KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADU INDIA

Estd : 1984

REGULATIONS, CURRICULUM & SYLLABI – 2022

(CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION)

(For the students admitted during 2022 - 2023 and onwards)

BACHELOR OF ENGINEERING DEGREE IN CHEMICAL ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

INDEX

KONGU ENGINEERING COLLEGE
PERUNDURAI ERODE – 638 060
(Autonomous)

INSTITUTE VISION

To be a centre of excellence for development and dissemination of knowledge in Applied Sciences, Technology, Engineering and Management for the Nation and beyond.

INSTITUTE MISSION

We are committed to value based Education, Research and Consultancy in Engineering and Management and to bring out technically competent, ethically strong and quality professionals to keep our Nation ahead in the competitive knowledge intensive world.

QUALITY POLICY

We are committed to

- Provide value based quality education for the development of students as competent and responsible citizens.
- Contribute to the nation and beyond through research and development
- Continuously improve our services

DEPARTMENT OF CHEMICAL ENGINEERING

VISION

To be a centre of excellence for development and dissemination of knowledge in ChemicalEngineering for the Nation and beyond.

MISSION

Department ofChemical Engineering is committed to:

MS1: Impart knowledge to students at all levels through a vibrant, dynamic and state of the art intellectual delivery to ensure the creation of a complete Chemical Engineer with a high sense of social responsibility and professional ethics.

MS2: Synergize the efforts of the students and faculty to evolve innovative engineering practices and teaching methodologies.

MS3: Generate an environment of continuous learning and research.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of ChemicalEngineering will

PEO1: Exhibit professional competency in design and development of chemical products, processes and equipment in chemical and allied industries

PEO2: Perform research and development by utilizing and continuously upgrading the experimental skills, Mathematical tools, applied software and simulation practices and engage in futuristic progression

PEO3: Demonstrate interpersonal skills and leadership qualities and contribute to solve multidisciplinary problems in national and global level

MAPPING OF MISSION STATEMENTS (MS) WITH PEOs

MS\PEO	PEO1	PEO2	PEO3
MS1	3	3	2
MS2	2	3	2
MS3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

PROGRAM OUTCOMES (POs)	
Graduates of Chemical Engineering will**:**	
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)	
Graduates of ChemicalEngineering will**:**	
PSO1	**Essentials of Chemical Engineering:**Correlate theoretical concepts with real time experimental and field data through application of process simulation and analytical techniques
PSO2	**Chemical Process Design and Development:**Develop cutting edge chemical processes, equipment and products for the benefit of the human kind using innovative research and development skills and continuous learning efforts

MAPPING OF PEOs WITH POs AND PSOs

PEO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
PEO1		3	3	3	3	2	2				2	1	3	3
PEO2	3		2		2	1	1	1	2	2	1	2	2	3
PEO3		1	2	1	2	3	3	2	3	3	2	1	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638060

(Autonomous)

REGULATIONS 2022

CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION

BACHELOR OF ENGINEERING (BE) / BACHELOR OF TECHNOLOGY (BTech) DEGREE PROGRAMMES

These regulations are applicable to all candidates admitted into BE/BTech Degree programmes from the academic year 2022 – 2023 onwards.

1. DEFINITIONS AND NOMENCLATURE

In these Regulations, unless otherwise specified:

i. “University” means ANNA UNIVERSITY, Chennai.

ii. “College” means KONGU ENGINEERING COLLEGE.

iii. “Programme” means Bachelor of Engineering (BE) / Bachelor of Technology (BTech) Degree programme

iv. “Branch” means specialization or discipline of BE/BTech Degree programme, like Civil Engineering, Information Technology, etc.

v. “Course” means a Theory / Theory cum Practical / Practical course that is normally studied in a semester like Mathematics, Physics etc.

vi. “Credit” means a numerical value allocated to each course to describe the candidate’s workload required per week.

vii. “Grade” means the letter grade assigned to each course based on the marks range specified.

viii. “Grade point” means a numerical value (0 to 10) allocated based on the grade assigned to each course.

ix. “Principal” means Chairman, Academic Council of the College.

x. “Controller of Examinations (COE)” means authorized person who is responsible for all examination related activities of the College.

xi. “Head of the Department (HOD)” means Head of the Department concerned.

2. PROGRAMMES AND BRANCHES OF STUDY

The following programmes and branches of study approved by Anna University, Chennai and All India Council for Technical Education, New Delhi are offered by the College.

Programme	Branch
BE	Civil Engineering
	Mechanical Engineering
	Electronics and Communication Engineering
	Computer Science and Engineering
	Electrical and Electronics Engineering
	Electronics and Instrumentation Engineering
	Mechatronics Engineering
	Automobile Engineering
	Computer Science and Design
BTech	Chemical Engineering
	Information Technology
	Food Technology
	Artificial Intelligence and Data Science
	Artificial Intelligence and Machine Learning

3. ADMISSION REQUIREMENTS

3.1 First Semester Admission

The candidates seeking admission to the first semester of the eight semester BE / BTech Degree Programme:

Should have passed the Higher Secondary Examination (10 + 2) in the academic stream with Mathematics, Physics and Chemistry as three of the four subjects of study under Part-III subjects of the study conducted by the Government of Tamil Nadu or any examination of any other University or authority accepted by the Anna University, Chennai as equivalent thereto.

(OR)

Should have passed the Higher Secondary Examination of Vocational stream (Vocational groups in Engineering / Technology) as prescribed by the Government of Tamil Nadu.

They should also satisfy other eligibility conditions as prescribed by the Anna University, Chennai and Directorate of Technical Education, Chennai from time to time.

3.2 Lateral Entry Admission

The candidates who hold a Diploma in Engineering / Technology awarded by the State Board of Technical Education, Tamilnadu or its equivalent are eligible to apply for Lateral entry admission to the third semester of BE / BTech.

(OR)

The candidates who hold a BSc degree in Science(10+2+3 stream) with mathematics as one of the subjects at the BSc level from a recognised University are eligible to apply for Lateral entry admission to the third semester of BE / BTech. Such candidates shall undergo two additional Engineering course(s) in the third and fourth semesters as prescribed by the College.

They should also satisfy other eligibility conditions prescribed by the Anna University, Chennai and Directorate of Technical Education, Chennai from time to time.

4. STRUCTURE OF PROGRAMMES

4.1 Categorisation of Courses

The BE / BTech programme shall have a curriculum with syllabi comprising of theory, theory cum practical, practical courses in each semester, professional skills training/industrial training, project work, internship, etc that have been approved by the respective Board of Studies and Academic Council of the College. All the programmes have well defined Programme Outcomes (PO), Programme Specific Outcomes (PSO) and Programme Educational Objectives (PEOs) as per Outcome Based Education (OBE). The content of each course is designed based on the Course Outcomes (CO). The courses shall be categorized as follows:

i. Humanities and Social Sciences (HS) including Management Courses, English Communication Skills, Universal Human Values and Yoga & Values for Holistic Development.

ii. Basic Science (BS) Courses

iii. Engineering Science (ES) Courses

iv. Professional Core (PC) Courses

v. Professional Elective (PE) Courses

vi. Open Elective (OE) Courses

vii. Employability Enhancement Courses (EC) like Project work, Professional Skills/Industrial Training, Comprehensive Test & Viva, Entrepreneurships/Start ups and Internship / In-plant Training in Industry or elsewhere

viii. Audit Courses (AC)

ix. Mandatory Courses (MC) like Student Induction Program and Environmental Science.

x. Honours Degree Courses (HC)

4.2 Credit Assignment and Honours Degree

4.2.1. Credit Assignment

Each course is assigned certain number of credits as follows:

Contact period per week	Credits
1 Lecture / Tutorial Period	1
2 Practical Periods	1
2 Project Work Periods	1
40 Training / Internship Periods	1

The minimum number of credits to complete the BE/BTech programme is 168.

4.2.2 Honours Degree

If a candidate earns 18 to 20 additional credits in an emerging area, then he/she can be awarded with Honours degree mentioning that emerging area as his/her specialization. The respective board of studies shall recommend the specializations for honours degree and appropriate additional courses to be studied by the candidate which shall get approval from Academic Council of the institution. A candidate shall have not less than 7.5 CGPA and no history of arrears to opt for the honours degree and has to maintain the same during the entire programme.

