Agitated Equipment, Condensation of Steam on Vertical Copper Tube, Radiation heat Transfer.

CH409S **PYTHON PROGRAMMING**

Instruction Hours/Week: 3(L) Credits: 2 Assessment : 40 + 60

Course Objectives:

The objective of the course is to impart to the students:

1. Python syntax and semantics and be fluent in the use of Python flow control and functions.
2. The concepts of Object-Oriented Programming as used in Python.
3. Exposure to various problems solving approaches of computer science in various Domains.
4. Various data structures like lists and dictionaries using python.
5. Introduce Python third- Party Tools for various domains.

UNIT I

Introduction to Python: Features and History of Python, Print and Input Functions, Variables, Keywords, Comments

Types: Numerical Types (int, float, complex), Strings, Boolean, Type Conversion Operators: Arithmetic, Relational, Logical, Bitwise, Assignment, Identity, Membership.

Control Flow: Indentation, if-elif-else, while, for, break, continue, pass, else-with loops.

UNIT II

Functions: Introduction, Required Arguments, Default Arguments, Keyword Arguments, Variable Number of Arguments, Variable Scope and Lifetime, Global Variables, Lambda Functions, Command Line Arguments.

Object-Oriented Programming: Classes and Objects, Built in Class Methods and Attributes, Self, Constructor, Destructor, Inheritance, Data Hiding, Overriding Methods and Overloading Operators.

UNIT III

Data Structures, Files and Exception Handling:

Lists, Nested Lists, List Comprehensions, Tuples and Sequences, Sets, Dictionaries. File I/O: Opening, Closing, Reading and Writing Handling Exceptions, Multiple Except Blocks, Multiple Exceptions in a Single Block, Except Block without Exception, The Else Clause, Raising Exceptions, Built-in and User-Defined Exceptions, The FinallyBlock.

UNIT IV

Modules, Packages and Standard Library:

Introduction Modules, Import and From-Import, Packages in Python, Used Defined Modules and Packages, PIP. The Python Standard Library: Numeric and Mathematical Modules, String Processing, Date & Time, Calendar, Operating System, Web Browser.

Python Third- Party Tools:

Survey of The Most Common 3rd Party Packages: Requests, Numpy/Scipy, Matplotlib/ Pyplot, Pandas, Pillow, Flask/Django/Twisted, Pep8, Scikit-Learn/Nltk, Stanford-Corenlp, Bcrypt, Beautiful Soup, and More.

UNIT V

GUI, Graphics and Applications:

GUI Design with Tkinter: Button, Canvas, Check Button, Entry, Frame, Label, List Box, Menu, Menu Button, Message, Radio Button, Scale, Scrollbar, Text Graphics with Turtle: Motion Control, Pen, Colour, Fill, Multiple Turtles, Reset and Clear.

Course Outcomes

Having successfully completed this course the students will be able to:

a) Understand the structure, syntax, and semantics of the Python language.
b) Interpret the concepts of Object-Oriented Programming as used in Python.
c) Demonstrate proficiency in handling Strings and File Systems.
d) Implement desktop/Web-based applications using the Python programming language.
e) Boost hireability through innovative and independent learning.

Text Books:

1. ReemaThareja, Python Programming using problem solving approach, First Edition, Oxford University Press, 2017
2. Mark Lutz, Learning Python, fifth Edition, O‟Rielly,2016

Reference Books:

1. Mark Lutz, Programming Python, Fourth Edition, O‟ReillyMedia,2010.
2. John V. Guttag, Introduction to Computation and Programming Using Python with Application to Understanding, PHI.
3. Allen Downey, Think Python: How to think like a Computer Scientist, Green Tea Press.
4. Paul Barry, Head First Python: A Brain-Friendly Guide, Second Edition, O‟Reilly.
5. The Python Standard Library, Python 3.6.5 documentation (Web Resource)https://docs.python.org/3/library/.

B.Tech.(Honors) requirements in Chemical Engineering

Total Credit requirement: 20

Student shall register for any 4 subjects (4*4 = 16 credits) from the following listed subjects, by selecting one subject for each IV, V, VI and VII semester. Further, they shall require 4 credits through two MOOCs (each of 2 credits), which shall be discipline-specific.

All courses – 40 marks (Internal) + 60 marks (End Semester)

The courses that are offered for B. Tech.(Honors) in Chemical Engineering are

Course Code	Course Title	L-T-P	Credits
CHHN01	Sustainable Process Engineering	3-1-0	4
CHHN02	Separation Processes	3-1-0	4
CHHN03	Chemical Reactor Theory	3-1-0	4
CHHN04	Applications of Nano Technology in Chemical Engineering	3-1-0	4
CHHN05	Advanced Heat Transfer	3-1-0	4
CHHN06	Process Plant Simulation	3-1-0	4
CHMNO7	MOOCS	0	4

CHHN01 SUSTAINABLE PROCESS ENGINEERING

Instruction Hours/Week: 3(L) +1(T) Credits: 4 Assessment: 40 + 60

UNIT I

Sustainability concepts – the concept of sustainable development, sustainability in the context of the process industries, some temporal characteristics of sustainability, the sustainable project or industry, conflicts in achieving sustainability objectives.

Cleaner production – introduction, the concept of cleaner production, the product life cycle, hierarchy of waste management, concepts and sources of waste, impacts of waste, driving forces for cleaner production, resistances to introducing cleaner production.

Industrial ecology – basic concepts, energy and materials recovery from waste streams, resource flow through the economy, transport and storage of raw materials and products, integrated site manufacture, some examples of industrial ecology initiatives.

UNIT II

Waste minimization in reactors – introduction, a checklist for reaction systems and reactors, chemistry of process route, impurities in reactor feed stocks, mixing of reactants, minimizing secondary reactions, recycle of unreacted feed from reactor outlet, reversible reactions, catalysis, agent materials, case studies.

Waste minimization in separation processes – classification of separation processes, sources of waste in separation processes, distillation, gas absorption, adsorption, filtration, drying, evaporation and condensation, extraction, use of extraneous materials, case studies.

UNIT III

Identification of waste in utility systems – introduction, fuels, fuel combustion, common fuels, environmental impacts of flue gases, theoretical flame temperature, furnaces, flare stacks, steam generation, steam use, water sources and uses, recirculated cooling water from cooling towers, sea water cooling, air cooling, refrigeration, electricity demand and supply, distribution and use of electricity, compressed air, inert gas, vacuum.

Energy conservation – introduction, energy consumption in compression of gases and pumping of liquids, pressure losses in piping and through equipment, agitation and mixing, heat recovery, energy recovery from high pressure streams, insulation, plant layout.

UNIT IV

Materials recycling – introduction, recycling of materials in chemical processes, closed loop and open loop recycling, onsite and offsite recycling, producer and consumer waste, hierarchical approach to materials recycling, plastics recycling, glass recycling, recycling of materials from products, waste treatment option, aqueous effluent treatment and water recycling, disposal of wastes.

Waste minimization in operations – non-flow sheet emissions from a process plant, plant startup, shut down of a plant, abnormal operation, plant maintenance, cleaning of plant and equipment, fouling, transport and storage of raw materials and products, fugitive emissions, environmental risks resulting from storm water, risks in mining and extraction of materials.

UNIT V

Life cycle assessment – introduction, product and process applications, basic steps, goal definition, inventory analysis, example of inventory data estimation, classification, improvement analysis, some challenges and uncertainties in LCA, alternative or supplementary approaches to LCA, LCA case studies on Hydro treating of diesel.

Planning for sustainable process industries – introduction, forecasting, scenario development, technology innovation transition to renewable feed stocks, site selection, integration of process plants and process industries, distributed manufacture, government legislation, stakeholder engagement, lifestyle implications.

Text books:

1. David Brennan, Sustainable Process Engineering, 2012, CRC Press.

CHHN02 SEPARATION PROCESSES

Instruction Hours/Week: 3(L) +1(T) Credits: 4 Assessment: 40 + 60

UNIT I

Use and Characteristics of Separation Processes – Importance and variety of Separations – Characteristics of separation Processes- Inherent separation factors for equilibrium and rate Governed Processes

Simple equilibrium processes: Equilibrium calculations- Checking phase conditions for a mixture- Analysis of simple equilibrium separation-processes for binary and multi component systems - Computational and Graphical Approaches.

Unit II

Additional Factors Influencing Product Purities – Incomplete Mechanical Separation of Product Phases – Flow Configuration and Mixing Effects – Batch Operations – Methods of Regeneration – Mass and Heat Transfer Limitations – Stage Efficiencies

Multistage Separation Processes: Increasing product purity - Reducing consumption of separating agent - co-current, crosscurrent and countercurrent flow - Other separation processes - Fixed bed processes.

Unit-III:

Binary Multistage Separations - Distillation: Binary Systems - Equilibrium stages and McCabe-Thiele Diagram - design and other problems – Multistage batch distillation - Straight operating lines and curved operating lines.

UNIT IV

Patterns of Change: Binary and Multi component multistage separations

Group Methods- Linear stage-exit relationships and constant flow rates- non linear stage –Exit Relationships and varying flow rates.

Capacity of contacting devices: factors limiting capacity and factors influencing efficiency.

UNIT V

Energy Requirements of separations processes:

Thermodynamic efficiency - single stage and multistage separation processes - reduction of energy consumption**.**

Selection of Separation processes: Factors influencing the choice of separation

Process - solvent extraction and Illustrative examples

TEXT BOOKS:

1. Separation Processes - C.Judson King,, McGraw – Hill, 1982

REFERENCE BOOKS

1. Separation Process Principles - J.D.Seader and E.J.Henley, , John Wiley, 1998.
2. Mass Transfer Operation - R.E. Treybal, , 3rd edition - McGraw – Hill 1980
3. Transport Processes and Unit Operations – Geankoplis C.J. 4thed – PHI Pvt. Ltd

CHHN03 CHEMICAL REACTOR THEORY

Instruction Hours/Week: 3(L) +1(T) Credits: 4 Assessment: 40 + 60

UNIT I

Isothermal Reactor design: Design structure for isothermal reactors - Scale-up of liquid phase batch reactor data to the design of a CSTR - Tubular reactors - Pressure drop in Reactors - Reversible reactions - unsteady state operation of reactors -Simultaneous reaction and Separation.

UNIT-II

Analysis of Non ideal Reactors - RTD - Measurement and characteristics of RTD- RTD in ideal reactors - Reactor modeling with the RTD - Zero and One parameter models - Two-Parameter model - Modeling real reactors with combinations of ideal reactors - Testing a model and determining it's parameters - Other models of non ideal reactors using CSTRs and PFRs

UNIT-III

External diffusion Effect on Heterogeneous Reactions - Binary diffusion - External resistance to mass transfer - the shrinking core model.

Diffusion and reaction in Porous Catalyst – Diffusion and reaction in spherical pellets - Internal Effectiveness factor - Falsified Kinetics - Overall effectiveness factor - Estimation of diffusion and reaction limited regimes - Mass transfer and reaction in a packed bed

UNIT-IV

Internal Transport Processes-Reaction and Diffusion in porous catalysts:

Intra pellet mass transfer and intra pellet heat transfer, Mass transfer with reaction, Mass and Heat transfer with reaction, effect of internal transport on selectivity and poisoning.

UNIT-V

Design of heterogeneous Catalytic Reactors: Fixed bed reactors and isothermal and adiabatic fixed-bed reactors, non isothermal, non adiabatic fixed bed reactors, Two phase model, Fluidized-Bed reactors, Operating characteristics of FBRs. Mass Transfer in Fluidized Beds: Gas-Solid Mass Transfer, Mass Transfer between the Fluidized-Bed Phases, Reaction in Fluidized Bed. Trickle bed reactor Models, Slurry reactor models.

Text Books

1. J.M.Smith "Chemical Engineering Kinetics" 3rd ED., Mc Graw Hill, New York 1980
2. Fogler H. S., Elements of Chemical Reaction Eng.", 3rd Ed., Prentice Hall, 1999
3. Levenspiel, O., "Chemical Reaction Eng." John Wiley & Sons 1972.

CHHN04 APPLICATIONS OF NANO TECHNOLOGY IN CHEMICAL ENGINEERING

Instruction, hours/week : 3 Credits : 3 Assessment : 40 + 60

Objectives

1. To understand the fundamentals of the preparation and properties of nanomaterials from a chemical engineering perspective.
2. To gain knowledge of structure, properties, manufacturing, and applications of various nanomaterials and characterization methods in nanotechnology
3. To give a survey of the key processes, principles, and techniques used to build novel nanomaterials and assemblies of nanomaterials

UNIT I : Introduction

Introduction to nanotechnology, Feynman's Vision-There's Plenty of Room at the Bottom, Classification of nanostructures, Nanoscale architecture, Chemical interactions at nanoscale, Types of carbon based nanomaterials, Synthesis of fullerenes, Graphene, Carbon nanotubes, Functionalization of carbon nanotubes, One, two and multidimensional structures, Crystallography.

UNIT II : Approaches to Synthesis of Nanoscale Materials and characterization

Top down approach, Bottom up approach Bottom-up vs. top-down fabrication; Top-down: Atomization, Sol gel technique, Arc discharge, Laser ablation, RF sputtering; Bottom-up: Chemical Vapor Deposition (CVD), Metal Oxide Chemical Vapor Deposition (MOCVD), Atomic layer deposition (ALD), Molecular beam Molecular self-assembly; Ultrasound assisted, microwave assisted, Mini, micro and nanoemulsion. Wet grinding method, Spray pyrolysis, Ultrasound assisted pyrolysis, atomization techniques. Surfactant based synthesis procedures, Types of molecular modeling methods. Size, shape, crystallinity, topology, chemistry analysis usingX-ray imaging, Transmission Electron Microscopy, HRTEM, Scanning Electron Microscopy, SPM, AFM, STM, PSD, Zeta potential, DSC and TGA.

UNIT III : Semiconductors and Quantum dots

Intrinsic semiconductors, Extrinsic semiconductors, Review of classical mechanics, de Broglie's hypothesis, Heisenberg uncertainty principle Pauli exclusion principle Schrödinger's equation Properties of the wave function, Applications: quantum well, wire, dot, Quantum cryptography

UNIT IV : Polymer-based and Polymer-filled Nanocomposites

Nanoscale Fillers, Nanofiber or Nanotube Fillers, Plate-like Nanofillers, Equi-axed Nanoparticle Fillers, Inorganic Filler Polymer Interfaces, Processing of Polymer Nanocomposites, Nanotube/Polymer Composites, Layered Filler Polymer Composite Processing, Nanoparticle/Polymer Composite Processing: Direct Mixing, Solution Mixing, In-Situ

Polymerization, In-Situ Particle Processing, In-Situ Particle Processing Metal/Polymer Nanocomposites, Properties of Nanocomposites.