Various specializations for various branches recommended by the respective boards of studies are given below:

SNo	Specializations for Honours degree in emerging areas	To be offered as Honours, Only for the following branches mentioned against the specialization
1.	Construction Technology	BE – Civil Engineering
2.	Smart Cities	BE – Civil Engineering
3.	Smart Manufacturing *	BE – Mechanical Engineering
4.	Computational Product Design *	BE – Mechanical Engineering
5.	Intelligent Autonomous Systems *	BE – Mechatronics Engineering
6.	E-Mobility *	BE – Automobile Engineering
7.	Artificial Intelligence and Machine Learning	BE – Electronics and Communication Engineering
8.	System on Chip Design *	BE – Electronics and Communication Engineering
9.	Electric Vehicles	BE – Electrical and Electronics Engineering
10.	Microgrid Technologies	BE – Electrical and Electronics Engineering
11.	Intelligent Sensors Technology *	BE – Electronics and Instrumentation Engineering
12.	Smart Industrial Automation *	BE – Electronics and Instrumentation Engineering
13.	Data Science	BE – Computer Science and Engineering
14.	Cyber Security	BE – Computer Science and Engineering
15.	Data Science	BTech – Information Technology
16.	Cyber Security	BTech – Information Technology
17.	Petroleum and Petrochemical Engineering *	BTech – Chemical Engineering
18.	Waste Technology *	BTech – Chemical Engineering

19.	Food Processing and Management *	BTech – Food Technology
20.	Virtual and Augumented Reality	BE- Computer Science and Design
21.	Data Science	BE- Computer Science and Design
22.	Internet of Things (IoT)	BTech – Artificial Intelligence and Data Science
23.	Blockchain	BTech – Artificial Intelligence and Data Science
24.	Internet of Things (IoT)	BTech – Artificial Intelligence and Machine Learning
25.	Blockchain	BTech – Artificial Intelligence and Machine Learning

*Title by KEC

The courses specified under Honours degree in the emerging area may include theory, theory cum practical, practical, project work, etc. under the particular specialization. A candidate can choose and study these specified courses from fourth semester onwards and he/she shall successfully complete the courses within the stipulated time vide clause 5. Total number of credits earned in each semester may vary from candidate to candidate based on the courses chosen. The registration, assessment & evaluation pattern and classification of grades of these courses shall be the same as that of the courses in the regular curriculum of the programme of the candidate vide clause 6, clause 7 and clause 15 respectively. A candidate can earn Honours degree in only one specialization during the entire duration of the programme.

4.3 Employability Enhancement Courses

A candidate shall be offered with the employability enhancement courses like project work, internship, professional skills training/industrial training, comprehensive test & viva, and entrepreneurships/start ups during the programme to gain/exhibit the knowledge/skills.

4.3.1 Professional Skills Training/ Indsutrial Training/Entrepreneurships/Start Ups/ Inplant Training

A candidate may be offered with appropriate training courses imparting programming skills, communication skills, problem solving skills, aptitude skills etc. It is offered in two phases as phase I in fourth semester and phase II in fifth semester including vacation periods and each phase can carry two credits.

(OR)

A candidate may be allowed to go for training at research organizations or industries for a required number of hours in fifth semester vacation period. Such candidate can earn two credits for this training course in place of Professional Skills Training course II in fifth semester. He/She shall attend Professional Skills Training Phase I in fourth semester and can earn two credits.

(OR)

A candidate may be allowed to set up a start up and working part-time for the start ups by applying his/her innovations and can become a student entrepreneur during BE/BTech programme. Candidates can set up their start up from fifth semester onwards either inside or outside of the college. Such student entrepreneurs may earn 2 credits in place of Professional Skills Training II. The area in which the candidate wants to initiate a start up may be interdisciplinary or multidisciplinary. The progress of the startup shall be evaluated by a panel of members constituted by the Principal through periodic reviews.

4.3.2 Comprehensive Test and Viva

The overall knowledge of the candidate in various courses he/she studied shall be evaluated by (i) conducting comprehensive tests with multiple choice questions generally with pattern similar to GATE and/or (ii) viva-voce examination conducted by a panel of experts assigned by the Head of the department. The members can examine the knowledge of the candidate by asking questions from various domains and the marks will be assigned based on their answers. This course shall carry two credits.

4.3.3 Full Time Project through Internships

The curriculum enables a candidate to go for full time project through internship during a part of seventh semester and/or entire final semester and can earn credits vide clause 7.6 and clause 7.11.

A candidate is permitted to go for full time projects through internship in seventh semester with the following condition: The candidate shall complete a part of the seventh semester courses with a total credit of about 50% of the total credits of seventh semester including Project Work-II Phase-I in the first two months from the commencement of the seventh semester under fast track mode. The balance credits required to complete the seventh semester shall be earned by the candidate through either approved One/Two Credit Courses /Online courses / Self Study Courses or Add/Drop courses as per clause 4.4 and clause 4.5 respectively.

A candidate is permitted to go for full time projects through internship during eighth semester. Such candidate shall earn the minimum number of credits required to complete eighth semester other than project through either approved One / Two Credit Courses /Online courses / Self Study Courses or Add/Drop courses as per clause 4.4 and clause 4.5 respectively.

Assessment procedure is to be followed as specified in the guidelines approved by the Academic Council.

4.3.4 A student shall go for in-plant training for duration of two weeks during the entire programme. It is mandatory for all the students.

4.4 One / Two Credit Courses / Online Courses / Self Study Courses

The candidates may optionally undergo One / Two Credit Courses / Online Courses / Self Study Courses as elective courses.

4.4.1 One / Two Credit Courses: One / Two credit courses shall be offered by the college with the prior approval from respective Board of Studies. A candidate can earn a maximum of six credits through one / two credit courses during the entire duration of the programme.

4.4.2 Online Courses: Candidates may be permitted to earn credits for online courses, offered by NPTEL / SWAYAM / a University / Other Agencies, approved by respective Board of Studies.

4.4.3 **Self Study Courses:** The Department may offer an elective course as a self study course. The syllabus of the course shall be approved by the respective Board of Studies. However, mode of assessment for a self study course will be the same as that used for other courses. The candidates shall study such courses on their own under the guidance of member of the faculty following due approval procedure. Self study course is limited to one per semester.

4.4.4 The elective courses in the final year may be exempted if a candidate earns the required credits vide clause 4.4.1, 4.4.2 and 4.4.3 by registering the required number of courses in advance.

4.4.5 A candidate can earn a maximum of 30 credits through all one / two credit courses, online courses and self study courses.

4.5 Flexibility to Add or Drop Courses

4.5.1 A candidate has to earn the total number of credits specified in the curriculum of the respective programme of study in order to be eligible to obtain the degree. However, if the candidate wishes, then the candidate is permitted to earn more than the total number of credits prescribed in the curriculum of the candidate's programme.

4.5.2 From the first to seventh semesters the candidates have the option of registering for additional elective/Honours courses or dropping of already registered additional elective/Honours courses within two weeks from the start of the semester. Add / Drop is only an option given to the candidates.

4.6 Maximum number of credits the candidate can enroll in a particular semester cannot exceed 30 credits.

4.7 The blend of different courses shall be so designed that the candidate at the end of the programme would have been trained not only in his / her relevant professional field but also would have developed to become a socially conscious human being.

4.8 The medium of instruction, examinations and project report shall be English.

5. DURATION OF THE PROGRAMME

5.1 A candidate is normally expected to complete the BE / BTech Degree programme in 8 consecutive semesters/4 Years (6 semesters/3 Years for lateral entry candidate), but in any case not more than 14 semesters/7 Years (12 semesters/6 Years for lateral entry candidate).

5.2 Each semester shall consist of a minimum of 90 working days including continuous assessment test period. The Head of the Department shall ensure that every teacher imparts instruction as per the number of periods specified in the syllabus for the course being taught.

5.3 The total duration for completion of the programme reckoned from the commencement of the first semester to which the candidate was admitted shall not exceed the maximum duration specified in clause 5.1 irrespective of the period of break of study (vide clause 11) or prevention (vide clause 9) in order that the candidate may be eligible for the award of the degree (vide clause 16). Extension beyond the prescribed period shall not be permitted.

6. COURSE REGISTRATION FOR THE EXAMINATION

6.1 Registration for the end semester examination is mandatory for courses in the current semester as well as for the arrear courses failing which the candidate will not be permitted to move on to the higher semester. This will not be applicable for the courses which do not have an end semester examination.

6.2 The candidates who need to reappear for the courses which have only continuous assessment shall enroll for the same in the subsequent semester, when offered next, and repeat the course. In this case, the candidate shall attend the classes, satisfy the attendance requirements (vide clause 8) and earn continuous assessment marks. This will be considered as an attempt for the purpose of classification.

6.3 If a candidate is prevented from writing end semester examination of a course due to lack of attendance, the candidate has to attend the classes, when offered next, and fulfill the attendance requirements as per clause 8 and earn continuous assessment marks. If the course, in which the candidate has a lack of attendance, is an elective, the candidate may register for the same or any other elective course in the subsequent semesters and that will be considered as an attempt for the purpose of classification.

6.4 A candidate shall register for the chosen courses as well as arrear courses (if any vide clause 6.2 and 6.3) from the list of courses specified under Honours degree.

7. ASSESSMENT AND EXAMINATION PROCEDURE FOR AWARDING MARKS

7.1 The BE/BTech programmes consist of Theory Courses, Theory cum Practical courses, Practical courses, Comprehensive Test and Viva, Project Work, Industrial Training /Professional Skills Training, Internship/In-plant Training and Entrepreneurships/ Start ups. Performance in each course of study shall be evaluated based on (i) Continuous Assessments (CA) throughout the semester and (ii) End Semester Examination (ESE) at the end of the semester except for the courses which are evaluated based on continuous assessment only. Each course shall be evaluated for a maximum of 100 marks as shown below:

Sl. No.	Category of Course	Continuous Assessment Marks	End Semester Examination Marks
1.	Theory	40	60
2.	Theory cum Practical (The distribution of marks shall be decided based on the credit weightage assigned to theory and practical components.)	50	50
3.	Practical	60	40
4.	Professional Skills Training / Comprehensive Test & Viva / Entrepreneurships / Start ups / Project Work I / Mandatory Course/Industrial Training/ Universal Human Values / Yoga and Values for Holistic Development	100	---
5.	Project Work II Phase I / Project Work II Phase II / Internships	50	50
6.	One / Two credit Course	The distribution of marks shall be decided based on the credit weightage assigned	---
7.	All other Courses		

7.2 Examiners for setting end semester examination question papers for theory courses, theory cum practical courses and practical courses and evaluating end semester examination answer scripts, project works, internships and entrepreneurships/start ups shall be appointed by the Controller of Examinations after obtaining approval from the Principal.

7.3 Theory Courses

For all theory courses out of 100 marks, the continuous assessment shall be 40 marks and the end semester examination shall be for 60 marks. However, the end semester examinations shall be conducted for 100 marks and the marks obtained shall be reduced to 60. The continuous assessment tests shall be conducted as per the schedule laid down in the academic schedule. The total of the continuous assessment marks and the end semester examination marks shall be rounded off to the nearest integer.

7.3.1 The assessment pattern for awarding continuous assessment marks shall be as follows:

Sl. No.	Type	Max. Marks	Remarks
1.	Test - I	20	Average of best 2 tests (20 marks)
	Test - II	20	
	Test - III	20	
2.	Tutorial: (Tutorial/Problem Solving (or) Simulation (or) Simulation & Mini Project (or) Mini Project (or) Case Studies (or) Any other relevant to the course)	15	Type of assessment is to be chosen based on the nature of the course and to be approved by Principal
3.	Others: Assignment / Paper Presentation in Conference / Seminar / Comprehension / Activity based learning / Class notes	05	To be assessed by the Course Teacher based on any one type.
	Total	40	Rounded off to the one decimal place

However, the assessment pattern for awarding the continuous assessment marks may be changed based on the nature of the course and is to be approved by the Principal.

7.3.2 A reassessment test or tutorial covering the respective test or tutorial portions may be conducted for those candidates who were absent with valid reasons (Sports or any other reason approved by the Principal).

7.3.3 The end semester examination for theory courses shall be for a duration of three hours and shall be conducted between November and January during odd semesters and between April and June during even semesters of every year.

7.4 Theory cum Practical Courses

For courses involving theory and practical components, the evaluation pattern as per the clause 7.1 shall be followed. Depending on the nature of the course, the end semester examination shall be conducted for theory and the practical components. The apportionment of continuous assessment and end semester examination marks shall be decided based on the credit weightage assigned to theory and practical components approved by Principal.

7.5 Practical Courses

For all practical courses out of 100 marks, the continuous assessment shall be for 60 marks and the end semester examination shall be for 40 marks. Every exercise / experiment shall be evaluated based on the candidate's performance during the practical class and the candidates' records shall be maintained.

7.5.1 The assessment pattern for awarding continuous assessment marks for each course shall be decided by the course coordinator based on rubrics of that particular course, and shall be based on rubrics for each experiment.

7.5.2 The end semester examination shall be conducted for a maximum of 100 marks for duration of 3 hours and reduced to 40 marks. The appointment of examiners and the schedule shall be decided by chairman of Board of Study of the relevant board.

7.6 Project Work II Phase I / Project Work II Phase II

7.6.1 Project work shall be assigned to a single candidate or to a group of candidates not exceeding 4 candidates in a group. The project work is mandatory for all the candidates.

7.6.2 The Head of the Department shall constitute review committee for project work. There shall be two assessments by the review committee during the semester. The candidate shall make presentation on the progress made by him/her before the committee.

7.6.3 The continuous assessment and end semester examination marks for Project Work II Phase I /Project Work II Phase II and the Viva-Voce Examination shall be distributed as below.

Continuous Assessment (Max. 50 Marks)						End Semester Examination (Max. 50 Marks)			
Zeroth Review		Review I (Max.. 20 Marks)		Review II (Max. 30 Marks)		Report Evaluation (Max. 20 Marks)	Viva - Voce (Max. 30 Marks)		
Rv. Com	Supervisor	Review Committee (excluding supervisor)	Supervisor	Review Committee (excluding supervisor)	Supervisor	Ext. Exr.	Supervisor	Exr.1	Exr. 2
0	0	10	10	15	15	20	10	10	10

7.6.4 The Project Report prepared according to approved guidelines and duly signed by the Supervisor shall be submitted to Head of the Department. The candidate(s) must submit the project report within the specified date as per the academic schedule of the semester. If the project report is not submitted within the specified date then the candidate is deemed to have failed in the Project Work and redo it in the subsequent semester.

7.6.5 If a candidate fails to secure 50% of the continuous assessment marks in the project work, he / she shall not be permitted to submit the report for that particular semester and shall have to redo it in the subsequent semester and satisfy attendance requirements.

7.6.6 The end semester examination of the project work shall be evaluated based on the project report submitted by the candidate in the respective semester and viva-voce examination by a committee consisting of two examiners and supervisor of the project work.

7.6.7 If a candidate fails to secure 50 % of the end semester examination marks in the project work, he / she shall be required to resubmit the project report within 30 days from the date of declaration of the results and a fresh viva-voce examination shall be conducted as per clause 7.6.6.

7.6.8 A copy of the approved project report after the successful completion of viva-voce examination shall be kept in the department library.

7.7 Project Work I / Industrial Training

The evaluation method shall be same as that of the Project Work II as per clause 7.6 excluding 7.6.3, 7.6.5, 7.6.6 and 7.6.7. The marks distribution is given below.

<table>
<tr><td colspan="9">Continuous Assessment
(Max. 100 Marks)</td></tr>
<tr><td colspan="2" rowspan="2">Zeroth Review</td><td colspan="2" rowspan="2">Review I
(Max.. 20 Marks)</td><td colspan="2" rowspan="2">Review II
(Max.. 30 Marks)</td><td colspan="3">Review III
(Max. 50 Marks)</td></tr>
<tr><td>Report Evaluation
(Max. 20 Marks)</td><td colspan="2">Viva - Voce
(Max. 30 Marks)</td></tr>
<tr><td>Review Committee</td><td>Supervisor</td><td>Review Committee (excluding supervisor)</td><td>Supervisor</td><td>Review Committee (excluding supervisor)</td><td>Supervisor</td><td>Review Committee</td><td>Supervisor</td><td>Review Committee</td></tr>
<tr><td>0</td><td>0</td><td>10</td><td>10</td><td>15</td><td>15</td><td>20</td><td>10</td><td>20</td></tr>
</table>

If a candidate fails to secure 50 % of the continuous assessment marks in this course, he / she shall be required to resubmit the project report within 30 days from the date of declaration of the results and a fresh viva-voce examination shall be conducted.

7.8 Professional Skills Training

Phase I training shall be conducted for minimum of 80 hours in 3rd semester vacation and during 4th semester. Phase II training shall be conducted for minimum of 80 hours in 4th semester vacation and during 5th semester. The evaluation procedure shall be approved by the board of the offering department and Principal.

7.9 Comprehensive Test and Viva

A candidate can earn 2 credits by successfully completing this course. The evaluation procedures shall be approved by the Principal.

7.10 Entrepreneurships/ Start ups

A start up/business model may be started by a candidate individually or by a group of maximum of three candidates during the programme vide clause 4.3.1. The head of the department concerned shall assign a faculty member as a mentor for each start up.