UNIT V : Applications to Safety, Environment and Others

Chemical and Biosensors- Classification and Main Parameters of Chemical and Biosensors, Nanostructured Materials for Sensing, Waste Water Treatment, Nanobiotechnology, Drug Delivery, Nanocoatings, Self cleaning Materials, Hydrophobic Nanoparticles, Photocatalysts, Biological nanomaterials, Nanoelectronics, Nanomachines & nanodevices, Societal, Health and Environmental Impacts.

References

1. Louis Hornyak G., Dutta Joydeep, Tibbals Harry F. and Rao Anil K., "Introduction to Nanoscience", (CRC Press of Taylor and Francis Group LLC), May 2008, 856pp, ISBN-13: 978142004805

2. Ajayan P. M., Schadler L. S., Braun P. V., "Nanocomposite Science and Technology", Edited by WILEY-VCH Verlag GmbH Co. KGaA, Weinheim ISBN: 3-527-30359-6, 2003.

3. Kelsall Robert W., Hamley Ian W., GeogheganMark, "Nanoscale Science and Technology", John Wiley & Sons, Ltd, 2006.

4. Kal Ranganathan Sharma, "Nanostructuring Operations in Nanoscale Science and Engineering", McGraw-Hill Companies, Inc. ISBN: 978-0-07-162609-5, 2010.

5. "Organic and inorganic nanostructures".-(Artech House MEMS series), Nabok, Alexei, ISBN 1-58053-818-5, 2005.

Course Outcomes: At the end of the course, the student will be able to:

1. Understanding the different top down and bottom up approaches for nanoparticles
2. Get to know the different applications of nanoparticles in chemical engineering field.
3. Learning the characterization techniques for nanoparticles

CHHN05 ADVANCED HEAT TRANSFER

Instruction Hours/Week: 3(L) +1(T) Credits: 4 Assessment: 40 + 60

UNIT I :

Process heat transfer: Introduction, Steady state conduction in multiple dimensions, Principles of convection, Radiation Heat Transfer-Physical mechanism, radiation properties, radiation shape factor and relations between shape factors.

UNIT II :

Heat-Transfer Equipment: Introduction, Basic design procedure and theory, Overall heat-transfer coefficient, Fouling factors, Shell and tube exchangers: construction details, Mean temperature difference (temperature driving force).

UNIT III:

Shell and Tube Exchangers: general design considerations, Tube-side heat-transfer coefficient and pressure drop (single phase), Shell-side heat-transfer and pressure drop (single phase), Flow pattern, Design methods, Kern's method, Bell's method, Shell and bundle geometry, Effect of fouling on pressure drop, Pressure-drop limitations.

UNIT IV:

Design of Condensers, Reboilers and Vaporizers.

UNIT V:

Design of Plate heat exchangers: Gasketed plate heat exchangers, Welded plate, Plate-fin, Spiral heat exchangers, Direct-contact heat Exchangers, finned tubes, Double-pipe heat exchangers, Air-cooled exchangers, Fired heaters (furnaces and boilers), Heat transfer to vessels.

References:

1. Chemical Engineering Design by Coulson & Richardson's,Volume 6 Fourth Edition.
2. Heat Transfer" by J.P.Holman, Ninth Edition.
3.Process Heat Transfer by Donald Q. Kern.

CHHN06 PROCESS PLANT SIMULATION

Instruction Hours/Week: 3(L) +1(T) Credits: 4 Assessment: 40 + 60

UNIT I

Modeling Aspects: Deterministic vs. Stochastic Processes, Physical modeling, Mathematical modeling, Chemical Systems Modeling, Cybernetics, Controlled System, Principles of Similarity

Classification of Mathematical Modeling: Independent and Dependent variables, Classification based on variation of independent variables, Classification based on state of the process, Classification based on type of the process, Boundary Conditions, The black Box Principle, Artificial Neural Networks

UNIT II - Process Modeling – I

Models from mass transfer: steady state single stage solvent extraction, steady state two stage solvent extraction, steady state two stage cross current solvent extraction, , steady state N- stage solvent counter current extraction, unsteady state single stage solvent extraction, unsteady state mass balance in a stirred tank and in a mixing tank.

Models from Heat Transfer : steady state heat conduction through a hollow cylindrical pipe, unsteady state steam heating of a liquid, unsteady state heat loss through a measuring tank, heat transfer through extended surfaces, unsteady state heat transfer in a tubular gas pre heater

UNIT III – Process Modeling –II

Models from fluid flow: flow through a packed bed column, flow of a film on the outside of a circular tube, annular flow with inner cylinder moving axially, flow between coaxial cylinders and concentric spheres

Models from Reaction Engineering : chemical reaction with diffusion in a tubular reactor, chemical reactor with heat transfer in a packed bed reactor, gas absorption accompanied by chemical reaction.

UNIT IV

Error Propagation & Data Regression :Propagation of errors through addition, subtraction, multiplication and division, Errors of measurement, Precision errors, errors method

Data Regression : Theoretical properties, data regression methods, Problems in data regression

Process Simulation : Modular Approach, The equation solving approach

UNIT V

Decomposition of Networks : Tearing Algorithms, Algorithms based on signal flow graph and reduced digraph

Convergence Promotion: Newton's method, direct substitution method, Wegstein's method, dominant Eigen value method, quasi Newton method, Criterion for acceleration, Physical and Thermodynamic Properties

TEXTBOOKS:

1. Process Plant Simulation, B.V.Babu, Oxford University press, 2004
2. Process Modeling, Simulation and Control for Chemical Engineers, 2nd ed., W. L. Luyben, McGraw-Hill, New York, 1990

REFERENCE:

1. Introduction to Numerical Methods in Chemical Engineering, P. Ahuja, PHI , New Delhi, 2010

DEPARTMENT OF CHEMICAL ENGINEERING
SRI VENKATESWARA UNIVERSITY COLLEGE OF ENGINEERING: TIRUPATI-517502

R-20 – Scheme of Instruction effective from the academic year 2020-2021

B. Tech. Minor Requirements in Chemical Engineering

Total Credit requirement: 20

Student shall register for any 4 subjects (4*4 = 16 credits) from the following listed subjects, by selecting one subject for each IV, V, VI and VII semester. Further, they shall require 4 credits through two MOOCs (each of 2 credits), which shall be discipline-specific.

All courses – 40 marks (Internal) + 60 marks (End Semester)

The courses that are offered for B. Tech. (Minor)in Chemical Engineering are

Course Code	Subject	L-T-P	Credits
CHMN01	Basic Process Calculations	3-1-0	4
CHMN02	Fluid and Particle Mechanics	3-1-0	4
CHMN03	Heat and Mass Transfer	3-1-0	4
CHMN04	Elementary Reaction engineering	3-1-0	4
CHMN05	Process Industrial Technology	3-1-0	4
CHMNO6	Fundamentals of Nanotechnology	3-1-0	4
CHMNO7	MOOCS	0	4

CHMN01 BASIC PROCESS CALCULATIONS

Instruction Hours/Week: 3(L) +1(T) Credits: 4 Assessment: 40 + 60

UNIT I:

Concept of Mole – Composition – Stoichiometry – Ideal Gas Law - Incomplete reaction - Excess – Degree of completion of Reaction

UNIT II:

Law of Conservation of Mass – Mass balance without and with reaction – Recycle, Purge, Bypassing

UNIT III:

Law of Conservation of Energy - Enthalpy calculation for physical changes – Enthalpy calculation for Chemical Reactions - Energy balance

UNIT IV:

Vapor Pressure – temperature dependence – vapor pressures of mixtures

Humidity – Mass and molar humidity – relative humidity – percentage humidity – humidity charts

UNIT V:

The first law of thermodynamics, Energy balance for closed systems, Thermodynamic state and state functions, equilibrium, The phase rule, The reversible process. Second law – Statement, Heat engine, Thermodynamic Temperature scale, concept of entropy, mathematical statement of second law, Entropy changes of an ideal gas, Calculation of ideal work and lost work The Third Law of Thermodynamics

Text Books

1. Hougan, Watson & Ragatz – Chemical Process Calculations Vol.1
2. Smith & Van Ness – Introduction to Chemical Engineering Thermodynamics

Reference :

1. Chemical Process Calculations - David Himmelblau

CHMN02 **FLUID AND PARTICLE MECHANICS**

Instruction Hours/Week: 3(L) +1(T) Credits: 4 Assessment: 40 + 60

UNIT I :

Introduction: Units, Dimensions and Dimensional analysis, Fluid statics and its applications.

UNIT II :

Fluid flow phenomena, kinematics of flow, velocity field - rate of shear - shear stress fields - Boundary layers - Newton's law of viscosity - Non-Newtonian fluids - Laminar and turbulent flows.

Basic equations of fluid flow - continuity equation - Bernoulli's equation and its applications.

UNIT III

Friction in flow through bed of solids - motion of particles through fluids - free and hindered settling - Mechanism and pressure drop of fluidization and its applications

UNIT IV

Characterization of solids – shape & size – Sieve analysis – Screening, screening equipment, Screen capacity and effectiveness

UNIT V

Reduction of Particle size –laws of crushing – Jaw Crusher & Ball mill – Separations based on motion of particles through fluids (Batch sedimentation and sorting classifiers)

TEXT BOOKS:

2. Unit operations of Chemical Engineering (7th ed) Warren L.McCabe, Juliane Smith and Peter Harriott, McGraw Hill.

REFERENCES:

4. Chemical Engineering Vol.I by Coulson and Richardson, Pergamon Press.
5. Solved Examples in Chemical Engineering by G.K.Roy

CHMN03 HEAT AND MASS TRANSFER

Instruction Hours/Week: 3(L) +1(T) Credits: 4 Assessment: 40 + 60

UNIT I:

Conduction - Fourier's law - one dimensional steady state conduction- compound resistances in series - plain wall, cylinder, sphere - critical thickness of insulation - Unsteady state heat conduction

Convection – Natural and forced convection definitions, Hydrodynamic and thermal boundary layers

Radiation - Fundamentals of Radiation heat transfer – laws of black body radiation

UNIT II:

Principles of heat flow in fluids – heat exchange equipment – parallel and countercurrent flow – energy balances – calculation of overall heat transfer coefficient – log mean temperature difference – single and multiple heat exchangers – correction for LMTD – Fouling Factors.

UNIT III : Diffusion In Fluids : Molecular diffusion - The equation of continuity - Steady state molecular diffusion of Fluids at rest and in laminar flow - Diffusivity of gases and liquids. Mass transfer coefficients definition

UNIT IV: Gas Absorption: Equilibrium solubility of gases in liquids - choice of solvent for absorption- Co-current and Counter current flow (one component transferred) – material balance, Minimum liquid - gas ratio for absorbers, Dilute gas mixtures, Absorption factor.

UNIT V:

Mass transfer operation, Distillation, Vapour Liquid Equilibrium, Relative Volatility, , Steam distillation - Flash vaporization - Differential Distillation – Distillation with Reflux(only Mccabe –theile method)

Text Books:

1. W.L. McCabe and J.C. Smith and Peter Harriott, “Unit Operations in Chemical Engineering”, Mc Graw Hill 5th Q Edn. 1993
2. Mass Transfer Operations - Robert E Treybal (3rd ed.) McGraw Hill, Kogakusha.

CHMN04 ELEMENTARY REACTION ENGINEERING

Instruction Hours/Week: 3(L) +1(T) Credits: 4 Assessment: 40 + 60

UNIT-I

Introduction to Chemical Reaction Engineering; Elementary and Non Elementary Reactions, Homogeneous and Heterogeneous Reaction, rate equation, Arrhenius Rate law.

UNIT-II

Interpretation of batch reactor data:

Constant volume batch reactor: Integral method of analysis of data– general procedure, irreversible first order and second order reactions, empirical reactions of nth order, zero-order reactions, overall order of irreversible reactions from the half-life, fractional life method, irreversible reactions in parallel, autocatalytic reactions, irreversible reactions in series, first order reversible reactions, differential method of analysis of data.

UNIT-III

Ideal reactors for a single reaction- Ideal batch reactor, Steady-state mixed flow reactor, Steady-state plug reactors.

Design for single reactions: Size comparison of single reactors, Multiple- reactor systems.

UNIT-IV

Multiple reactions- introduction to multiple reactions, qualitative discussion about product distribution, Irreversible first order reactions in series, qualitative discussion about product distribution, quantitative treatment in Batch, CSTR and Plug flow reactors.

UNIT-V

Adsorption - Physical adsorption and Chemical Adsorption. Adsorption Isotherms, Solid catalysis - Determination of physical properties - Surface Area, Void volume, solid density, Classification of catalysts - Catalyst preparation - promoters and inhibitors, catalyst deactivation.

Text Book:

1. Levenspiel.O., “Chemical Reaction Engineering”, 3rd Edition, John Wiley and Sons, 2007.
2. Smith, J.M., “Chemical Engineering Kinetics”, 3rd Edition, McGraw Hill, 1981.

References:

1. Fogler, H.S., “Elements of Chemical Reaction Engineering”, 5th Edit ion, John Wiley, 2016.

CHMN05 PROCESS INDUSTRIAL TECHNOLOGY

Instruction Hours/Week: 3(L) +1(T) Credits: 4 Assessment: 40 + 60

UNIT-I

Food Related industries - Synthetic ammonia – urea –Phosphoric acid - complex fertilizers - Pesticides – Dairy (Milk to milk powder) – Sugar

UNIT-II

Pharma Industries – Penicillin - Fermentation

UNIT-III

Polymer Industries - Vinyl chloride and vinyl acetate, manufacture of phenol formaldehyde resin and polyvinyl chloride polymer, SBR, manufacture of Nylon 66.

UNIT -IV

Petroleum: Origin, classification, composition of crude oil, production of crude oil, distillation of crude petroleum, refining-methods, uses of products

UNIT –V

Oils: extraction and expression of vegetable oils, refining and hydrogenation of oils.

Soaps and detergents: continuous process for the production of fatty acids, glycerin and soap, production of detergents

Pulp and paper industry: methods of pulping, production of sulphate and sulphite pulp, production of paper –wet process

Text Books:

1. Austin. G.T., Shreve's Chemical Process Industries, Mc.Graw-Hill.5th edition.1985.

2. Gopal Rao M. and Sittig M., Dryden's Outlines of Chemical Technology, 3rd edition, East-West Press Pvt Ltd., New Delhi, 2000.

References:

1. B.K. Sharma, Industrial Chemistry, GOEL publishing house, 2000.

2. K.H.Dav& F.S. Berner and S.C. Bhatia, Handbook of industrial chemistry Vol 1& II, CBS Publishers Chemical Technology: G.N. Panday, Vol 1& Vol II

CHMNO6 FUNDAMENTALS OF NANOTECHNOLOGY

Instruction Hours/Week: 3(L) +1(T) Credits: 4 Assessment: 40 + 60

UNIT – I

Introduction: Importance of Nanotechnology emergence of nanotechnology, size range of Nanoparticles - Thermodynamics and properties of Nano scale materials, classification of Nanostructured materials - Bottom-up and top-down approaches- challenges in nanotechnology. Future of nanotechnology in chemical and Biochemical engineering.