A review committee shall be formed by the Principal for reviewing the progress of the Start ups / Business models, innovativeness, etc. The review committee can recommend the appropriate grades for academic performance for the candidate(s) involved in the start ups. This course shall carry a maximum of two credits in fifth semester and shall be evaluated through continuous assessments for a maximum of 100 marks vide clause 7.1. A report about the start ups is to be submitted to the review committee for evaluation for each start up and the marks will be given to Controller of Examinations after getting approval from Principal.

7.11 In-Plant Training

Each candidate shall go for In-Plant training for a duration of minimum of two weeks during the entire programme of study and submit a brief report about the training undergone and a certificate issued from the organization concerned.

7.12 One / Twe Credit Courses

For all one/ two credit courses out of 100 marks, the continuous assessment shall be 50 marks and the model examination shall be for 50 marks. Minimum of two continuous assessments tests shall be conducted during the one / two credit course duration by the offering department concerned. Model examination shall be conducted at the end of the course.

7.13 Online Course

The Board of Studies will provide methodology for the evaluation of the online courses. The Board can decide whether to evaluate the online courses through continuous assessment and end semester examination or through end semester examination only. In case of credits earned through online mode from NPTEL / SWAYAM / a University / Other Agencies approved by Chairman, Academic Council, the credits may be transferred and grades shall be assigned accordingly.

7.14 Self Study Course

The member of faculty approved by the Head of the Department shall be responsible for periodic monitoring and evaluation of the course. The course shall be evaluated through continuous assessment and end semester examination. The evaluation methodology shall be the same as that of a theory course.

7.15 Audit Course

A candidate may be permitted to register for specific course not listed in his/her programme curriculum and without undergoing the rigors of getting a 'good' grade, as an Audit course, subject to the following conditions.

The candidate can register only one Audit course in a semester starting from second semester subject to a maximum of two courses during the entire programme of study. Such courses shall be indicated as 'Audit' during the time of registration itself. Only courses currently offered for credit to the candidates of other branches can be audited.

A course appearing in the curriculum of a candidate cannot be considered as an audit course. However, if a candidate has already met the Professional Elective and Open Elective credit requirements as stipulated in the curriculum, then, a Professional Elective or an Open Elective course listed in the curriculum and not taken by the candidate for credit can be considered as an audit course.

Candidates registering for an audit course shall meet all the assessment and examination requirements (vide clause 7.3) applicable for a credit candidate of that course. Only if the candidate obtains a performance grade, the course will be listed in the semester Grade Sheet and in the Consolidated Grade Sheet along with the grade SC (Successfully Completed). Performance grade will not be shown for the audit course.

Since an audit course has no grade points assigned, it will not be counted for the purpose of GPA and CGPA calculations.

7.16 Mandatory Courses

A candidate joined in first semester shall attend and complete a mandatory course namely Student Induction Program of duration three weeks at the beginning of first semester. The candidates studying in second year shall attend and complete another one mandatory course namely Environmental Science. No credits shall be given for mandatory courses and shall be evaluated through continuous assessment tests only vide clause 7.1 for a maximum of 100 marks each. Upon the successful completion, these courses will be listed in the semester grade sheet and in the consolidated grade sheet with the grade “SC” (Successfully Completed). Since no grade points are assigned, these courses will not be counted for the purpose of GPA and CGPA calculations.

7.17 Universal Human Values (UHV) and Yoga and Values for Holistic Development (YVHD)

Courses YVHD shall be offered to all first year candidates of all BE/ BTech programmes to impart knowledge on yoga and human values. Course UHV shall be offered to all the second year BE/ BTech students. These courses shall carry a maximum of 100 marks each and shall be evaluated through continuous assessment tests only vide clause 7.1. The candidate(s) can earn 2 credits for UHV and 1 credit for YVHD by successfully completing these courses. Two continuous assessment tests will be conducted and the average marks will be taken for the calculation of grades.

8. REQUIREMENTS FOR COMPLETION OF A SEMESTER

8.1 A candidate who has fulfilled the following conditions shall be deemed to have satisfied the requirements for completion of a semester and permitted to appear for the examinations of that semester.

8.1.1 Ideally, every candidate is expected to attend all classes and secure 100 % attendance. However, a candidate shall secure not less than 80 % (after rounding off to the nearest integer) of the overall attendance taking into account the total number of working days in a semester.

8.1.2 A candidate who could not satisfy the attendance requirements as per clause 8.1.1 due to medical reasons (hospitalization / accident / specific illness) but has secured not less than 70 % in the current semester may be permitted to appear for the current semester examinations with the approval of the Principal on payment of a condonation fee as may be fixed by the authorities from time to time. The medical certificate needs to be submitted along with the leave application. A candidate can avail this provision only twice during the entire duration of the degree programme.

A candidate who could not satisfy the attendance requirements as per clause 8.1.1 due to his/her entrepreneurships/ start ups activities, but has secured not less than 60 % in the current semester can be permitted to appear for the current semester examinations with the recommendation of review committee and approval from the Principal.

8.1.3 In addition to clause 8.1.1 or 8.1.2, a candidate shall secure not less than 60 % attendance in each course.

8.1.4 A candidate shall be deemed to have completed the requirements of study of any semester only if he/she has satisfied the attendance requirements (vide clause 8.1.1 to 8.1.3) and has registered for examination by paying the prescribed fee.

8.1.5 Candidate's progress is satisfactory.

8.1.6 Candidate's conduct is satisfactory and he/she was not involved in any indisciplined activities in the current semester.

8.2. The candidates who do not complete the semester as per clauses from 8.1.1 to 8.1.6 except 8.1.3 shall not be permitted to appear for the examinations at the end of the semester and not be permitted to go to the next semester. They have to repeat the incomplete semester in next academic year.

8.3 The candidates who satisfy the clause 8.1.1 or 8.1.2 but do not complete the course as per clause 8.1.3 shall not be permitted to appear for the end semester examination of that course alone. They have to repeat the incomplete course in the subsequent semester when it is offered next.

9. REQUIREMENTS FOR APPEARING FOR END SEMESTER EXAMINATION

9.1 A candidate shall normally be permitted to appear for end semester examination of the current semester if he/she has satisfied the semester completion requirements as per clause 8, and has registered for examination in all courses of that semester. Registration is mandatory for current semester examinations as well as for arrear examinations failing which the candidate shall not be permitted to move on to the higher semester.

9.2 When a candidate is deputed for a National / International Sports event during End Semester examination period, supplementary examination shall be conducted for such a candidate on return after participating in the event within a reasonable period of time. Such appearance shall be considered as first appearance.

9.3 A candidate who has already appeared for a course in a semester and passed the examination is not entitled to reappear in the same course for improvement of letter grades / marks.

10. PROVISION FOR WITHDRAWAL FROM EXAMINATIONS

10.1 A candidate may, for valid reasons, be granted permission to withdraw from appearing for the examination in any regular course or all regular courses registered in a particular semester. Application for withdrawal is permitted only once during the entire duration of the degree programme.

10.2 The withdrawal application shall be valid only if the candidate is otherwise eligible to write the examination (vide clause 9) and has applied to the Principal for permission prior to the last examination of that semester after duly recommended by the Head of the Department.

10.3 The withdrawal shall not be considered as an appearance for deciding the eligibility of a candidate for First Class with Distinction/First Class.

10.4 If a candidate withdraws a course or courses from writing end semester examinations, he/she shall register the same in the subsequent semester and write the end semester examinations. A final semester candidate who has withdrawn shall be permitted to appear for supplementary examination to be conducted within reasonable time as per clause 14.

10.5 The final semester candidate who has withdrawn from appearing for project viva-voce for genuine reasons shall be permitted to appear for supplementary viva-voce examination within reasonable time with proper application to Controller of Examinations and on payment of prescribed fee.

11. PROVISION FOR BREAK OF STUDY

11.1 A candidate is normally permitted to avail the authorised break of study under valid reasons (such as accident or hospitalization due to prolonged ill health or any other valid reasons) and to rejoin the programme in a later semester. He/She shall apply in advance to the Principal, through the Head of the Department, stating the reasons therefore, in any case, not later than the last date for registering for that semester examination. A candidate is permitted to avail the authorised break of study only once during the entire period of study for a maximum period of one year. However, in extraordinary situation the candidate may apply for additional break of study not exceeding another one year by paying prescribed fee for the break of study.

11.2 The candidates permitted to rejoin the programme after break of study / prevention due to lack of attendance shall be governed by the rules and regulations in force at the time of rejoining.

11.3 The candidates rejoining in new Regulations shall apply to the Principal in the prescribed format through Head of the Department at the beginning of the readmitted semester itself for prescribing additional/equivalent courses, if any, from any semester of the regulations in-force, so as to bridge the curriculum in-force and the old curriculum.