UNIT – II

Synthesis of nanoparticles and processing**:** Methods for creating nanostructures – processes for producing ultra fine powders – Mechanical grinding – wet chemical synthesis of nano materials – sol-gel emulsion processes-liquid-solid reactions- Gas phase synthesis of nano materials – Furnace, flame assisted ultra sonic spray pyrolysis – Gas condensation (CVC) – cold plasma methods- particle precipitation aided CVD.

UNIT – III:

Characterization of nanosystems**:** Sample preparation and characterization techniques of Nanostructured materials – scanning electron microscopy (SEM) – Transition election microscopy and X-Ray photo electron and Auger electron spectroscopy (XPS, AES) – Scanning tunneling microscopy (STM), atomic force microscopy (AFM) – powder X-ray difractometry (XRD).

UNIT – IV:

special nanomaterials**:** Carbon fullerences and nanotubes – onions – carbon fullerrence-formation, properties and uses – Porous silicon preparation methods- Nano particles of SiC, alumina and zirconia and their sintering techniques – Wafer preparation, wafer cleaning techniques – lithography – etching – Mechanical attrition and Nanocomposites.

UNIT – V:

Nano – Engineering applications**:** Micro electromechanical systems (MEMS) and Nano electromechanical systems (NEMS), sensors, Micro fluidic devices – Nano pump – molecular motors – Nano bots – Nano medicine – drug delivery systems – catalysis by gold Nano particles – wear resistance coatings – weapons – battery and fuel cell electrodes – thermal management – automotive and aerospace components. Environmental impact of Nano-particles – ethical, legal and social issues.

Text Books:

1. Introduction to nanotechnology, by Charles P.Poole and Frank Jowens, John wiley (2003)
2. Nanotechnology Research and perspectives, MIT Press (1992)

References:

1. Understanding of Nano science and technology, Poori Dutta & Sushmita Gupta, Global vision, New Delhi – (2006)

CH501C **MASS TRANSFER OPERATIONS – II**

Instruction Hours/Week: 3(L) **Credits: 3** **Assessment: 40 + 60**

COURSE DESCRIPTION:

This course is designed to chemical engineering students to learn the vapor-liquid equilibrium of mixture of components for the separation. Students can learn various equipments used for the continuous separation of components by considering the physical properties of the mixture by distillation process. Based on the solubility of the components students are able to use liquid-liquid equilibrium of the mixtures for their separation. Various methods are used for the extraction of valuable components present in solids. In this course various membrane separation processes are used for separation of mixture of components based on physical properties of components. Can understand the principles of ion exchange and adsorption process.

Course Educational Objectives:

1. To understand VLE and to learn the different types of distillation operations.
2. To understand the design of continuous fractionating columns in distillation operations.
3. To understand LLE and to learn the design of staged columns for liquid-liquid and solid-liquid extraction and also to learn the construction and operation of different equipment for the said operations.
4. To get a fundamental understanding of membrane separations and solid –liquid leaching operations.
5. To understand the mechanism of adsorption and ion exchange processes

UNIT – I : Distillation – I

Vapor- Liquid Equilibria - P-x-y and t-x-y diagrams – x-y and H-x-y diagrams - ideal solutions - Raoult's Law, positive and negative deviations from ideality, Minimum and Maximum boiling azeotropes Steam distillation - Flash vaporization - Differential Distillation – batch distillation with reflux.

UNIT – II : Distillation – II

Continuous Fractionation - Binary systems, Multistage towers - The method of Ponchan and Savarit - The method of McCabe-Thiele - Feed tray location, total reflux, minimum reflux ratio, optimum reflux ratio, use of open steam, multiple feeds, partial and total condensers - Packed bed distillation. – Principles of azeotropicand Extractive Distillation.

UNIT - III: Liquid - Liquid Extraction

Liquid Extraction - Fields of usefulness - Liquid Equilibria - Equilateral Triangular coordinates - Rectangular coordinates - Rectangular coordinates on solvent free basis - Systems of three liquids - One pair partially soluble, two pairs partially soluble - Effect of temperature, choice of solvent. Single stage Extraction - Multistage cross current extraction and continuous counter current multistage extraction with out and with reflux - Insoluble liquids – Equipment for solvent extraction - agitated vessels, Emulsions and Dispersions, Mixer - settler cascades, sieve tray towers. Continuous contact (Differential)contactors - Spray towers - packed towers - Mechanically agitated counter current extractors, Rotating Disc contactors, centrifugal Extractors.

UNIT IV: Leaching

Preparation of the solid - Temperature of Leaching - unsteady - state operation - in-place Leaching, Heap leaching, percolation tanks - Counter current multiple contact (the shanks system), percolation in closed vessels, Filter - press leaching Agitated vessels. –Batch settling - Steady - stage (continuous) operation - Leaching during grinding, Agitated vessel, Thickeners, continuous counter current Decantation, Hydro cyclones, continuous leaching of course solids, classifiers, leaching of vegetable seeds.

Basics of Membrane Separations – classification – capillary and solution diffusion models – retention coefficient – concentration polarization – fouling – membranes (operational requirement – structure and preparation) – components of a typical membrane separation plant – micro filtration – ultrafiltration – reverse osmosis – dialysis – electro dialysis - pervaporation

UNIT – V: Adsorption

Types of adsorption - Nature of Adsorbents - Adsorption equilibrium – single gases and vapors, vapor and gas mixtures, liquids. Adsorption operations – Stage wise operation – Multistage cross current and counter current operation, application of the Freundlich equation, Equipment - Agitated vessels, Fluidized beds, Steady state fixed bed absorbers, adsorption wave, Ion Exchange – Principles of ion exchange, Techniques and applications, Equilibrium Rate of ion exchange.

Text Book:

1. Mass Transfer Operations – Robert E Treybal (3rd ed.) McGraw Hill, Kogakusha.

Reference Books :

1. Bioseparations – Principles and Techniques – B.Sivasankar

2. Principles of Mass transfer and Separation Processes – B. K.Datta - PHI

Course Outcomes:

1. To be able to analyze different phase diagrams – pxy, txy, hxy, bimodal solubility curve and Nxy representations. To be able to calculate flash calculations. To be able to apply Rayleigh's equation (differential distillation).
2. To be able to calculate the number of ideal stages using Ponchon-Savarit and McCabe-Theile procedures. To acquire a fundamental understanding of azeotropic and extractive distillation.

3. To be able to calculate the solvent requirement and number of stages for different contacting patterns like single stage, cross current and countercurrent modes.
4. To be familiar with different constructions of equipment suitable for extraction and leaching.
5. To be able to explain the equilibrium of adsorption and to calculate the material requirement and number of stages for different contacting schemes. To have visualized fixed and moving bed adsorption and regeneration.

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

CH502C CHEMICAL REACTION ENGINEERING - I

Instruction Hours/Week: 3(L) Credits: 3 Assessment: 40 + 60

COURSE DESCRIPTION:

This course is designed for chemical engineering student to understand the principles of chemical reactions, the mathematical rate equations for various types of reactions occurring in process industries. Various types of reactors used in process industries, rate equations for series and parallel multiple reaction can be discussed. The temperature and pressure effects in various chemical reactions can be discussed.

Course Educational Objectives:

1. To provide knowledge on different types of reactions, reaction rate and mechanism
2. To provide knowledge on collection and analysis of batch reactor data for homogeneous reactions
3. To provide knowledge of different types of ideal reactors and to derive their design equations
4. To teach about different reactor configurations, their selection and performance analysis and to provide a foundation on deriving rate expressions for multiple reactions.
5. To teach about the heat effects during the reaction and finding the rate of reaction

UNIT - I:

Introduction: Performance equation, Classification of Reactions, Variables affecting the rate of reaction, Definition of Reaction rate.

Kineticsof Homogeneous Reaction: Concentration - dependent term of a rate equation - Temperature dependent term of Rate equation, Searching for a mechanism.

UNIT - II:

Interpretation of Batch Reactor Data: Constant - Volume Batch Reactor - Integral method and differential method of Analysis of Data. Variable - Volume Batch Reactor - differential and integral methods of analysis of Data.Temperature and Reaction Rate, the search for a rate equation.

Single Ideal Reactor Design - Ideal Batch Reactor - Steady state mixed flow Reactor - Steady state plug flow Reactor - Space time, Space velocity, holding time in flow systems.

UNIT - III:

Design for Single Reactions: Size comparison of Single Reactions - Batch Reactors - Mixed Vs.Plug flow Reactors - First and Second order Reactions - Variations of Reactant ratio for second order reactions - General graphical procedure. Multiple Reactor systems - plug flow Reactors in series and/ or in parallel, Equal size mixed Reactors in series and/or in parallel, mixed reactors of different sizes in series - reactors of different types in series, Recycle reactor (omit auto catalytic reactions).

UNIT - IV:

Design for Multiple Reactions: Reactions in Parallel - in series - successive first order reactions - first order followed by zero order reaction - zero order followed by first order

reaction successive irreversible reactions of different orders. Reversible reactions; series/parallel reactions and applications.

UNIT - V:

Temperature and Pressure Effects: Single Reactions - Heats of Reactions from Thermodynamics, Equilibrium constant from Thermodynamics, General Graphical Design Procedure, Optimum temperature progression. Heat effects, Adiabatic and Non-adiabatic operations, comments and Extensions. Exothermic Reactions in Mixed Reactors - A special problem.

TEXT BOOK:

1. Chemical Reaction Engineering (3rd Ed) Octave Levenspiel.

REFERENCES:

1. Chemical Engineering Kinetics (3rd ed) J M Smith.
2. Elements of Chemical Reaction Engineering (2nd) - H.ScottFoggler

Course Outcomes :

1. To be able to write rate expressions for elementary reactions and to study the temperature dependence of reactions.
2. To be able to apply analytical procedures (integral, differential, fractional life, initial velocity methods) to convert batch reactor data in to kinetic expression.
3. To be able to make performance analysis of multiple reactor systems – PFR in series and parallel, CSTRs in series and in parallel, mixed reactors in series.
4. To be able to analyze multiple reactions – series, parallel and series-parallel. To be able to suggest reaction controls for desired product distribution.
5. To be able to estimate heat effects of industrial reactions. To be able to suggest optimum temperature progression.

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

CH503C **PROCESS DYNAMICS AND CONTROL**

Instruction hours /week: 3 (L) Credits: 3 Assessment: 40 + 60

COURSE DESCRIPTION:

This course is designed for chemical engineering students to understand the transfer functions for different types of systems in process industries, able to identify different controller elements used in process industries, can draw the block diagrams for control systems and able to learn the stability of systems in process industries. Frequency response of control systems can be studied. Different types of controller arrangements and controller tuning methods are studied.

Course Educational Objectives:

1. To introduce the fundamental principles of system dynamics and response, with emphasis on process systems
2. To introduce the basic features of different controllers and control elements
3. To develop and analyze feedback control loops for stability
4. To introduce the features of advanced control strategies
5. To train the students in the basic approach of modeling a physical process

UNIT I:

Response of first order systems: Physical examples of first order systems, Response of first order systems in series.

UNIT II:

Higher Order Systems: Characteristics, response and transportation lag,Control systems: controllers and final control elements, Block diagrammatic representation.

UNIT III:

Closed loop transfer functions, Transient response of simple control systems Stability, Routh Criterion.

UNIT - IV:

Root Locus : Transient response from locus, Application of root locus to control systems
Introduction To Frequency Response: control systems design by frequency response.

UNIT – V:

Advanced Control Strategies : Cascade control, feed forward control, ratio control, Smith predictor, internal model control, Controller tuning and process identification, control valves.

TEXT BOOK:

2. Process systems Analysis and process Control by D R Coughanowr, 2nd ed. McGraw Hill.

REFERENCES:

3. Chemical Process Control by G.Stephanopolous, Prentice Hall 1998.
4. Computer Control of Industrial Processes, Emenule, S.Savas, McGraw-Hill, London.

Course Outcomes :

1. To be able to model physical systems/processes like thermometer / level systems / manometer. To have acquired the ability to study the response behavior of systems.
2. To be able to suggest an appropriate controller for an application.To develop feed back control loops and reduce it to single block representation for further analysis.
3. To be able to construct and analyze Routh array.
4. To be able to obtain the locus of roots of a characteristic equation. To be able to make stability analysis-based frequency response (Bode plots) approach.
5. To have learnt the basics of advanced control strategies. To have learnt controller tuning rules.

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

CH504C **MATERIAL SCIENCE**

Instruction hours /week: 3 (L) Credits: 3 Assessment: 40 + 60

COURSE DESCRIPTION:

This course is designed to chemical engineering students to understand different types of engineering materials, their physical properties and their structures. The phase diagrams, heat treatment of materials can be studied. Different ceramics, composite and nano material can be studied. The corrosion types in materials can be studied.

Course Educational Objectives:

1) To have fundamental knowledge on engineering materials.
2) To study Phase diagrams and its applications and can learn different Heat treatment processes.
3) To have knowledge on Ceramic and composite materials.
4) To study Corrosion, its nature and its prevention
5) To learn a basic view of Nano materials.

UNIT - I: **ENGINEERING MATERIALS**

Classification - levels of structure - properties Mechanical, thermal, electrical, and magnetic properties) - structure - property relationship. Structure of solids - crystalline and non crystalline state - Inorganic solids - Crystal Imperfections (point defects, line defects and surface imperfections, Grain boundaries).

UNIT - II: **METALS AND ALLOYS**

Elastic and Plastic deformations - Re-crystallization - cold and hot working - creep, fatigue and Fracture. Phase diagrams and their applications - phase rule - completely soluble, partially soluble, Insoluble in solid phase, peritectic phase diagrams. Iron - Iron carbide phase diagram. Heat treatment processes - Annealing - quenching and tempering - Age hardening.

UNIT – III :**CERAMIC PHASES AND THEIR PROPERTIES**

Structure of ceramics - Mechanical and electrical properties. Abrasives - silicon carbide various silicates - structure of quartz - uses. Piezo and Ferroelectric material - $BaTiO_3$.

COMPOSITE MATERIALS - Fiber, particle and Plastic reinforced composites. Whiskers. Porosity - Bulk characteristics. Agglomerated materials - concrete - Asphalt and Asphalt mixtures.

UNIT - IV: **CORROSION**

Definition - Electrochemical principles - Environmental effects - oxidizers, Temperature, Agitation(velocity) and polarization. Passivity. Eight forms of corrosion(brief) - Galvanic, Crevice corrosion, Selective leaching, Erosion and Hydrogen damage. Corrosion of metals and Alloys due to sulfuric, hydrochloric nitric, phosphoric and acetic acids. Corrosion prevention and control - Selection of materials - Design principles - Inhibitors -

Alteration of environment - Anodic protection. Inorganic and Metallic coatings. Organic coatings.

UNIT - V : **NANOMATERIALS**

Evolution of nanotechnology - Electron Microscopy – Priniciples of SEM, TEM, SPM and STM - Manipulation of atoms (manipulator – tweezer – nanodots – self assembly – nanolithography) - Nano materials - Plasma arcing - Chemical Vapor Deposition - Sol gel - Electrodeposition - Ball milling - Applications of Nanomaterials

TEXT BOOKS:

1. Elements of material science by Van Vlack L.R. Addison Wesley Publishing Co.
2. Corrosion Engineering by Mars G.Fontana
3. Nanotechnology : Basic Science and Emerging Trends – Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons and BurkhardReguse, Overseas Press

REFERENCES :

1. Material science and Engineering by V.Raghavan.
2. Material Science by William Smith

Course Outcomes:

1. Able to understand classification, properties and the structures of Engineering materials. Able to have knowledge on Crystal imperfections.
2. To learn various deformations regarding Creep, Fracture, Cold and Hot working.Able to understand Phase diagram and its applications. To learn various heat treatment process regarding Annealing, Quenching and Tempering.
3. Able to understand the Mechanical and Electrical properties of Ceramic materials. Able to understand various forms of Composites.
4. Able to learn various forms of Corrosion. Able to have knowledge on Corrosion prevention and control.
5. Able to have knowledge on Evolution of Nanotechnology, Electron Microscope and its applications.

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

CH505C **INDUSTRIAL MANAGEMENT**

Instruction hours /week: 3 (L) Credits: 3 Assessment: 40 + 60

COURSE DESCRIPTION:

This course is designed for students to understand the functions of management at various levels of an organization. Plant layout and the factors influencing production are also discussed. Elements of cost, quality control and plant maintenance are also discussed.

Course Objectives:

1. To understand the concept of management, administration, organization, objectives, nature, scope, role, responsibilities & approaches of a management.
2. Enable the students to be educated with planning/production and plant layouts, studying about strategies of material handling and equipment's, selection of site locations andStudy PPC through PERT/CPM.
3. Able to familiarize the basic cost concepts, allocation and control of various costs and methods of costing, purchasing, inventory control systems, EOQ models, etc.
4. Understand the concept of control charts, TQM concepts towards improvement of quality through quality improvement techniques.
5. Gain personal and professional insight intoplant Maintenance in an Industry, personnel management, exposure to the industrial relations and related aspects prevailing in industries and various Labor Legislations applicable to businesses.

UNIT:I

Administration, Management and Organisation, Scientific management, functions of management, principles of management, types of organization/Principles for organization, enterpreneurship - Concept, need development of enterpreneual talents, pitfalls and steps for successful enterpreneurship.

UNIT - II:

Plant location, location factors, plant layout, objectives, types of lay outs, material handling, objectives, equipment and factors influencing their selection.

Production planning and control - objectives and functions, types of production systems - project scheduling: Introduction to PERT/CPM Techniques,

Marketing management – introduction and functions.

UNIT - III:

Elements of cost - methods of allocation of overhead charges - outlines of financial cost and cost accounting - methods of costing and control - sources of finance.

Purchasing - objectives, source selection and vendor rating - stores management - inventory management, basic EOQ model and inventory control systems – ABC Analysis

UNIT - IV:

Quality – Control charts – Control charts for Variables (X and R charts) – Control charts for attributes (p and C charts only) - acceptance sampling plans(single sampling only) - OC curve and its characteristics – Reliability - Total Quality Management - Quality costs – Quality Circles – Six-sigma concept – Quality improvement techniques – Introduction to ISO-9000

UNIT - V:

Plant Maintenance – need and Objectives – types of maintenance – safety in industries – principles of accident prevention in chemical industries

Personnel Management - functions - role of personnel manager -concepts of job evaluation and merit rating- Factories act - Industrial disputes - Collective bargaining - labor participation in management .

Text Books:

1. Management for business and industry - Claude S George Jr.
2. Industrial Engineering and Management - O.P.Khanna

Reference Books:

1. Production Control - Moore
2. Production -operation Management - Adam &Eberts.
3. Operations management - Joseph G. Marks.

Course Outcomes:

1. Understand the evolutionary development of management thought, general principles of management and conceptof entrepreneurship.
2. Able to identify and design plant location, plant layout, material handling systems and apply forecasting and PPC techniques to production systems.
3. To realize the importance of significance of quality, manage quality improvement teams and identify requirements of quality improvement programs for various industries.
4. Able to construct an operating characteristic curve for various sampling plans, construct and interpret various charts and apply quality improvement techniques in real world situations.
5. Understand the philosophy and basic concepts of quality improvement, design, use, and interpret control charts for variables, attributes, and quality improvement techniques.

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

CH506C INDUSTRIAL SAFETY& HAZARD ANALYSIS

Instruction hours /week : 3 Credits : 3 Assessment: 40+ 60

Course Description:

This course is designed to chemical engineering students to understand the importance of safety in process industries. Various government regulations to be followed in process industries can be learned. Safety measure to be taken when any accident took place in process industries and various software techniques to identify the range of damage to the process industries are studied.

Course Objectives

1. To learn about accident and loss statistics, safety concepts
2. To educate about industrial hygiene, evaluation and control of toxic releases
3. To give knowledge about fire and explosions, prevention methods and designs
4. To know about relief systems like types, relief sizing for different services
5. To educate about hazards identification and different hazop studies.

UNIT – I

Introduction: Safety concepts and programs, Engineering ethics – Accident and loss statistics – Acceptable risk public perceptions – Nature of the accident process and inherent safety.

Toxicology: Methods of entry of toxins in to biological organisms and their effects – Elimination of toxicants from Biological organisms – Toxicological studies – Thresh hold limits – models for dose and response curves.

UNIT – II

Industrial Hygiene: Government regulations – process safety and risk management. Plan – Industrial hygiene identification, evaluation and control toxic release and dispersion models; important source models dispersion models of puff with no wind and wind pubb with no wind and with source on ground – pasquill – Gifford model – worst case conditions – effect of release momentum and Buoyancy and release mitigation.

UNIT – III

Fires and Explosions : The fire triangle – distinction between fires and explosions – definitions – Flammability characteristics of liquids and vapors – Flam mobility diagram ignition energy – Auto ignition and adiabatic compression – ignition sources – sprays and mists – explosions and their characteristics – damage to people and property – fires explosion – prevention methods and designs.

UNIT – IV

Relief concepts – definitions – location of relieves – Relief types, scenarios data for sizing and relief systems relief-sizing for liquid and gas services – rupture disc relieves – two-phase flow during run away reaction relieves – deflagration venting for dust and vapor explosions – venting for fires external to process vessels – venting for thermal expansion of process fluids.

UNIT – V

Hazard Identification – Check lists – Surveys HAZOP and HAZAN Studies – safety reviews – Review of probability theory – Event trees – Fault trees – QRA and LOPA analysis – Accident Investigations with typical case histories.

Text Book:-

D.A. Crowl and J.F.Louvar – Chemical process safety (Fundamentals with applications) Printice Hall (2002)

References:-

1. H.H.Faweett and W.S.Wood – Safety and accident prevention in chemical operations, 2nd edn, John wiley and sons, 1982.
2. Coulsion and Richardson – Chemical Engineering – R.K.Sinnot, Vol-6, Butterworth – Heinmann Ltd., 1996.

Course Outcomes: At the end of the course, student will be able to

1. Knows about different types of accidents and loss statistics, risk to public life and safety measures to be taken
2. Is able to understand about government regulations of industrial hygiene , identification of hygiene evaluation and control of toxic releases
3. Able to learn difference between fire and explosion, flammability characteristics of liquids and vapors
4. Knows about relief definition, types, relief sizing for liquid and gas services and about rupture disc relieves
5. Have knowledge about hazard, surveys of hazard and different hazop studies and Can understand QRA and LOPA analysis, event trees, fault trees, accident investigations

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

CH506C **ENERGY ENGINEERING**

Instruction hours /week : 3 Credits : 3 Assessment: 40+ 60

Course Description:
This course is designed to chemical engineering students to understand the energy consumption at various sectors and to identify various sources of alternative energy. Students can identify various techniques for renewable energy sources.

Course Educational Objectives:

1. To understand the present situation of energy supply and consumption rate in the world and India.
2. Make the students to have knowledge on alternative energy sources like solar energy,nuclear energy resources, and hydrogen energy and non-conventional energies like gobar gas plants, wind energy, ocean energy and geothermal energy.
3. To understand the importance of fuel cell and their working
4. To understand the renewable energy sources like wind energy.
5. Students will learn principles of conservation and audit,to get knowledge on economic concept of energy.

UNIT – I:

Scenario – Energy Consumption as a measure of prosperity – World energy future – Energy consumption (world & India) Energy Sources and its availability

Fossil fuels - Coal and coke – Occurrence, preparation, classification

Petroleum and natural gas – Constitution, occurrence, sources and production.

Processed fuels - Water gas, Producer gas, Refinery gas, LPG.

UNIT – II:

Solar energy– Solar radiation at earth's surface – Solar energy collectors – Flat plate collectors, Concentrating collectors, non concentrating collectors Storage systems – Solar pond, extraction of thermal energy, applications . Applications of Solar Energy and conversion methods.

UNIT – III:

Chemical energy sources – Fuel Cells – Classification – Types – Applications

Nuclear energy – Uranium as Energy source, types of reactors – sources in India, Nuclear Fuel Complex

Hydrogen energy – Introduction – Storage – Transportation – Utilization of Hydrogen gas – Hydrogen as an alternative fuel

UNIT - IV:

Other non-conventional energy sources –

Gobar gas plants – Principle, construction and working – KVIC Plant – Impact on rural development –

Wind energy - Introduction – Wind energy conversion system – classification - advantages & disadvantages – applications – storage

Ocean energy – Ocean Thermal electric conversion – open cycle, closed cycle – Utilization

Geothermal energy – Introduction – Geothermal sources – hydrothermal sources – advantages & disadvantages – applications

UNIT – V :

Energy conservation – Economic concept of energy – Principles of conservation and audit – cogeneration – heat recuperators – regenerators – heat pipe – heat pump

REFERENCE:

1. Conventional Energy Technology – Fuels an Chemical Energy by S.B.Pandya, TMH
2. Energy Resources, Demand and Conservation (with special reference to India) by ChamanKashkari, TMH (1975).
3. Solar Energy Utilization, G.D.Rai, Khanna Pub. (1984).
4. Non-conventional Energy Sources G.D.Rai, Khanna publications.
5. Energy Conservation and Utilization by JerroldH.Krentz, Allyn and Bacur Inc1976.
6. Elements of Energy Conservation by Rused C.K, McGraw-Hill

Course outcomes

1. Students will be able to understand present situation of energy resources
2. Students will be able to get knowledge on solar energy collectors ,Students will come to know applications of solar energy and conversion methods .
3. Able to understand utilization of Hydrogen energy, Have the knowledge on fuel cells
4. Able to implement principles and working knowledge of Gobar plants, Will have the knowledge on wind energy and its applications, Acquired knowledge on ocean thermal electric conversion.
5. Acquired basic knowledge on economic concept of energy and principles of conservation and audit.

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

CH506C **INDUSTRIAL EFFLUENT TREATMENT**

Instruction: 3 hr/week Credits : 3 Assessment: 40+ 60

Course Description:

This course is designed for chemical engineering students to understand the various laws for theprotection of environment. Types of pollutions, causes for pollution and different methods used for the mitigation of pollution can learn by the students.

Course Educational Objectives:

1. Develop and apply high performance structural materials ,systems and Improve the reliability, performance, and disaster-resistance of water supplies, treatment processes, and distribution systems
2. Create new engineering materials to improve the performance of infrastructure and Characterize and mitigate natural and man-made hazards
3. Improve fundamental knowledge of the inter-relationships between the built environment and natural systems
4. Develop the technological innovations needed to safeguard, improve, and economize infrastructure and society
5. Pursue lifelong learning through continuing education and/or advanced degrees in environmental engineering or other related fields.

UNIT – I:

INTRODUCTION TO ENVIRONMENT - Environmental pollution - causes and effects - Legislation for environmental pollution control - water act 1974 and clean air act 1981.Waste water sources – domestic, municipal and industrial - characterization – treatment requirements, Analysis of pollutants.

UNIT - II:

WASTE WATER TREATMENT - Removal of BOD- biological treatment- activated sludge process, aerobic and anaerobic processes, Neutralization and clarification, etc., special separations such as adsorption, ion exchange, reverse osmosis, electro dialysis.

UNIT – III:

POLLUTION CONTROL FOR SPECIFIC POLLUTANTS – Removal of Chromium, phenolic effluents, particulate matter, sulfur dioxide, oxides of nitrogen, Pollution control aspects of fertilizer industries, petroleum refinery and petrochemical units and miscellaneous industries.

UNIT –IV:

AIR POLLUTION - Types of pollutants and their effect on vegetation and materials – meteorological factors – air quality - control methodologies for air pollution, Solid waste management – Characteristics of municipal solid waste and hazardous materials – collection and transportation - treatment methods - land filling, incineration - recovery and disposal.

UNIT – V :

HAZARD WASTE TREATMENT: Types – Sources, properties of hazardous waste.Primary, secondary & tertiary treatment for liquid wastes, treatment of gaseous wastes.Conventional/modern unit operations for separations, bio-remediation.Physico chemical and biological treatment. Case studies; CN, HCN, phenolics.

REFERENCES:

1. S.P. Mahajan ,Pollution Control in process Industries Tata McGraw Hill
2. E.B.Beseheivre, M.Schwartz, Treatment of Industrial Wastes McGraw Hill.
3. Pollution control in Process Industries, Mahajan byC.S.Rao Wiley Eastern Ltd., (1992).
4. Environmental pollution control Engg by C.S.Rao Wiley Eastern.
5. Industrial Effluent Treatment Vol.1 J.K.Walters and A.Wint.
6. Industrial Effluent Treatment Vol.2 J.K.Walters&A.Wint Applied Science publishing Ltd. London.
6. Treatment of Hazardous wastes Noyes Data corp. NJ (1983).

COURSE OUTCOMES :

1. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability.
2. An ability to recognition of the water treatment processes and control methodologies for air pollution. An ability to use different techniques for hazard waste treatment. Able to understand about removal of BOD, Chromium and Particulate matter.
3. An ability to know about the main sources of different types of pollutions and control methods, Student can reach to reduce the pollution control aspects of fertilizer industries, petroleum refineries.
4. An ability to know types of air pollution and their effect on vegetation, control methodologies for air pollution. Characteristics of municipal solid waste, its treatment methods.
5. An ability to apply knowledge of biological treatment methods and case studies for hazard waste treatments like CN, HCN and heavy metals. An ability to design the equipment for removal of particulate matter from effluent gases.