11.4 The total period of completion of the programme reckoned from the commencement of the semester to which the candidate was admitted shall not exceed the maximum period specified in clause 5 irrespective of the period of break of study in order to qualify for the award of the degree.

11.5 If any candidate is prevented for want of required attendance, the period of prevention shall not be considered as authorized break of study.

11.6 If a candidate has not reported to the college for a period of two consecutive semesters without any intimation, the name of the candidate shall be deleted permanently from the college enrollment. Such candidates are not entitled to seek readmission under any circumstances.

12. PASSING REQUIREMENTS

12.1 A candidate who secures not less than 50 % of total marks (continuous assessment and end semester examination put together) prescribed for the course with a minimum of 45 % of the marks prescribed for the end semester examination in all category of courses vide clause 7.1 except for the courses which are evaluated based on continuous assessment only shall be declared to have successfully passed the course in the examination.

12.2 A candidate who secures not less than 50 % in continuous assessment marks prescribed for the courses which are evaluated based on continuous assessment only shall be declared to have successfully passed the course. If a candidate secures less than 50% in the continuous assessment marks, he / she shall have to re-enroll for the same in the subsequent semester and satisfy the attendance requirements.

12.3 For a candidate who does not satisfy the clause 12.1, the continuous assessment marks secured by the candidate in the first attempt shall be retained and considered valid for subsequent attempts. However, from the fourth attempt onwards the marks scored in the end semester examinations alone shall be considered, in which case the candidate shall secure minimum 50 % marks in the end semester examinations to satisfy the passing requirements.

13. REVALUATION OF ANSWER SCRIPTS

A candidate shall apply for a photocopy of his / her semester examination answer script within a reasonable time from the declaration of results, on payment of a prescribed fee by submitting the proper application to the Controller of Examinations. The answer script shall be pursued and justified jointly by a faculty member who has handled the course and the course coordinator and recommended for revaluation. Based on the recommendation, the candidate can register for revaluation through proper application to the Controller of Examinations. The Controller of Examinations will arrange for revaluation and the results will be intimated to the candidate concerned. Revaluation is permitted only for Theory courses and Theory cum Practical courses where end semester examination is involved.

14. SUPPLEMENTARY EXAMINATION

If a candidate fails to clear all courses in the final semester after the announcement of final end semester examination results, he/she shall be allowed to take up supplementary examinations to be conducted within a reasonable time for the courses of final semester alone, so that he/she gets a chance to complete the programme.

15. AWARD OF LETTER GRADES:

For all the passed candidates, the relative grading principle is applied to assign the letter grades.

Marks / Examination Status	Letter Grade	Grade Point
Based on the relative grading	O (Outstanding)	10
	A+ (Excellent)	9
	A (Very Good)	8
	B+ (Good)	7
	B (Average)	6
	C (Satisfactory)	5
Less than 50	U (Reappearance)	0
Successfully Completed	SC	0
Withdrawal	W	-
Absent	AB	-
Shortage of Attendance in a course	SA	-

The Grade Point Average (GPA) is calculated using the formula:

$$\text{GPA} = \frac{\sum[(\text{course credits}) \times (\text{grade points})] \text{ for all courses in the specific semester}}{\sum(\text{course credits}) \text{ for all courses in the specific semester}}$$

The Cumulative Grade Point Average (CGPA) is calculated from first semester (third semester for lateral entry candidates) to final semester using the formula

$$\text{CGPA} = \frac{\sum[(\text{course credits}) \times (\text{grade points})] \text{ for all courses in all the semesters so far}}{\sum(\text{course credits}) \text{ for all courses in all the semesters so far}}$$

The GPA and CGPA are computed only for the candidates with a pass in all the courses.

The GPA and CGPA indicate the academic performance of a candidate at the end of a semester and at the end of successive semesters respectively.

A grade sheet for each semester shall be issued containing Grade obtained in each course, GPA and CGPA.

A duplicate copy, if required can be obtained on payment of a prescribed fee and satisfying other procedure requirements.

Withholding of Grades: The grades of a candidate may be withheld if he/she has not cleared his/her dues or if there is a disciplinary case pending against him/her or for any other reason.

16. ELIGIBILITY FOR THE AWARD OF DEGREE

A candidate shall be declared to be eligible for the award of the BE / BTech Degree provided the candidate has

i. Successfully completed all the courses under the different categories, as specified in the regulations.
ii. Successfully gained the required number of total credits as specified in the curriculum corresponding to the candidate's programme within the stipulated time (vide clause 5).
iii. Successfully passed any additional courses prescribed by the respective Board of Studies whenever readmitted under regulations other than R-2022 (vide clause 11.3)
iv. No disciplinary action pending against him / her.

17. CLASSIFICATION OF THE DEGREE AWARDED

17.1 First Class with Distinction:

17.1.1. A candidate who qualifies for the award of the degree (vide clause 16) and who satisfies the following conditions shall be declared to have passed the examination in First class with Distinction:

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) excluding the authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 8.50

(OR)

17.1.2 Acandidate who joins from other institutions on transfer or a candidate who gets readmitted and has to move from one regulations to another regulations and who qualifies for the award of the degree (vide clause 16) and satisfies the following conditions shall be declared to have passed the examination in First class with Distinction:

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) excluding the authorized break of study (vide clause 11) after the commencement of his / her study.
- Submission of equivalent course list approved by the respective Board of studies.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 9.00

17.2 First Class:

A candidate who qualifies for the award of the degree (vide clause 16) and who satisfies the following conditions shall be declared to have passed the examination in First class:

- Should have passed the examination in all the courses of all eight semesters (six semesters for lateral entry candidates) within ten consecutive semesters (eight consecutive semesters for lateral entry candidates) excluding authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from the examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 6.50

17.3 Second Class:

All other candidates (not covered in clauses 17.1 and 17.2) who qualify for the award of the degree (vide clause 16) shall be declared to have passed the examination in Second Class.

17.4 A candidate who is absent for end semester examination in a course / project work after having registered for the same shall be considered to have appeared for that examination for the purpose of classification.

17.5 Honors Degree:

A candidate who qualifies for the award of the degree (vide clause 16) and who satisfies the following conditions shall be declared to have earned the BE/BTech degree with Honours (vide clause 16 and clause 4.2.2):

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) excluding the authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 7.50

18. MALPRACTICES IN TESTS AND EXAMINATIONS

If a candidate indulges in malpractice in any of the tests or end semester examinations, he/she shall be liable for punitive action as per the examination rules prescribed by the college from time to time.

19. AMENDMENTS

Notwithstanding anything contained in this manual, the Kongu Engineering College through the Academic council of the College, reserves the right to modify/amend without notice, the Regulations, Curricula, Syllabi, Scheme of Examinations, procedures, requirements, and rules pertaining to its BE / BTech programme.

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CURRICULUM BREAKDOWN STRUCTURE – R2022 (For 2022-23 students)										
Summary of Credit Distribution										
Category	**Semester**								**Total number of credits**	**Curriculum Content (% of total number of credits of the program)**
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
HS	**4**	**4**	**3**	**1**	**-**	**-**	**4**	**-**	**16**	**9.52**
BS	**8**	**9**	**4**	**-**	**-**	**-**	**-**	**-**	**21**	**12.5**
ES	**8**	**7**	**4**	**3**	**-**	**-**	**-**	**-**	**22**	**13.1**
PC	**3**	**3**	**12**	**16**	**15**	**8**	**-**	**-**	**57**	**33.93**
PE	**-**	**-**	**-**	**-**	**3**	**3**	**9**	**3**	**18**	**10.71**
OE	**-**	**-**	**-**	**-**	**4**	**4**	**3**	**3**	**14**	**8.33**
EC	**-**	**-**	**-**	**2**	**2**	**7**	**5**	**4**	**20**	**11.9**
MC	**0**	**-**	**0**	**-**	**-**	**-**	**-**	**-**	**0**	**0**
Semester wise Total	**23**	**23**	**23**	**22**	**24**	**22**	**21**	**10**	**168**	**100**

Category	**Abbreviation**
Lecture hours per week	**L**
Tutorial hours per week	**T**
Practical, Project work, Internship, Professional Skill Training, Industrial Training hours per week	**P**
Credits	**C**

CATEGORISATION OF COURSES

HUMANITIES AND SOCIAL SCIENCE INCLUDING MANAGEMENT (HS)