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

CH507L **MASS TRANSFER OPERATIONS LAB**

Instruction : 3hr/ week Credits:1.5 Assessment: 40 + 60 V Semester

10 / 12 experiments from

1. Diffusion In Still Air
2. .Diffusion Through Porous Wall
3. Surface Evaporation
4. Wetted Wall Coloumn
5. Vapour- Liquid Equilibrium
6. Liquid-Liquid Equilibrium
7. Humidification/Dehumidification In Packed Column
8. Continuous Drying
9. Differential Distillation
10. Absorption In Bubble Column
11. Spray Extraction Column
8. Ion-Exchange Column
12. Absorption In Packed Tower

CH508L **PROCESS DYNAMICS AND CONTROL LAB**

Instruction hours /week : 3 (P) Credits: 1.5Assessment: 40 + 60 VI Semester

1. Characteristics of Control Valves
2. Dynamics of Liquid Filled Manometer
3. Dynamics of Mixing Process
4. Study of Two Interacting Liquid Level Systems
5. Characterization of Liquid Level System
6. Dynamics of Stirred Tank with Heat Transfer
7. Study of Temperature Control Loop
8. Characteristics of I/P Converter
9. Response of Pressure Vessels
10. Dynamics of Thermometer

CH509S **COMPUTATIONAL TECHNIQUES LAB**

Instruction : 3hr/ week Credits: 1.5 Assessment: 40 + 60 V Semester

Exposure to MAT Lab with the following

1. Euler's Method
2. Runge-Kutta Fourth Order Method
3. Regular Falsi Method
4. Newton Raphson Method
5. Newton Raphson Multiple Roots Method
6. Newton Forward Interpolation Method
7. Newton Backward Interpolation Method
8. Lagranges Interpolation Method
9. Jacobi Iteration Method
10. Gauss-Siedel Iteration Method

MC510B **UNIVERSAL HUMAN VALUES**

Instruction: Hours/Week: **2L:0T:0P** **Credits: 0** **Marks:100**

Pre-requisites/co-requisites: None.

COURSE DESCRIPTION:

The methodology of this course is universally adaptable, involving a systematic and rational study of the human being vis-à-vis the rest of existence. It is free from any dogma or value prescriptions. This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with and within the student himself/herself finally.

COURSE OBJECTIVES:

1. To develop a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. To understand (or developing clarity) the harmony in the human being, family, society and nature/existence.
3. To strengthen self-reflection and to develop commitment and courage to act.
4. To understand social responsibility of an engineer.
5. To appreciate ethical dilemma while discharging duties in professional life.

COURSE CONTENT:

UNIT I: Introduction – Need, Basic Guidelines, Content and Process for Value Education: Purpose and motivation for the course, Self-Exploration–what is it? – Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. Continuous Happiness and Prosperity- A look at basic Human Aspirations. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.Understanding Happiness and Prosperity correctly – A critical appraisal of the current scenario. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

UNIT II: Understanding Harmony in The Human Being – Harmony in Myself! :

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' – happiness and physical facility (Sukh and Suvidha). Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Health.

UNIT III: Understanding Harmony in The Family and Society- Harmony in Human-Human Relationship: Understanding harmony in the Family – the basic unit of human interaction. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness (Ubhay-tripti); Trust **(Vishwas)** and Respect **(Samman)** as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and competence.

Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution (Samadhan), Prosperity (Samridhi), fearlessness (**Abhay**) and co-existence as comprehensive Human Goals.Visualizing a universal harmonious order in society- Undivided Society (AkhandSamaj), Universal Order (SarvabhaumVyawastha) – from family to world family.

UNIT IV: Understanding Harmony in The Nature and Existence – Whole Existence as Coexistence: Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature.Understanding Existence as Co-existence of mutually interacting units in all-pervasive space. Holistic perception of harmony at all levels of existence.

UNIT V: Implications of The Above Holistic Understanding of Harmony on Professional Ethics: Natural acceptance of human values. Definitiveness of Ethical Human Conduct.Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations.

COURSE OUTCOMES: On completion of this course, the students will be able to

1. To become more aware of themselves, and their surroundings (family, society, nature)
2. Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.
3. Understand the role of a human being in ensuring harmony in society and nature.
4. To become sensitive to their commitment towards what they have understood (human values, human relationship and human society)
5. Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.

TEXT BOOKS:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.
2. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan VidyaPrakashan, Amarkantak, 1999.

REFERENCE BOOKS:

1. E. F. Schumancher, 1973, Small is Beautiful: a study of economics as if people mattered. Blond & Briggs, Britain.
2. A. N. Tripathy, 2003, Human Values, New Age International Publishers.

3. Ivan IIIich, 1974, Energy & Equity, The Trinity Press, Worcester, and HarperCollins, USA
4. A Nagraj, 1998 Jeevan VidyaekParichay, Divya Path Sansthan, Amarkantak.
5. Sussan George, 1976, How the Other Half Dies, Penguin Press, Reprinted 1986, 1991.
6. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen(Vaidik) Krishi Tantra Shodh, Amravati.
7. E G Seebauer& Robert L.Berry, 2000, Fundamentals of Ethics for Scientists & Engineers, Oxford University Press.
8. M Govindrajan, S Natrajan& V. S Senthilkumar, Engineering Ethics (including Humna Values), Eastern Economy Edition, Prentice Hall of India Ltd.
9. The Story of My Experiments with Truth – by Mohandas Karamchand Gandhi.
10. India Wins Freedom – Maulana Abdul Kalam Azad.

Relevant CDs, Movies, Documentaries & Other Literature:

1. value Education website, http://www.uptu.ac.in
2. Story of Stuff, http://www.storyofstuff.com
3. AI Gore, An Inconvenient Truth, Paramount Classics, USA
4. Charle Chaplin, Modern Times, United Artists, USA
5. IIT Delhi, Modern Technology – the Untold Story.

B.TECH VI SEMESTER CHEMICAL ENGINEERING

CH601C **CHEMICAL REACTION ENGINEERING - II**

Instruction hours /week: 3 (L) Credits: 3 Assessment: 40 + 60

COURSE DESCRIPTION:

This course is designed to chemical engineering students to understand the reasons for non-ideality of reactor used in process industries, can able to identify the types of reactions occurring and the rate controlling mechanism in solid-fluid reactions. Types of catalysts and mechanism of catalyst in chemical reactions can be identified. Adsorption phenomena and types of adsorption isotherms can be studied.

Course Educational Objects:

1. To develop a general methodology of combining reaction chemistry and chemical engineering concepts,
2. To optimize variety of systems where modeling or engineering of reactions is needed.
3. To understand the suitability and performance characteristics of different types of reactors like packed bed reactors mixed reactors
4. To teach various types of flows like Ideal flow, Non-Ideal flow and mixing of fluids
5. To understand the mechanism of solid Catalyzed reactions and fluid –fluid reactions

UNIT - I: Non Ideal Flow

Residence time Distribution of fluid in Vessels - E curve, the age distribution of fluid leaving in Vessel, Experimental methods, the F curve the C curve Relations among F, C and E curves, mean time for closed vessels, useful mathematical tools, ways of using Age distribution information. Conversion directly from Tracer information - linear process. Models for Non ideal flow - Segregation model, Dispersion Model, Tanks in series Model, Diagnosing ills of operating Equipment. Chemical reaction and dispersion.Mixing of fluids - self mixing of a single fluid and Mixing of two miscible fluids.

UNIT - II: Heterogeneous processes, catalysis and adsorption:

Heterogeneous Processes - Global Rates of Reaction, types of heterogeneous reactions. Catalysis - The nature of catalytic reactions, the mechanism of catalytic reactions.

Adsorption - Physical adsorption and Chemical Adsorption. Adsorption Isotherms, Rates of Adsorption. Solid catalysis - Determination of physical properties - Surface Area, Void volume, solid density, pore volume distribution.Classification of catalysts - Catalyst preparation - promoters and inhibitors, Catalyst deactivation.

UNIT - III : Solid - Catalyzed Reactions:

The Rate Equation Rate of Adsorption, Desorption, Surface Reaction, Rate of equations in terms of Fluid - phase concentrations at the catalyst surface - film resistance controls, surface phenomenon controls, Qualitative analysis of rate equation, qualitative predictions from Active - site theory, Quantitative interpretation of kinetic data, pore diffusion resistance important, diffusion in single cylindrical pores, diffusion porous catalysts, heat effects during reaction, combination of resistances for isothermal particles.

Experimental methods for finding rates - Comparison of Experimental Reactors, Determination of controlling resistances and the rate equation.

UNTI - IV : Fluid- Fluid Reactions:

The rate equation, kinetic regimes for Mass Transfer and Reaction, Rate equations for instantaneous fast, slow, intermediate and infinitely slow reactions. Hatta number and enhancement factor for first order reactions, tower reactor design.

UNIT - V : Fluid particle non-catalytic reactions;

selection of a model - unreacted core model for spherical particles of unchanging size - diffusion through gas film controls - diffusion through ash layer controls - chemical reaction controls - rate of reaction for shrinking spherical particles - chemical reaction controls - gas film diffusion controls - determination of the rate - controlling step - application to design.

Text Books:

1. Levenspiel O Chemical Reaction Engineering 3rd ed. John Willey
2. 2. Smith J.M. Chemical Engineering Kinetics 3rd ed. McGraw Hill Newyork

Reference Books:

1. Elements of Chemical Reaction Engineering by H Scott Fogler, 2nd ed. PHI 1992

Course Outcomes:

1. Residence time Distribution of fluid in Vessels, the F curve the C curve Relations. Formulate a residence time distribution from tracer experiment results and use it to predict conversion in a non-ideal reactor.
2. Write reaction rate equations for common types of homogeneous and heterogeneous reactions. Physical adsorption and Chemical Adsorption.
3. Identify the mechanisms involved in a heterogeneous reaction and formulate an effective rate equation.
4. Calculate the impact of changing solid (or fluid) properties on the conversion of a heterogeneous reaction.
5. Fluid particle non-catalytic reactions. unreacted core model for spherical particles, chemical reaction controls.

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

CH602C **TRANSPORT PHENOMENA**

Instruction hours /week: 3 (L) Credits: 3 Assessment: 40 + 60

COURSE DESCRIPTION:

This course is designed to chemical engineering students to understand the fluid flow dynamics in different conduits. Students are able to apply the fundamental mass, energy, and momentum balance equations to identify the flow conditions. They can able to apply boundary conditions for any flow system.

Course Educational Objectives

1. Study the fluid dynamics, heat transfer and mass transfer together at the introductory level.
2. Carry out macroscopic mass, momentum and energy balance to solve engineering problems related to fluid and heat flow laminar flow.
3. Give an idea about simple flow problems involving Non-Newtonian models and turbulent flows.
4. Perform dimensional analysis of equation of motion and energy, time smoothed operations.
5. Analyze flow past solid surface, through packed bed and in fluidized beds and they can able to Focus on diffusivity and mechanism of mass transport, diffusion through a stagnant gas film and falling film

UNIT - I: Introduction to momentum transport - viscosity and the non-Newtonian fluids – pressure and temperature dependence of viscosity of liquids and gases. Viscosity distribution in laminar flow, shell momentum balances and boundary conditions, flow of a falling film – flow through circular tube and annulus – adjacent flow of two immiscible liquids.

UNIT - II: Equations of continuity and motion – Application of Navier Stokes equation and Euler equation for laminar - steady flow problems, tangential annular flow of a newtonian fluid - shape of the surface of a rotating liquid – dimensional analysis of the equation of change – 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 flow (far from wall).

UNIT – III: Inter-phase transport in isothermal systems, friction factors for flow in tube – pressure drop calculations, friction factors for flow around spheres – packed columns. Macroscopic mass, momentum and mechanical energy balances, Estimation of friction loss - pressure rise and friction loss in a sudden expansion, performance of a liquid – liquid ejector - power requirements for a pipe line flow.

UNIT - IV: Energy transport by 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 an 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 and around submerged

objects - heat loss by free convection from a horizontal pipe – condensation of pure vapors on a solid surface.

UNIT - V: 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.

Text Books:

1. Transport Phenomena by R.B.Bird, Warren E stewart and Edwin N Light foot, Wiley International Editors, Chemical Engineering Series.

Course Out comes:

1. Have the knowledge of derivations of the momentum, heat, mass flux distributions and also velocity, temperature, concentration distributions for various systems.
2. Able to Solve continuity, Navier-Stokes and energy equations to analyze engineering problems related to Newtonian fluid flow laminar flow,Perform dimensionless forms of three transport phenomena.
3. Educate about the formation and calculation of fluid friction in pipes, conduits and around sphere.
4. Know the different types of heat transfer coefficients and performance of liquid – liquid ejector.Have the knowledge of temperature, pressure dependence of viscosity, thermal conductivity and mass diffusivity.
5. Understand the diffusion with homogeneous and heterogeneous chemical reaction.

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

CH603C PLANT DESIGN AND PROCESS ECONOMICS

Instruction hours / week: 3 hr/week Credits : 3 Assessment : 40 +60

Course Description:

This course is designed for chemical engineering students to understand the concepts of plant design, layout and safety majors to be taken in chemical industries. Students are able identify piping patterns in industries. Can be able to calculate the cash flow patterns by using different methods. Students can learn the various replacement methods used to identify the cost of equipments.

Course Objectives:

1. To understand the general overall design considerations and practical design considerations
2. To understand the plant location ,plant layout, plant operation and control and patent considerations
3. To understand the process design development
4. Gives an idea on time value of money and cash flow patterns
5. It gives an idea on analysis of cost estimation and to determine profitability, alternative investments and replacements

UNIT – I :

Introduction – Chemical Engineering Plant Design-General Overall Design Considerations – Practical Considerations in Design - Engineering Ethics

General Design Considerations – Health and Safety hazards – Loss Prevention – Environmental Protection Plant Location – Plant Layout – Plant Operation and Control – Patent Considerations

UNIT – II :

Process Design Development – Development of Design database – Process Creation – Process Design – Process Flow Diagrams – Piping and Instrumentation Diagrams – Vessel and Piping layout – Equipment Design and Specifications

UNIT – III :

Interest, Time Value of Money, Taxes , and Fixed Charges – Interest – Cost of Capital – Time Value of Money – Cash Flow Patterns – Compounding and Discounting factors – Income taxes – Fixed Charges

UNIT – IV:

Analysis of Cost Estimation – Cash flow for industrial Operations – Factors affecting investment and production costs – capital investment – Estimation of capital investment – Cost Indexes – Cost components in Capital Investment – Methods for estimating capital investment – estimation of revenue – Gross Profit, Net profit and cash flow – contingencies.

UNIT – V:

Profitability, Alternative investments and Replacements – Profitability Standards – Methods for calculating Profitability – Alternative Investments – Replacements – Practical factors in alternative investment and replacement analysis

Text Books:

Plant Design and Economics for Chemical Engineers , 5 th Ed. – Max S.Peters and Klaus D. Timmerhaus and Ronald E.West – McGraw Hill

References :

1. Chemical Engineering Plant Design by Vilbrandt and Dryden, McGraw Hill Intl.
2. Process Engineering Economics by H.E. Schweyer McGraw Hill Co.

Course Outcomes:

1. Students will have knowledge to understand design considerations and engineering ethics. Students able to understand plant location, plant lay out, plant operation and control in a profitable way.
2. Students able to design process flow diagrams, piping and instrumentation diagrams and vessel and piping layout.
3. Students will have the knowledge on interest, time value of money and cash flow patterns useful for cost estimation.
4. Students will have an idea on analysis of cost estimation involves capital investments, estimation of revenue, and cost indexes, students will come to know factors affecting investment and production costs.
5. They will able to find out the alternate investments and replacements, it will also helps the students to understand profitability standards and methods for calculating profitability.

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

CH604C **PROCESS INSTRUMENTATION**

Instruction hours / week: 3 hr/week Credits : 3 Assessment : 40 +60

Course Description:
This course is designed to chemical engineering students to understand various instruments used in process industries to measure the parameters like temperature, pressure, level, composition of various mixtures.

Course Educational Objectives:

1. To learn basic structure and characteristics of measuring elements
2. To learn the construction, working and features of instruments suitable for temperature measurement
3. To learn construction and operation of pressure measuring instruments.
4. To learn construction and working of liquid-level measuring instruments.
5. To understand the utilization of different instruments like Refractometers, spectrometers and to give knowledge about recording, indicating, signaling type instrument.

UNIT - I:

Elements of instruments, static and dynamic characteristics, basic concepts of response of first order type instruments,

Temperature Measurement : mercury in glass thermometer, bimetallic thermometer, pressure spring thermometers, static accuracy and response of thermometers, thermoelectric temperature measurement, resistance thermometer bulbs and circuits, radiation receiving elements, radiation, photoelectric and optical pyrometers.

UNIT - II:

Composition Analysis, spectroscopic analysis by absorption, emission, mass and color measurement spectrometers, gas analysis by thermal conductivity, analysis of moisture, gas chromatography, refractometer.

UNIT - III:

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

UNIT - IV:

Measurement of Head & Level: Head, density and specific gravity - direct measurement of liquid level, pressure measurement in open vessels, level measurements in pressure vessels, measurement of interface level, density measurement, level of dry materials.

UNIT - V:

Flow Measurement : Measurement of Head flow meters, area flow meters, open channel meters, viscosity meters.

Recording instruments, indicating and signaling instruments, transmission of instrument reading, control center, instrumentation diagram, process analysis.

TEXT BOOK:

1. Industrial Instrumentation by Donald P. Eckman, Wiley Eastern, 1950.

REFERENCE:

1.Principles of Industrial instrumentation by Patranabis, TMH.

Course Outcomes :

1. Can understand the basic for measuring device of temperature
2. Can able to measure the composition of the mixture with driffent analytical instruments
3. Can understand driffent instrument for pressure measurement of driffent liquid and elements of pressure measuring device
4. Can understand the level measurement device in the industries
5. Can understand the flow measuring device and various system of control unit in various plant

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

CH604C **POLYMER SCIENCE AND ENGINEERING**

Instruction hours /week : 3 Credits: 3 Assessment: 40+ 60

Course Description;

This course is designed for chemical engineering students to understand various types of polymer materials, various methods for the preparation of polymer components

UNIT - I:

Classification of Polymers, Functionality, Mechanisms of Polymerization, Chair Polymerisation - Free radical, Ionic and cationic Polymerisation - Step polymerization methods. Stereoisomerism in Polymers, Chemicals and Geometrical structures in Polymers.Block and Graft Polymers. Molecular weight of Polymers - weight average, number average and viscosity average molecular weight. Principles and calculations for determination of the molecular weights - Osmometry, Ebulliometry, Light scattering, ultracentrifugation, End group Analysis and viscosity methods.

UNIT II:

Thermodynamics of Solubility of polymers.Transition in polymers.Crystallinity in Polymers.Polymer Degradation method.Kinetics of Polymerization Reactions– Free radical, Ionic Polymerization and step polymerization reactions. Derivation of rate equations and related numerical problems.

UNIT-III:

Polymerization Methods - Bulk, solution, suspension and emulsion polymerization. Comparison of Polymerization methods.Fabrication methods - Compounding Injection molding, Extrusion blow, blow extrusion, calendaring, Rotational molding, Thermoforming and vacuum forming.Polymer processing and Rheology: Non-Newtonian flow, Viscosity of Polymer solutions and suspensions, Constitutive, equations; Capillary Rheometer, Couette Rheometer, Cone and Plate Rheometer, Rheometric characterization of polymer solution and melts.

UNIT-IV:

Brief description of individual polymers.Reaction equations, brief process description with a schematic flow sheet, physical properties and uses of the following polymers.

Individual Polymers**:** Thermosets: Phenol Formaldehyde, Urea formaldehyde, Polyester and epoxy resins, Polyrethane. Thermo plastics: Polyethylene, Polypropylene, PVC, Polystyrene, and Co-polymers, PMMA, Polycarbonates.

UNIT-V:

Applications of Polymers: Membrane Separations: Membrane Applications for Polymeric materials, mechanisms of transport and membrane preparation: Biomedical Applications: Artificial organs, Controlled drug delivery, hemodialysis and hemo filtration; Electronics: Electrically conductive polymers, electronic shielding, encapsulation, photonic polymers.

Reference Books:

1. Polymer Science, V.R.Gowariker, M.V.Viswanthan, Jaidev Sridhar, Wiley eastern Ltd, 1988.
2. Plastics engineering – R.J.Crawford, Butterworth Heinemann
3. Rubber and Plastic Technology – R.Chandra and S.Mishra, CBS Publishers
4. Outlines of Polymer Technology: Manufacture of Polymers by R.N.Sinha, Prentice Hall India.
5. J R Fried – Polymer Science and Technology, Prentice Hall of India Pvt., New Delhi, Eastern Economy Edition, 2000.

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

CH604C **FUNDAMENTALS OF NANOTECHNOLOGY**

Instruction: 3 hr/week **Credits: 3** Assessment: 40+ 60

UNIT – I

Introduction: Importance of Nanotechnology emergence of nanotechnology, size range of nano particles - Thermodynamics and properties of nano scale materials, classification of nano structured materials - Bottom-up and top-down approaches- challenges in nanotechnology. Future of nanotechnology in chemical and Biochemical engineering.

UNIT – II

Synthesis of nano particles and processing: Methods for creating nano structures – processes for producing ultra fine powders – Mechanical grinding – wet chemical synthesis of nano materials – sol-gel emulsion processes-liquid-solid reactions- Gas phase synthesis of nano materials – Furnace, flame assisted ultra sonic spray pyrolysis – Gas condensation (CVC) – cold plasma methods- particle precipitation aided CVD.

UNIT – III:

Characterization of nano systems: Sample preparation and characterization techniques of nano structured materials – scanning electron microscopy (SEM) – Transition election microscopy and X-Ray photo electron and Auger electron spectroscopy (XPS, AES) – Scanning tunneling microscopy (STM), atomic force microscopy (AFM) – powder X-ray difractometry (XRD).

UNIT – IV:

special nano materials: Carbon fullerences and nanotubes – onions – carbon fullerrence- formation, properties and uses – Porous silicon preparation methods- Nano particles of SiC, alumina and zirconia and their sintering techniques – Wafer preparation, wafer cleaning techniques – lithography – etching – Mechanical attrition and nano composites.

Unit – V:

Nano – Engineering applications: Micro electromechanical systems (MEMS) and nano electromechanical systems (NEMS), sensors, microfluidic devices – nano pump – molecular motors – Nano bots – nano medicine – drug delivery systems – catalyis by gold nano particles – wear resistance coatings – weapons – battery and fuel cell electrodes – thermal management – automotive and aerospace components. Environmental impact of nano-particles – ethical, legal and social issues.

Text Books:

3. Introduction to nanotechnology, by Charles P.Poole and Frank Jowens, John wiley (2003)
4. Nanotechnology Research and perspectives, MIT Press (1992)

References:

5. understanding of Nano science and technology, poori Dutta & Sushmita Gupta, Global vision, New Delhi – (2006)
6. Nano materials : Synthesis, properties and Applications A.S.Edestien, R.C.Cammarata, IOP publications, UK (1998)
7. Hand Book of Nanotechnology by Bhushan ,Bharat (Ed) springer (2004)

CH607L **REACTION ENGINEERING LAB**

Instruction hours /week : 3 (P) Credits: 1.5 Assessment: 40 + 60 VI Semester

1. Study of Temperature Dependence of Reaction
2. Kinetics Study under Pseudo Behaviour Conditions
3. Kinetics Study in a Mixed Flow Reactor
4. Kinetics Study in Adiabatic Batch Reactor
5. Modeling of a Mixed Flow Reactor
6. Flow Characterization of a Plug Flow Reactor
7. Modeling of a Packed Bed Reactor
8. Residence Time Distribution in Tanks in Series Assembly
9. Kinetics of Saponification in a Batch Reactor
10. Effect of Mass Transfer on Reaction

CH608S **SIMULATION LABORATORY** **VI Semester**

Instructions/Week: 1 (L) +2 (P) **Credits: 2** **Assessment: 100**

Objectives:

To introduce students to use of software packages for simulation and also analyzing flow sheets

1. Introduction of Software packages.
2. Setting up models for simulation.
3. Flow sheeting concepts.
4. Steady state simulation for generation of VLE data.
5. Steady state simulation for conversion calculation for single and multiple reactions
6. Steady state simulation for heat and cooling duty of heat exchangers.
7. Simulation of flash column.
8. Steady state simulation for Bubble point and dew point calculations.

MC609C **PROFESSIONAL ETHICS IN ENGINEERING**

Instruction: Hours/Week: **2L:0T:0P** **Credits: 0** **Marks:100**

Pre-requisites/co-requisites: None.

COURSE DESCRIPTION:

This course is designed to introduce engineering students to the concepts of engineering ethics. It will allow students to explore the relationship between ethics and engineering and apply classical moral theory and decision making to engineering issues encountered in academic and professional careers. It mainly focuses on improving the capacities of leadership /management through training in professional ethics. Codes of ethics have been invoked as a basis for professional engineering licensure. Violations of such ethical codes have led to many well-known tragic engineering failures that endangered human life and jeopardized public welfare. This discipline will doubtless take its place alongside such well-established fields as medical ethics, business ethics, and legal ethics.

COURSE OBJECTIVES:

To enable the students

1. To create an awareness on Engineering Ethics and Human Values.
2. To instill Moral and Social Values and Loyalty and to appreciate the rights of others.
3. To study the moral issues and decisions confronting individuals and organizations engaged in engineering profession.
4. To study the related issues about the moral ideals, character, policies, and relationships of people and corporations involved in technological activity.

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 – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II Engineering Ethics:

Senses of Engineering Ethics – Variety of moral issues – Types of inquiry – Moraldilemmas – Moral Autonomy – Kohlberg''s theory – Gilligan's theory – Consensus and Controversy –Models of professional roles – 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.

UNIT-IV Safety, Responsibilities and Rights:

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) Discrimination.

UNIT V Global Issues:

Multinational Corporations – Business Ethics – Environmental Ethics – Computer Ethics – Role in Technological Development – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct – Corporate Social Responsibility.

COURSE OUTCOMES:

Upon completion of the course, the student should be able to:

Discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

1. Learn the moral issues and problems in engineering; find the solution to those problems.
2. Learn the need for professional ethics, codes of ethics and roles, concept of safety, risk assessment.
3. Gain exposure to Environment Ethics & computer ethics; know their responsibilities and rights.

Grading /Assessment:

(i). Attendance: 20 marks

(ii). Group Activities/Assignments: 20 marks

(iii). Semester End Examination: 60 marks

TEXTBOOKS:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

REFERENCES:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009.
3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003.
4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.
5. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd.,New Delhi, 2013.

B.TECH VII SEMESTER CHEMICAL ENGINEERING

CH701C BIOPROCESS ENGINEERING

Instruction : 3 hr/week Credits : 3 Assessment : 40 + 60

Course Description:
This course is designed to chemical engineering students to understand the enzyme kinetics for a catalytic actions and industrial applications of enzymes. Students can learn the culture preparation for enzymes, quality control, operating reactors and various product recovery methods.

Course Objectives:

1. To study the mechanism of catalytic action and study production of enzymes
2. To have a view on cell growth
3. To study the operation and cultivation method of cells in bio reactors
4. To have a view on selection and control of bio-reactors
5. To have a knowledge on recovery and purification of products

Unit I : Enzymes :Introduction – Mechanism of catalytic action – Enzyme kinetics – Immobilized Enzyme systems – Methods and kinetics – large scale production of enzymes – medicinal and industrial utilization of enzymes

Unit II : Cells :Microbial diversity- naming of cells – cell nutrients – metabolic regulation – transport of small molecules across cellular membrane Cell Growth – batch growth – Quantifying cell growth – cell growth in continuous culture

Unit III : Bioreactors – I : Operating considerations : choosing the cultivation method – batch and continuous reactors – immobilized cell systems – Solid State Fermentations

Unit IV : Bioreactors – II : Selection, Scale-up and Control: Scale up – bioreactor instrumentation and its control – sterilization of Process fluids

Unit V : Recovery and Purification of Products : Product recovery strategy – separation of insoluble products – cell disruption – separation of soluble products – finishing steps – integration of reactor and separation

Text Book :

3. Bioprocess Engineering – Basic Concepts by Michael L. Shuler and FikretKargi, Prentice Hall of India Pvt. Ltd.,

References :

1. Biochemical Engineering Fundamentals by J.E.BaileyandD.O.Ollis (McGraw-Hill)
2. Biochemical Engineering by S.Aiba, Humphrey and Millis.

Course Outcomes:

1. Able to analyze kinetics of enzymes and immobilized enzyme systems
2. Able to have knowledge on medicinal and industrial utilization of enzymes can learn microbial diversity Have knowledge on cell growth in batch and continuous reactors
3. Able to choose different cultivation methods
4. Have knowledge on bio reactor instrumentation and its control
5. Can understand the strategies of product recovery and separation of soluble and insoluble products

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

CH702C **OPTIMIZATION TECHNIQUES**

Instruction : 3 hr/week Credits : 3 Assessment : 40 + 60

Course Educational Objectives:

1. To teach the best design finding with the available resources is the goal of design optimization. Many of the design problems in aerospace systems (and also other areas) can be cast as optimization problems.
2. To teach the problems can then be solved using the optimization techniques.
3. One can model the problems well only with a good understanding of the theory behind optimization.
4. In this course we will deal with continuous optimization methods with emphasis upon nonlinear programming.
5. Application of optimization techniques for various operations.