S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22EGT11	Communication Skills I	3	0	0	3	I
2.	22TAM01	Heritage of Tamils	1	0	0	1	II
3.	22VEC11	Yoga and Values for Holistic Development	1	0	1	1	I
4.	22EGT21	Communication Skills II	3	0	0	3	II
5.	22TAM02	Tamils and Technology	1	0	0	1	III
6.	22EGL31	Communication Skill Development Laboratory	2	0	0	1	III
7.	22GET31	Universal Human Values	2	0	0	2	VI
8.	22CHT71	Process Engineering Economics and Management	3	1	0	4	VII
Total Credits to be earned						**16**	

BASIC SCIENCE (BS)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22MAC11	Matrices and Ordinary Differential Equations	3	0	2	4	I
2.	22PHT17	Physics for Chemical Engineering	3	0	0	3	I
3.	22PHL17	Physics Laboratory for Chemical Engineering	0	0	2	1	I
4.	22MAC22	Multivariable Calculus and Partial Differential Equations	3	0	2	4	II
5.	22CYT27	Chemistry for Chemical Engineers	3	0	0	3	II
6.	22MEL11	Engineering Practices Laboratory	0	0	2	1	II
7.	22CYL23	Chemistry Laboratory for Chemical Engineering	0	0	2	1	II
8.	22MAT31	Statistics and Numerical Methods	3	1	0	4	III
Total Credits to be earned						**21**	

ENGINEERING SCIENCE (ES)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22CSC11	Problem Solving and Programming in C	3	0	2	4	I
2.	22MET13	Basics of Mechanical and Electrical Engineering	3	0	0	3	I
3.	22MEL12	Basics of Mechanical and Electrical Engineering Laboratory	0	0	2	1	I
4.	22CSC21	Fundamentals of Data Structures	3	0	2	4	II
5.	22MEC21	Engineering Drawing	3	0	0	3	II
6.	22ITC32	Introduction to Python	3	0	2	4	III
7.	22CHC41	Materials of Construction for Process Industries	3	0	0	3	IV
Total Credits to be earned						**22**	

PROFESSIONAL CORE (PC)								
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**	**Domain/ Stream**
1.	22CHT11	Chemical Process Industries	3	0	0	3	I	TO & PPO
2.	22CHT21	Chemical Process Plant Safety	3	0	0	3	II	CT
3.	22CHT31	Chemical Process Calculations	3	1	0	4	III	TO & PPO
4.	22CHT32	Applied Organic Chemistry	3	0	0	3	III	AC & RE
5.	22CHT33	Fluid Mechanics	2	1	0	3	III	TO & PPO
6.	22CHL31	Applied Organic Chemistry Laboratory	0	0	2	1	III	AC & RE
7.	22CHL32	Fluid Mechanics Laboratory	0	0	2	1	III	TO & PPO
8.	22CHC42	Chemical Engineering Thermodynamics	3	0	2	4	IV	AC & RE
9.	22CHT41	Mass Transfer I	3	1	0	4	IV	TO & PPO
10.	22CHT42	Process Heat Transfer	2	1	0	3	IV	TO & PPO
11.	22CHT43	Mechanical Operations	2	1	0	3	IV	TO & PPO
12.	22CHL41	Process Heat Transfer Laboratory	0	0	2	1	IV	TO & PPO
13.	22CHL42	Mechanical Operations Laboratory	0	0	2	1	IV	TO & PPO
14.	22CHT51	Mass Transfer II	2	1	0	3	V	TO & PPO
15.	22CHT52	Chemical Reaction Engineering I	2	1	0	3	V	AC & RE
16.	22CHT53	Process Instrumentation Dynamics and Control	2	1	0	3	V	CSMS & C
17.	22CHC51	Chemical Equipment Design and Drawing	3	0	2	4	V	TO & PPO
18.	22CHL51	Mass Transfer Laboratory	0	0	2	1	V	TO & PPO
19.	22CHL52	Process Instrumentation Dynamics and Control Laboratory	0	0	2	1	V	CSMS & C
20.	22CHT61	Chemical Reaction Engineering II	2	1	0	3	VI	AC & RE
21.	22CHC61	Process Modeling and Simulation	2	0	2	3	VI	CSMS & C
22.	22CHL61	Chemical Reaction Engineering Laboratory	0	0	2	1	VI	AC & RE
23.	22CHL62	Process Computations Laboratory	0	0	2	1	VI	CSMS & C
Total Credits to be earned						**57**		

Domain: AC&RE –Applied Chemistry & Reaction Engineering, CSMS&C-Chemical Systems Modeling & Simulation & Control, CT-Chemical Technology, E&E-Energy & Environment, TO & PPO-Transport Operations & Process Plant Operation, GE - General Engineering

LIST OF PROFESSIONAL ELECTIVES (PEs)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Domain/ Stream**
Semester - V							
Elective – I							
1.	22CHE01	Organic Synthesis	3	0	0	3	AC&RE
2.	22CHE02	Fertilizer Technology	3	0	0	3	CT
3.	22CHE03	Polymer Technology	3	0	0	3	CT
4.	22CHE04	Air Pollution Control	3	0	0	3	E&E
5.	22CHE05	Ores and Mineral Processing	3	0	0	3	TO&PPO
Semester - VI							
Elective – II							
6.	22CHE06	Bio Chemical Engineering	3	0	0	3	AC&RE
7.	22CHE07	Machine Learning for Process Engineers	3	0	0	3	CSMS&C
8.	22CHE08	Pulp and Paper Technology	3	0	0	3	CT
9.	22CHE09	Industrial Waste Water Treatment	3	0	0	3	E&E
10.	22CHE10	Modern Separation Processes	3	0	0	3	TO&PPO
Semester - VII							
Elective - III							
11.	22CHE11	Instrumental Methods of Analysis	3	0	0	3	AC&RE
12.	22CHE12	Surface Coating Technology	3	0	0	3	CT
13.	22CHE13	Energy Technology	3	0	0	3	E&E
14.	22CHE14	Fluid Movers	3	0	0	3	TO&PPO
15.	22CHE15	Process Plant Safety	3	0	0	3	CT
Elective – IV							
16.	22CHE16	Momentum, Heat and Mass Transport	3	0	0	3	TO&PPO
17.	22CHE17	Corrosion Science and Engineering	3	0	0	3	AC&RE
18.	22CHE18	Advanced Process Control	3	0	0	3	CSMS&C
19.	22CHE19	Natural Gas Engineering	3	0	0	3	CT
20.	22CHE20	Battery and Fuel Cell Technology	3	0	0	3	E&E
Elective –V							
21.	22CHE21	Piping Engineering	3	0	0	3	TO&PPO

22.	22GEE02	Total Quality Management	3	0	0	3	GE
23.	22CHE22	Nano materials and composite materials for Chemical Engineers	3	0	0	3	AC&RE
24.	22CHE23	Petroleum Refinery Engineering	3	0	0	3	CT
25.	22GEE01	Fundamentals of Research	3	0	0	3	GE
Semester – VIII							
Elective - VI							
26.	22CHE24	Fundamentals of Computational Fluid Dynamics	3	0	0	3	CSMS&C
27.	22CHE25	Recent Trends in Chemical Engineering	3	0	0	3	GE
28.	22CHE26	Process Optimization	3	0	0	3	CSMS&C
29.	22CHE27	Nuclear Engineering for Chemical Engineers	3	0	0	3	CT
30.	22CHE28	Pharmaceutical Process Technology	3	0	0	3	CT
Total Credits to be earned						**18**	

Domain:AC&RE –Applied Chemistry & Reaction Engineering, CSMS&C-Chemical Systems Modeling & Simulation & Control, CT-Chemical Technology, E&E-Energy & Environment, TO & PPO-Transport Operations & Process Plant Operation, GE - General Engineering

EMPLOYABILITY ENHANCEMENT COURSES (EC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22GEL41	Professional Skills Training I	--	--	--	2	IV
2.	22GEL51	Professional Skills Training II	--	--	--	2	V
3.	22CHP61	Project Work I	0	0	8	4	VI
4.	22GEP61	Comprehensive Test and Viva	--	--	--	2	VI
5.	22GEI61	Industrial Training	--	--	--	1	VI
6.	22CHP71	Project Work II Phase I	0	0	10	5	VII
7.	22CHP81	Project Work II Phase II	0	0	8	4	VIII
Total Credits to be earned						**20**	

MANDATORY COURSES (EC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22MNT11	Student Induction Program	--	--	--	0	I
2.	22MNT31	Environmental Science	2	0	0	0	III
Total Credits to be earned						**00**	