UNIT I : Introduction : Formulation of objective function, fitting models to data, classification of functions, necessary and sufficient conditions for optimum, unimodel & multi model functions, analytical methods, Lagrange multiplier method

UNIT II : Numerical methods : Unimodel functions, Newton, quasi-Newton, secant methods, region elimination methods, polynomial approximation, quadratic and cubic interpolation technique for optimum, multimodel functions, direct methods, random, grid, hooke'snelder and mead methods, powell's technique, indirect methods, gradient and conjugate gradient methods, secant method

UNIT III : Linear and Non-Linear Programming : Review of basic concepts of LP Formulations, simplex method, integer, quadratic, geometric and dynamic programming

UNIT IV : Applications- I : Heat transfer and energy conservation, separation processes, fluid flow systems, reactor design and operation, large scale operations

UNIT V : Applications – II :Optimal pipe diameter, optimal residence time for maximum yield in an ideal batch reactor, chemostat, optimization of a thermal cracker using linear programming

Text Book :

1. Optimization of Chemical Process by T F Edgar and D M Himmelblau, McGraw Hill 1998

References :

1. Reklaitis,G.V., Ravindran A., Ragsdell K.M. Engineering Optimization, John Wiley, NY 1980

2. Bile,W.E., Swain J.J., Optimization and Industrial Experimentation, Inter Science,NY 1980

3. Seinfeld J.H., Lapidus L., Process Modeling, Estimation and Identification, Prentice Hall,Engelwood Cliffs, New Jersey,1974

4. Beveridge,C.S., Schechter,R.S., Optimization Theory and Practice McGraw Hill, NY 1970

5. Plant Design & Economics for Chemical Engineers, 5 th Ed – Max S.Peters, Klaus D.Timmerhaus and Ronald E.West, McGraw Hill

Outcomes:

1. An ability to apply knowledge of mathematics, science, and engineering, An ability to design and conduct experiments, as well as to analyze and interpret data.

2. Become familiar with optimization methods Mathematical modeling of optimization problems

3. Implementation of the algorithms discussed and solve realistic design problems,The student should master most of the issues in numerical optimization

4. Develops ability to obtain data and information necessary to formulate and to solve problems related to Chemical Engineering with or without the support of software8.

5. This course introduces you to the optimization theory and tells you how it can be applied to solve design problems.

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

CH703C PETROLEUM REFINING PROCESSES

Instruction Hours/Week: 3(L) Credits: 3 Assessment: 40 + 60

Course Description:

This course is designed for students to understand the origin, composition and physical properties of petroleum. Different treatment methods of crude mixture to get various petroleum products are covered in this course. Various methods to increase the physical properties of petroleum products are also discussed.

Course Objectives:

1. Learn the formation, refining of crude oil and products of refinery.
2. Understand the means of processing data including thermal properties, important products characteristics.
3. Develop skills in drawing neat flow diagrams of different petroleum refining processes. (cracking/reforming/alkylation/isomerization / hydrocracking etc.,) that are aimed at producing high value/demand products.
4. Identify important testing methods for important petroleum products.
5. Have idea on Indian standards for major petroleum products.

UNIT I : Origin, Formation and Composition of Petroleum: Origin and Formation of Petroleum, Reserves and Deposits of World, Petro Glimpses and Petroleum Industry in India, Composition of Petroleum Petroleum Processing Data: Evaluation of Petroleum, Thermal Properties of Petroleum Fractions.

UNIT II : Important Products – Properties and Test Methods

UNIT III : Fractionation of Petroleum: Dehydration and Desalting of Crudes, Heating of Crude-Pipe Still Heaters, Distillation of Petroleum, Blending of Gasolines.

UNIT IV : Treatment Techniques: Fractions-Impurities, Gasoline Treatment, Treatment of Kerosene, Treatment of Lubes, Wax and Purification.

UNIT V: Thermal and Catalytical Processes : Cracking ,Catalytic Cracking, Catalytic Reforming- Introduction and Theory, Naptha Cracking ,Coking, Hydrogen Processes, Alkylation, Isomerization Processes, Polymer Gasolines Asphalt Technology **:** Source of Asphalt , Air Blowing of Bitumen, Upgradation of Heavy Crudes

Text Book

Modern Petroleum Refining Processes by B.K.Bhaskara Rao

Reference Books:

1. Petroleum Refining and Petrochemicals by N.K Sinha

2. Petroleum Refinery Engineering by Nelson, McGraw Hill.

Course Outcomes:

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

1. Describe the formation of crude oil, its refining techniques.
2. Describe the chemical composition and physical properties of crude oil

3. Understand various processes employed in petroleum refinery such that we can meet customer demand in terms of quality & quantity.
4. Demonstrate the different methods available for removal of impurities from crude and products manufacture.
5. Understand, draw and describe the process flow diagrams of various refinery processes like distillation, cracking and reforming etc.

	PO 1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1					1		1	1	1			1
CO2					1							1
CO3					1		1		1			1
CO4					1		1		1			1
CO5					1				1			1

CH703C **CO_2 CAPTURE and UTILIZATION**

Instruction Hours/Week: 3(L) Credits: 3 Assessment: 40 + 60

Course Description:

This course is designed for students to understand the uses of CO_2 ,its capture and storage. Various CO_2 capture techniques are covered. CO_2 utilization techniques and various methods for methods for the assessment of CO_2 life cycle are discussed.

Course Educational Outcomes:

2. To learn the carbon capture and storage techniques
3. To learn various technologies available for carbon capture
4. To learn CO_2 storage and its sequestration
5. To learn various utilizations of CO_2
6. To learn the life cycle assessment of CO_2

UNIT-I : Introduction: Global status of CO_2 emission trends, Policy and Regulatory interventions in
abatement of carbon footprint, carbon capture, storage and utilization (CCS&U)

UNIT-II : CO_2 capture technologies from power plants: Post-combustion capture, Pre-combustion
capture, Oxy-fuel combustion, chemical looping combustion, calcium looping combustion
CO_2 capture agents and processes: Capture processes, CO_2 capture agents, adsorption,
ionic liquids, metal organic frameworks

UNIT-III: O_2 storage and sequestration: Geological sequestration methods, Biomimetic carbon Sequestration

UNIT-IV: CO_2 Utilization: CO_2 derived fuels for energy storage, polymers from CO_2, CO_2 based solvents, CO_2 to oxygenated organics, Conversion into higher carbon fuels, High temperature catalysis

UNIT-V: Environmental assessment of CO_2 capture and utilization: Need for assessment, Green chemistry and environmental assessment tools, Life cycle assessment (LCA), ISO standardization of LCA, Method of conducting an LCA for CO_2 capture and Utilization.

Text Books:

1. Carbon dioxide utilization: Closing the Carbon Cycle, Peter Styring, Elsje Alessandra Quadrelli, Katy Armstrong, Elsevier, 2015, 1st Edition.
2. Carbon Capture, Storage and, Utilization: A Possible Climate Change Solution for Energy Industry , Goel M, Sudhakar M, Shahi RV, TERI, Energy and Resources Institute, 2015, 1st Edition.
3. Carbon Capture and Storage, CO2 Management Technologies, AmitavaBandyopadhyay, CRC Press, 2014, 1st Edition.

Reference Books:

1. Calcium and Chemical Looping Technology for Power Generation and Carbon Dioxide (CO2) Capture, Fennell P, Anthony B, Woodhead Publishing Series in Energy: No. 82, 2015, 1st Edition.
2. Developments in Innovation in Carbon Dioxide Capture and Storage Technology: Carbon Dioxide Storage and Utilization, Mercedes Maroto-Valer M, Vol 2, Woodhead Publishing Series in Energy, 2014, 1st Edition.
3. Fundamentals of Enhanced Oil and Gas Recovery from Conventional and Unconventional Reservoirs, AlirezaBahadori, Elsevier Inc., 2018, 1st Edition.

Online Resources:

1. https://nptel.ac.in/courses/103/107/103107157/
2. https://sequestration.mit.edu/
3. http://www.coal.nic.in/
4. http://moef.gov.in/en/
5. https://mnre.gov.in/
6. https://climate.mit.edu/explainers/carbon-capture
7. https://www.sciencedirect.com/book/9780128130278/fundamentals-of-enhanced-oil-andgas-recovery-from-conventional-and-unconventional-reservoirs#book-info

Course Outcomes: At the end of the course the student will able to

1. Know the CO_2 capture and its importance
2. Know various capture technologies available for CO_2 and its storage
3. Know Geological sequestration methods of CO_2
4. Know various utilization of CO_2
5. Know life cycle assessment of CO_2

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

CH703C WATER CONSERVATION AND MANAGEMENT

Instruction Hours/Week: 3(L) Credits: 3 Assessment: 40 + 60

Course Description:

This course is designed for chemical engineering student to understand the importance of water for various applications. Storage of water, quality, water management methods, minimizing the waste of water and different audit methods for the conservation of water in various industries can be studied.

Course Educational Objectives:

1. Able to learn water quality and its storage methods
2. Able to learn water conservation methods at various work places.
3. Able to learn water flow measurement techniques
4. Able to learn water preservation methods and methods to minimize water evaporation techniques.
5. Able to learn water audit methods at various work places.

UNIT I: Introduction: water cycle, water storage, water quality

UNIT II: water conservation in homes; water conservation in the work place;

UNIT III: water management-water quality, controlling use and quality of water, water flow measurement,

UNIT IV: water quality control, testing water salinity, preserving water quality, minimising evaporation, water sanitation,

UNIT V: water audits; water conservation in agriculture; water conservation in process industry; water conservation in construction industry; water conservation in service industry.

Course Outcomes: At the end of the course the student will able

1 To know the importance of water and its storage techniques

2 To know water conservation techniques at various levels

3 To know water management at various stages

4 To know water quality and water testing methods

5 To know water conservation audits at various places.

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

CH704C **FLUIDIZATION ENGINEERING**

Instruction Hours/Week: 3(L) Credits: 3 Assessment: 40 + 60

Course Description:

This course is designed for students to understand various types of fluidization and its application at industrial levels. Types of gas fluidization and terminal velocity of particle are also discussed. Entrainment in fluidized beds and high velocity fluidization are discussed. Various industrial applications of fluidized bed are covered in this course.

Course Objectives:

1. This course focuses on different types of fluidization, their advantages and disadvantages.
2. Analyze the various types of distributors used for fluidized beds and its design.
3. Study the classification of particles, carry over particles in fluidization and pneumatic transport of solids.
4. Give the knowledge of Transport Disengaging Height (TDH) and its significance in entrainment.
5. This course will help to understand elutriation from fluidized beds and Elutriation constants.
6. This subject focus on solid circulation systems for fast fluidized operations and flow patterns of gas-solid mixtures flowing in horizontal and vertical pipes.
7. Educate the industrial applications of fluidized beds and spouted beds with examples.

UNIT- I

Introduction**:** The Phenomenon of fluidization, Liquid like Behavior of a fluidized Bed, Comparison with other Contacting Methods, Advantages and Disadvantages of Fluidized beds for Industrial Operations, Fluidization Quality, Selection of a Contacting Mode for a given Application, Overall Plan.

Fluidization and mapping of regimes.: Fixed beds of particles: Characterization of particles, fixed beds- One size of particles, fixed beds- Solid with a Distribution of sizes, Determination of the effective Spericity from Experiment. Fluidization without Carryover of particles Minimum Fluidizing Velocity, μ_{mf} ,Pressure Drop-verses-Velocity Diagram, Effect of Pressure and Temperature on Fluidized Behavior, Sintering and Agglomeration of Particles at High Temperature.

UNIT-II

Types of Gas Fluidization without carryover – The Geldart classification of particles; Fluidization with carryover particles – Terminal velocity of particles, u_t — Turbulent and Churning Fluidization – Pneumatic Transport of solids – Fast Fluidization – Voidage Diagrams for All Solid Carryover Regimes; The Mapping of Fluidization Regimes.

The Dense Bed: Distributors, Gas Jets, and Pumping Power: Distributor Types – Ideal Distributors – Perforated and Multiorifice Plates – Tuyeres and Caps – Pipe Grids and Spargers; Gas Entry Region of a Bed; Gas Jets in Fluidized Beds; Pressure Drop Requirements across distributors; Design of Gas Distributors Power Consumption.

UNIT – III

Entrainment and Elutriation From Fluidized Beds**:** Freeboard Behavior – Origin of Solids Ejected in to the Freeboard – experimental Findings; Location of the Gas Outlet of a Vessel – Estimation Of the TDH; Entrainment from Tall Vessels: H_f>TDH – Procedure of Zenz et al. [21,8] – The Elutriation Constant Approach – Relationship between **k** and G_s – Experimental Methods for finding **k** and $\mathbf{k}^*$ - Experimental Findings for $\mathbf{k}^*$ - Entrainment from Short Vessels: H_f<TDH – Freeboard – Entrainment Model.

UNIT – IV

High – Velocity Fluidization**:** Turbulent Fluidized Beds – Experimental Findings; Fast Fluidization - Experimental Findings; The Freeboard – Entrainment Model Applied to Fast Fluidization – Design Considerations; Pressure Drop in Turbulent and Fast Fluidization.

Circulation systems**:** Circuits for the Circulation of Solids – Classification of Circulation Loops – Pressure Balance in a Circulation loop; Finding Require Circulation Rates - Circulation Rate for Deactivating Catalysts – Circulation Rate for a Require Heat Removal Rate.

UNIT – V

Industrial Applications of Fluidized Beds**:** Historical Highlights – Coal Gasification – Gasoline from other Petroleum Fractions – Gasoline from natural and Synthesis Gases - Synthesis Reactions – Metallurgical and Other Processes; Physical Operations – Heat exchange – Solidification of a Melt to make Granules – Coating metal objects with plastic – Drying of Solids - Coating of Objects and Growth of Particles – Adsorption; Synthesis Reactions – Phallic Anhydride – Fischer – Tropsch Synthesis – acrylonotrile by the Sohio Process- Maleic anhydride - Other Catalytic Reactions – Comments – Polymerization of Olefins; Cracking of Hydrocarbons – Fluid catalytic Cracking (FCC) – Fluid Cooking and Flexi – Coking – Thermal cracking; Combustion and Incineration – Fluidized Combustion of coal – Incineration of Solid Waste; carbonization and gasification – Gasification of Coal and coke – Activation of Carbon – Gasification of Solid waste; Cacination; Reactions Involving Solids – roasting Sulfide Ores – Silicon for Semiconductor and Solar cell industries - Chlorination and Fluorination of Metal Oxides – Reduction of Iron oxide; Biofluidization.

Text Book :

1. Fluidization Engineering by Diazo Knuizz&D.Leveaspiel John Wiley.

References :

1. Fluidization by Davidson JF &Harison B, Academic Press.
2. Fluidization and Fluid Particle systems Zenz PA &Othmer D F, Reinhold Pub. Co

Course Out comes:

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

1. Know the advantages, disadvantages, and different types of fluidization and can understand the comparison and selection of contacting methods.
2. Determine the minimum fluidization velocity and terminal velocity and able to design gas distributors and calculate power consumption for fluidized beds.
3. Have the knowledge of characterization of particles and determination of effective sphericity from experiment.

4. Experimental findings of entrainment, Estimation of TDH, and determination of elutriation constants and understand the fast fluidization, application of entrainment models to fast fluidization and solid circulation systems for fluidized beds.
5. Have the knowledge of FCC, Combustion and Incineration of coal and Chlorination and Fluorination of Metal Oxides.

	PO 1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1			1	1	1			1	1			2
CO2			1	1	2			1	2			1
CO3			2	1	1			1	1			1
CO4			1	2	2			1	1			1
CO5			1	1	1			1	1			1

CH704C **FUEL CELL SYSTEMS**

Instruction Hours/Week: 3(L) Credits: 3 Assessment: 40 + 60

Course Description:
This course is designed for students to understand the importance of fuel cells, electrochemistry of fuel cells. Working and components of various types of fuel cell are discussed. Applications of fuel cells, technological and economical challenges are also discussed.

Course Educational Objectives:

1. To understand the evolution of electrochemistry and electrode interfaces
2. To get the knowledge of electrochemical technologies and applications
3. Student will learn the learn the fuel cell principles
4. To understand the electro catalysis of fuel cell reactions
5. To study the modeling analysis

UNIT-I

Introduction – Fuel Cells- Relevance and Importance – Historical Highlights - Difference from Batteries – Fuel Choice – Classification

Electrochemistry – Thermodynamic Aspects of Electrochemical(EC) Energy Conversion – Theoretical Efficiency of Heat of a Reaction to Mechanical Energy – Efficiency of EC Energy Conversion – Factors Affecting Efficiency of EC Energy Conversion Electrode Kinetics of EC Energy Conversion

UNIT-II

Alkaline Fuel Cells – Description – Working Principle – Components - Modules – Fuel Cell Stacks – General Performance Characteristics – Advancements – System Issues – Ammonia as AFC Fuel

Molten Carbonate Fuel Cells – General Principle – Cell Components – Mechanisms of Electrode Reactions- Status

UNIT-III

Phosphorus Acid Fuel Cells- Technology- Electrode Materials and Manufacturing – Stacks and Systems

Solid Oxide Fuel Cells – History – Advantages and Limitations- Cell Components – Electrode Materials – Interconnects – Fuel – Configuration and Performance – Environmental Impact – Applications

UNIT-IV

Direct Methanol Fuel Cells – Technology Evolution – The Noble Metal Issue- The Catalyst – Electro-oxidation of Methanol – The Electrolyte – Non Catalytic Aspects – Methanol Cross over to DMFC – catalyst Optimization and Scale up – Engineering Aspects

UNIT-V

Proton Exchange Membrane Fuel Cells – Basic Scientific aspects- Challenges – Technology Development – Fuel Processing – Modeling Studies of PEMFC Performance – Applications – Challenges to High Temperature Operations – Technological and Economic Challenges

Text Book :

1. Fuel Cell : Principles and Applications – B.Viswanathan and M. AuliceScibioh – Universities Press - 2006

Course outcomes: At the end of the course the student
:Have the knowledge on electrode and electrolyte interfaces

1. Able to implement various electrochemical technologies
2. Will have an idea on fuel cell principles and able to implement the principles
3. Acquire basic knowledge on electrolysis of fuel cell reactions
4. Will have a good knowledge on modeling analysis of fuel cell systems and Can give particular attention to half cell systems.

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

CH704C FUNDAMENTALS OF MICROELECTRONIC MATERIAL PROCESSING

Instruction Hours/Week: 3(L) +1(T) Credits: 3 Assessment: 40 + 60

Course Description:
This course is designed for students to understand the physical properties of various material used as semiconductors. The crystal structure of the materials, chemical rate process kinetics is also discussed. Various chemical vapor deposition techniques are covered in this course.

Cource Educational Objectives :

1) To have a fundamental knowledge about Integrated Circuits and its fabrication.
2) To learn the basic units of Integrated Circuits and Microelectronics processing.
3) To study in detail regarding Incorporation and Transport of Dopants.
4) To learn the Chemical rate processes and Kinetics of Micro processing and o Chemical Vapor deposition reactors and its design.
5) To study in detail regarding to physical and physicochemical rate process and its reactors.

UNIT - I: Integrated circuits and fabrication : Integrated circuits - Semiconductors and charge carriers - Basic relationships and conductivity - Basic units of Integrated circuits – Microelectronics processing.

Silicon Refining and other Raw Materials: Metallurgical Grade Silicon and source Gases – Electronic Grade silicon – Metal organic compounds.

UNIT - II: Bulk Crystal Growth: Introduction - Crystal structures and defects – Crystal Growth and Impurity distribution (Czochralski Technique) – Oxygen precipitation.

Incorporation and Transport of Dopants – introduction - - nature of diffusion in solids - dopant incorporation - radiation damage and annealing - dopant redistribution and autodoping - lithography.

UNIT – III: Chemical Rate Processes and Kinetics: Introduction – Growth processes of films of crystalline structure – homogenous reactions – heterogeneous reactions and deposition kinetics – gas – solid reactions – photochemical reactions – selective deposition

UNIT – IV: Chemical Vapor Deposition Reactors : CVD reactors - regimes of fluid flow – free convection and flow stability - intrinsic kinetics and transport effects - reactor design (isothermal, non isothermal, molecular flow reactors) and further considerations.

UNIT - V: Physical and Physicochemical Rate Processes and Apparatus : Introduction - Evaporation and physical vapor deposition – plasma – Physical sputtering – plasma deposition and gas – solid reactors – plasma etching - PVD apparatuses – plasma reactors.

.Text Book:

1. Fundamentals of Microelectronics Processing – Hong H.Lee, McGraw-Hill

Course Outcomes :

1. To be able to design an Integrated Circuit.Able to have knowledge on Integrated Circuit processing.
2. Able to learn the nature of Diffusion in solids ,Incorporation of dopants and dopant redistribution,to learn the concept of Lithography.

3. Able to have knowledge on Homogenous and Heterogenous reactions involvimg in process.
4. Able to design a Chemical Vapor deposition reactor.
5. Able to design a Physical Vapor deposition apparatus and plasma reactors

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

CH705C PROCESS MODELING AND SIMULATION

Instruction Hours/Week: 3(L) Credits: 3 Assessment: 40 + 60

Course Description:

This course is designed for students to understand to fundamental laws used for the development of mathematical models for chemical engineering systems. Various examples of chemical engineering systems are discussed for mathematical modeling. Numerical methods are also discussed for solving differential equations. Some of the examples are also discussed for simulation.

Course Educational Objectives:

1. To understand the concepts of model, development of model, algebraic equations and linearization.
2. To educate about the development of model in the field of chemical engineering.
3. To have the knowledge on classification of models with examples.
4. To learn about the numerical methods, computer programming and simulation methods.
5. To acquire abilities to propose, solve and simulate simple chemical process, unit operation and control system models in the chemical industry.

UNIT - I: Mathematical models of Chemical Engineering systems. - Fundamentals - Introduction - Fundamental laws. Principles of formation, review of algebraic, ordinary and partial differential equations, solutions of the above equations.
Linearization, probabilization models, development of models by experiment and statistic, regression and correlation analysis.
UNIT - II: Examples of mathematical models of chemical engineering systems, constant volume CSTRs, two heated tanks, gas phase pressurized CSTR, non-isothermal CSTR.
UNIT - III: Introduction to Matrix models, lumped parameter model, distributed parameter model. Examples of single component vaporizer, batch reactor, reactor with mass transfer, ideal binary distillation column, batch distillation with holdup.
UNIT - IV: Computer simulation, numerical methods, computer programming, iterative convergence methods, numerical integration of ODEs. Discrete even and continuous simulation.
UNIT - V: Computer simulation, examples gravity flow tank, three CSTRs, in series, binary distillation column, batch reactor, VLE, dew point &bubble point calculations, counter current heat exchanger. simulation in process control.
Text Book:

1. Process Modeling, Simulation and Control for Chemical Engineering by W.L.Luyben, 2nd ed. McGraw Hill (1990).
2. Ramirez, W: Computational Methods in Process Simulation, Butter worths publishers, New York, 1989
3. LorentzeT.Biegler, Ignacio Grossmann and Arthur W.Westerberg – Systematic Methods of Chemical Process Design – Prentice Hall International, 1997

Reference Book:

1. Edgar, T.F; Himmelblau, D.M; Optimisation of Chemical Processes, McGraw-Hill Book Co; New York.
2. Gaikwad R.W. and Dhirendra – Process Modeling and Simulation – Central Techno Publications, Nagpur, 2004
3. Morton M.Denn – Process Modeling – Longman Scientific & Technical , 1987
4. A.W.Westerberg, H.P.Hutchinson, R.L.Motard and P.Winter – Process Flowsheeting – Cambridge University Press, 1985

Course outcomes: At the end of the course the student will able

1. To understand the use of mathematical model, principles of formulation and fundamental laws and develop models by experiment and correlation analysis,
2. To develop mathematical models of chemical engineering systems like two heated tanks, constant volume CSTRs and gas pressurized CSTR.
3. To have the knowledge of different types of models like lumped parameter, distributed parameter and matrix models.
4. To write the computer programming, learn the simulation of numerical methods, iterative convergence methods, and discrete even and continuous methods.
5. Ability to design, manage and operate chemical process simulation, control and instrumentation procedures.

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

CH705C **COMPUTATIONAL FLUID DYNAMICS**

Instruction Hours/Week: 3(L) Credits: 3 Assessment: 40 + 60

Course Description:

This course is designed to students to understand the importance of computational fluid dynamics and to develop fluid flow equation with computational fluid dynamics. Mathematical behavior of various partial differential equations is discussed. Discretization and simple computational fluid dynamics techniques are also discussed.

Course Educational Outcomes:

1. To learn the importance of computational fluid dynamics in developing the models in fluid dynamics
2. To learn the classification of partial differential equations
3. To learn the various discretization techniques
4. To learn the generation of grid with suitable boundary conditions
5. To learn simple computational fluid dynamics techniques

UNIT I :

Philosophy of CFD – CFD - CFD as a research tool – CFD as a design tool – Examples **Governing Equations of Fluid Dynamics** – Introduction – Models of Flow – The sustainable derivative- Divergence of Velocity – Continuity Equation – Momentum Equation – Energy Equation – Physical boundary conditions – Forms of Governing equations suited to CFD

UNIT II :

Mathematical Behaviour of Partial Differential Equations (PDEs) – Classification of quasi linear PDEs – General Method of determining the classification of PDEs – General Behavior of different classes of PDEs

UNIT III :

Discretization – Basic aspects – Finite Differences – Difference equations – Explicit and Implicit approaches – Errors and analysis of stability

UNIT IV :

Grids with appropriate transformations – General transformation of equations **–** Metrics and Jacobians – Form of governing equations suited to CFD – Stretched grids – boundary fitted coordinate systems – adaptive grids – modern developments in grid generation, finite volume mesh

UNIT V :

Simple CFD Techniques - The Lax – Wendroff Technique – MacCormack's technique - Viscous Flows, Conservation form and space marching **–** Relaxation Technique – Aspects of numerical dissipation and dispersion – Alternating – Direction- Implicit technique – Pressure correction technique

Text Book :

1. CFD : The Basics with Applications – John D. Anderson Jr. TMH Publication

Reference

1 Introduction to CFD – PradipNiyogi, S K Chakrabarthy, M K Laha , Pearson Edu.:

Course outcomes: At the end of the course the student will able to

2 Understand the importance of computational fluid dynamics in fluid dynamics

3 Classify the partial differential equations for computational fluid dynamics

4 Use various discretization techniques

5 Apply boundary condition with the generation grids for fluid flow systems

6 Apply computational fluid dynamics techniques for fluid flow systems

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

CH705C **MEMBRANE SEPARATIONS**

Instruction Hours/Week: 3(L) Credits: 3 Assessment: 40 + 60

Course Description:

This course is designed for students to understand various membranes separation techniques used for separation of the mixture components into pure components. Various applications of membrane separation processes are also discussed. Equipment for membrane systems and various designs of membrane systems are also discussed.

COURSE OBJECTIVES

1. To learn classification and principles of membrane separation processes.
2. To know the applications of membrane separation processes.
3. To get knowledge about ideal separations on capabilities of membrane processes and secondary phenomena occurring in membrane processes.
4. To know about the equipments of membrane processes.
5. To understand the design of membrane systems.

UNIT- I

Introduction to Membrane Separation Processes : Classification of separation process – separating agents – principles of gas permeation, reverse osmosis, ultra-filtration, pervaporation, dialysis, electro-dialysis.

Unit II :

Applications of membrane separation processes - separation of hydrogen or acid gases, Oxygen – nitrogen separation starting from air,- stability of membrane processes for waste water treatment, applications in pulp and paper, electroplating and electro-coating industries – applications in food industry – denaturing of liquid foods , cheese making and whey production.

Unit III :

Ideal separations on capabilities of membrane processes – separation factor, rejection factor, expressions for ideal separation factors

Secondary phenomena in membrane processes : secondary physical and transport phenomena in membrane processes, concentration polarization

Unit IV :

Equipment for membrane processes : Flat sheet, tubular, spiral wound and hollow fiber, membrane modular designs , single entry and double entry separating elements, separation stage, flow configuration.

Unit V :

Design of membrane systems : Design equations for perfect mixing and cross floe configuration, separation stages for gas permeation, reverse osmosis and ultra-filtration. Design equations foe perfect mixing and parallel flow dialyze, simple design equations for electro-dialytic stacks

Reference Books :

1) Membranes in Separation – S.T.Hwang and K.Mammermeyer, Wiley-Interscience, Newyork (1975)

2) Transport Processes and Unit Operations – Christie J.Geankoplis, Prentice Hall of India Pvt.Ltd (2000)

Course Out comes

1. Able to understand overall view of membrane separation processes. Able to learn different processes in reverse osmosis, ultra filtration, dialysis, electrodialysis.
2. have the knowledge on applications of membrane separation processes
3. to have a knowledge on separation factor, expressions for ideal separation factor. To have a knowledge on transport phenomena in membrane processes
4. able learn knowledge on membrane modular designs, single and double entry separating elements.
5. Can understand design equations for mixing and cross flow configurations. Able to design equation for perfect mixing and parallel flow dialyze. to develop the design equation for
   electrodialytic stacks

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