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22CHO01	Industrial Enzymology	3	1	0	4	V
2.	22CHO02	Waste to Energy Conversion	3	1	0	4	V
3.	22CHO03	Applied Nanotechnology	3	1	0	4	V
4.	22CHO04	Air Pollution Monitoring and Control	3	1	0	4	VI
5.	22CHO05	Paints and Coatings	3	1	0	4	VI
6.	22CHO06	Powder Technology	3	1	0	4	VI
7.	22CHO07	Hydrogen Energy	3	0	0	3	VII
8.	22CHO08	Rubber Technology	3	0	0	3	VII
9.	22CHO09	Industrial Accident Prevention and Management	3	0	0	3	VIII
10.	22CHO10	Electrochemical Engineering	3	0	0	3	VIII
11.	22CHO11	Smart and Functional Materials	3	0	0	3	VIII

CURRICULUM BREAKDOWN STRUCTURE – R2022 (For 2023-24 students)

Summary of Credit Distribution

Category	Semester								Total number of credits	Curriculum Content (% of total number of credits of the program)
	I	II	III	IV	V	VI	VII	VIII		
HS	5	4	1	-	-	2	4	-	16	9.52
BS	8	8	4	-	-	-	-	-	20	11.9
ES	10	7	4	3	-	-	-	-	24	14.29
PC	-	3	12	16	15	8	3	-	57	33.93
PE	-	-	-	-	3	3	6	3	15	8.93
OE	-	-	-	-	4	4	3	3	14	8.33
EC	-	-	-	2	2	8	6	4	22	13.1
MC	0	-	0	-	-	-	-	-	0	0
Semester wise Total	23	22	21	21	24	25	22	10	168	100

Category	Abbreviation
Lecture hours per week	L
Tutorial hours per week	T
Practical, Project work, Internship, Professional Skill Training, Industrial Training hours per week	P
Credits	C

CATEGORISATION OF COURSES

HUMANITIES AND SOCIAL SCIENCE INCLUDING MANAGEMENT (HS)

S. No.	Course Code	Course Name	L	T	P	C	Sem
1.	22EGT11	Communication Skills I	3	0	0	3	I
2.	22TAM01	Heritage of Tamils	1	0	0	1	I
3.	22VEC11	Yoga and Values for Holistic Development	1	0	1	1	I
4.	22EGT21	Communication Skills II	3	0	0	3	II
5.	22TAM02	Tamils and Technology	1	0	0	1	II
6.	22EGL31	Communication Skill Development Laboratory	2	0	0	1	III
7.	22GET31	Universal Human Values	2	0	0	2	VI
8.	22CHT71	Process Engineering Economics and Management	3	1	0	4	VII
Total Credits to be earned						**16**	

BASIC SCIENCE (BS)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22MAC11	Matrices and Ordinary Differential Equations	3	0	2	4	I
2.	22PHT17	Physics for Chemical Engineering	3	0	0	3	I
3.	22PHL17	Physics Laboratory for Chemical Engineering	0	0	2	1	I
4.	22MAC22	Multivariable Calculus and Partial Differential Equations	3	0	2	4	II
5.	22CYT27	Chemistry for Chemical Engineers	3	0	0	3	II
7.	22CYL23	Chemistry Laboratory for Chemical Engineering	0	0	2	1	II
8.	22MAT31	Statistics and Numerical Methods	3	1	0	4	III
Total Credits to be earned						**20**	

ENGINEERING SCIENCE (ES)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22CSC11	Problem Solving and Programming in C	3	0	2	4	I
2.	22MEC21	Engineering Drawing	3	0	0	3	I
3.	22GCL12	Foundation Lab – Electrical, IoT and Web	0	0	6	3	I
4.	22CSC21	Fundamentals of Data Structures	3	0	2	4	II
5.	22GCL11	Foundation Lab – Manufacturing, Design and Robotics	0	0	6	3	II
6.	22ITC32	Introduction to Python	3	0	2	4	III
7.	22CHC41	Materials of Construction for Process Industries	3	0	0	3	IV
Total Credits to be earned						**24**	

PROFESSIONAL CORE (PC)								
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**	**Domain/ Stream**
1.	22CHT11	Chemical Process Industries	3	0	0	3	I	TO & PPO
2.	22CHT31	Chemical Process Calculations	3	1	0	4	III	TO & PPO
3.	22CHT32	Applied Organic Chemistry	3	0	0	3	III	AC & RE
4.	22CHT33	Fluid Mechanics	2	1	0	3	III	TO & PPO
5.	22CHL31	Applied Organic Chemistry Laboratory	0	0	2	1	III	AC & RE
6.	22CHL32	Fluid Mechanics Laboratory	0	0	2	1	III	TO & PPO
7.	22CHC42	Chemical Engineering Thermodynamics	3	0	2	4	IV	AC & RE
8.	22CHT41	Mass Transfer I	3	1	0	4	IV	TO & PPO
9.	22CHT42	Process Heat Transfer	2	1	0	3	IV	TO & PPO
10.	22CHT43	Mechanical Operations	2	1	0	3	IV	TO & PPO
11.	22CHL41	Process Heat Transfer Laboratory	0	0	2	1	IV	TO & PPO
12.	22CHL42	Mechanical Operations Laboratory	0	0	2	1	IV	TO & PPO
13.	22CHT51	Mass Transfer II	2	1	0	3	V	TO & PPO
14.	22CHT52	Chemical Reaction Engineering I	2	1	0	3	V	AC & RE
15.	22CHT53	Process Instrumentation Dynamics and Control	2	1	0	3	V	CSMS & C
16.	22CHC51	Chemical Equipment Design and Drawing	3	0	2	4	V	TO & PPO
17.	22CHL51	Mass Transfer Laboratory	0	0	2	1	V	TO & PPO
18.	22CHL52	Process Instrumentation Dynamics and Control Laboratory	0	0	2	1	V	CSMS & C
19.	22CHT61	Chemical Reaction Engineering II	2	1	0	3	VI	AC & RE
20.	22CHC61	Process Modeling and Simulation	2	0	2	3	VI	CSMS & C
21.	22CHL61	Chemical Reaction Engineering Laboratory	0	0	2	1	VI	AC & RE
22.	22CHL62	Process Computations Laboratory	0	0	2	1	VI	CSMS & C
23.	22CHT72	Transport Phenomena	3	0	0	3	VII	TO & PPO
Total Credits to be earned						**57**		

Domain: AC&RE –Applied Chemistry & Reaction Engineering, CSMS&C-Chemical Systems Modeling & Simulation & Control, CT-Chemical Technology, E&E-Energy & Environment, TO & PPO-Transport Operations & Process Plant Operation, GE - General Engineering

LIST OF PROFESSIONAL ELECTIVES (PEs)							
S. No.	Course Code	Course Name	L	T	P	C	Domain/ Stream
Semester - V							
Elective – I							
1.	22CHE01	Organic Synthesis	3	0	0	3	AC&RE
2.	22CHE02	Fertilizer Technology	3	0	0	3	CT
3.	22CHE03	Polymer Technology	3	0	0	3	CT
4.	22CHE04	Air Pollution Control	3	0	0	3	E&E
5.	22CHE05	Ores and Mineral Processing	3	0	0	3	TO&PPO
Semester - VI							
Elective – II							
6.	22CHE06	Bio Chemical Engineering	3	0	0	3	AC&RE
7.	22CHE07	Machine Learning for Process Engineers	3	0	0	3	CSMS&C
8.	22CHE08	Pulp and Paper Technology	3	0	0	3	CT
9.	22CHE09	Industrial Waste Water Treatment	3	0	0	3	E&E
10.	22CHE10	Modern Separation Processes	3	0	0	3	TO&PPO
Semester - VII							
Elective - III							
11.	22CHE11	Instrumental Methods of Analysis	3	0	0	3	AC&RE
12.	22CHE12	Surface Coating Technology	3	0	0	3	CT
13.	22CHE13	Energy Technology	3	0	0	3	E&E
14.	22CHE14	Fluid Movers	3	0	0	3	TO&PPO
15.	22CHE15	Process Plant Safety	3	0	0	3	CT
Elective – IV							
16.	22CHE16	Momentum, Heat and Mass Transport	3	0	0	3	TO&PPO
17.	22CHE17	Corrosion Science and Engineering	3	0	0	3	AC&RE
18.	22CHE18	Advanced Process Control	3	0	0	3	CSMS&C
19.	22CHE19	Natural Gas Engineering	3	0	0	3	CT
20.	22CHE20	Battery and Fuel Cell Technology	3	0	0	3	E&E
21.	22CHE21	Piping Engineering	3	0	0	3	TO&PPO
22.	22GEE02	Total Quality Management	3	0	0	3	GE

23.	22CHE22	Nano materials and composite materials for Chemical Engineers	3	0	0	3	AC&RE
24.	22CHE23	Petroleum Refinery Engineering	3	0	0	3	CT
25.	22GEE01	Fundamentals of Research	3	0	0	3	GE
Semester – VIII							
Elective - V							
26.	22CHE24	Fundamentals of Computational Fluid Dynamics	3	0	0	3	CSMS&C
27.	22CHE25	Recent Trends in Chemical Engineering	3	0	0	3	GE
28.	22CHE26	Process Optimization	3	0	0	3	CSMS&C
29.	22CHE27	Nuclear Engineering for Chemical Engineers	3	0	0	3	CT
30.	22CHE28	Pharmaceutical Process Technology	3	0	0	3	CT
Total Credits to be earned						**15**	

Domain:AC&RE –Applied Chemistry & Reaction Engineering, CSMS&C-Chemical Systems Modeling & Simulation & Control, CT-Chemical Technology, E&E-Energy & Environment, TO & PPO-Transport Operations & Process Plant Operation, GE - General Engineering

EMPLOYABILITY ENHANCEMENT COURSES (EC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22GEL41	Professional Skills Training I	--	--	--	2	IV
2.	22GEL51	Professional Skills Training II	--	--	--	2	V
3.	22CHP61	Project Work I	0	0	10	5	VI
4.	22GEP61	Comprehensive Test and Viva	--	--	--	2	VI
5.	22GEI61	Industrial Training	--	--	--	1	VI
6.	22CHP71	Project Work II Phase I	0	0	12	6	VII
7.	22CHP81	Project Work II Phase II	0	0	8	4	VIII
Total Credits to be earned						**22**	

MANDATORY COURSES (EC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22MNT11	Student Induction Program	--	--	--	0	I
2.	22MNT31	Environmental Science	2	0	0	0	III
Total Credits to be earned						**00**	

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22CHO01	Industrial Enzymology	3	1	0	4	V
2.	22CHO02	Waste to Energy Conversion	3	1	0	4	V
3.	22CHO03	Applied Nanotechnology	3	1	0	4	V
4.	22CHO04	Air Pollution Monitoring and Control	3	1	0	4	VI
5.	22CHO05	Paints and Coatings	3	1	0	4	VI
6.	22CHO06	Powder Technology	3	1	0	4	VI
7.	22CHO07	Hydrogen Energy	3	0	0	3	VII
8.	22CHO08	Rubber Technology	3	0	0	3	VII
9.	22CHO09	Industrial Accident Prevention and Management	3	0	0	3	VIII
10.	22CHO10	Electrochemical Engineering	3	0	0	3	VIII
11.	22CHO11	Smart and Functional Materials	3	0	0	3	VIII

KEC R2022: SCHEDULING OF COURSES – B.Tech (Chemical Engineering) Total Credits: 168 (For 2022-23 students)

Sem	Course1	Course2	Course3	Course4	Course5	Course6	Course7	Course8	Course9	Course10	Course11	CH
I	22EGT11 Communication Skills I (3-0-0-3)	22MAC11 Matrices and Ordinary Differential Equations (3-0-2-4)	22PHT17 Physics for Chemical Engineering (3-0-0-3)	22CHT11 Chemical Process Industries (3-0-0-3)	22CSC11 Problem Solving and Programmin g in C (3-0-2-4)	22MET13 Basics of Mechanical and Electrical Engineering (3-0-0-3)	22PHL17 Physics Laboratory for Chemical Engineering (0-0-2-1)	22MEL12 Basics of Mechanical and Electrical Engineering Laboratory (0-0-2-1)	22VEC11 Yoga and Values for Holistic Development (1-0-1-1)	22MNT11 Student Induction Program (0-0-0-0)		23
II	22EGT21 Communication Skills II (3-0-0-3)	22MAC22 Multivariable Calculus and Partial Differential Equations (3-0-2-4)	22CYT27 Chemistry for Chemical Engineers (3-0-0-3)	22CHT21 Chemical Process Plant Safety (3-0-0-3)	22CSC21 Fundamental s of Data Structures (3-0-2-4)	22MET21 Engineering Drawing (3-0-0-3)	22TAM01 Heritage of Tamils (1-0-0-1)	22MEL21 Engineering Practices Lab (0-0-2-1)	22CYL23 Chemistry Laboratory for Chemical Engineering (0-0-2-1)			23
III	22MAT31 Statistics and Numerical Methods (3-1-0-4)	22ITC32 Introduction to Python (3-0-2-4)	22CHT31 Chemical Process Calculations (3-1-0-4)	22CHT32 Applied Organic Chemistry (3-0-0-3)	22CHT33 Fluid Mechanics (2-1-0-3)	22GET31 Universal Human Values (2-0-0-2)	22TAM02Tamil s and Technology (1-0-0-1)	22CHL31 Applied Organic Chemistry Laboratory (0-0-2-1)	22CHL32 Fluid Mechanics Laboratory (0-0-2-1)			23
IV	22CHC41 Materials of Construction for Process Industries (3-0-0-3)	22CHC42 Chemical Engineering Thermodynamics (3-0-2-4)	22CHT41 Mass Transfer I (3-1-0-4)	22CHT42 Process Heat Transfer (2-1-0-3)	22CHT43 Mechanical Operations (2-1-0-3)	22CHL41 Process Heat Transfer Laboratory (0-0-2-1)	22CHL42 Mechanical Operations Laboratory (0-0-2-1)	22EGL31 Communicatio n Skill Development Laboratory (0-0-2-1)	22GEL41 Professional Skills Training I (0-0-0-2)			22
V	22CHT51 Mass Transfer II (2-1-0-3)	22CHT52 Chemical Reaction Engineering I (2-1-0-3)	22CHT53 Process Dynamics and Control (2-1-0-3)	22CHC51 Chemical Equipment Design and Drawing (3-0-2-4)	Professional Elective I (3-0-0-3)	Open Elective I (3-1/0-0/2-4)	22CHL51 Mass Transfer Laboratory (0-0-2-1)	22CHL52 Process Dynamics and Control Laboratory (0-0-2-1)	22GEL51 Professional Skills Training II (0-0-0-2)			24
VI	22CHT61 Chemical Reaction Engineering II (2-1-0-3)	22CHC61 Process Modeling and Simulation (2-0-2-3)	Professional Elective II (3-0-0-3)	Open Elective II (3-1/0-0/2-4)	22CHL61 Chemical Reaction Engineering Laboratory (0-0-2-1)	22CHL62 Process Computation s Laboratory (0-0-2-1)	22CHP61 Project Work I (0-0-8-4)	22MNT31 Environmental Science (2-0-0-0)	22GEP61 Comprehensi ve Test and Viva (0-0-0-2)	22GEI61 Industrial Training (0-0-0-1)		22
VII	22CHT71 Process Engineering Economics and Management (3-0-0-3)	Professional Elective III (3-0-0-3)	Professional Elective IV (3-0-0-3)	Professiona l Elective V (3-0-0-3)	Open Elective III (3-0-0-3)	22CHP71 Project Work II Phase I (0-0-10-5)						21
VIII	Professional Elective IV (3-0-0-3)	Open Elective IV (3-0-0-3)	22CHP81 Project Work II Phase I (0-0-8-4)									10

KEC R2022: SCHEDULING OF COURSES – B.Tech (Chemical Engineering) Total Credits: 168 (For 2023-24 students)

Sem	Course1	Course2	Course3	Course4	Course5	Course6	Course7	Course8	Course9	Course10	Course11	CH
I	22EGT11 Communication Skills I (3-0-0-3)	22MAC11 Matrices and Ordinary Differential Equations (3-0-2-4)	22PHT17 Physics for Chemical Engineering (3-0-0-3)	22CSC11 Problem Solving and Programmi ng in C (3-0-2-4)	22MET21 Engineering Drawing (3-0-0-3)	22TAM01 Heritage of Tamils (1-0-0-1)	22PHL17 Physics Laboratory for Chemical Engineering (0-0-2-1)	22GCL12 Foundation Lab – Electrical, IoT and Web (0-0-6-3)	22VEC11 Yoga and Values for Holistic Development (1-0-1-1)	22MNT11 Student Induction Program (0-0-0-0)		23
II	22EGT21 Communication Skills II (3-0-0-3)	22MAC22 Multivariable Calculus and Partial Differential Equations (3-0-2-4)	22CYT27 Chemistry for Chemical Engineers (3-0-0-3)	22CSC21 Fundament als of Data Structures (3-0-2-4)	22CHT11 Chemical Process Industries (3-0-0-3)	22TAM02Ta mils and Technology (1-0-0-1)	22GCL11Foun dation Lab- Manufacturing, Design and Robotics (0-0-6-3)	22CYL23 Chemistry Laboratory for Chemical Engineering (0-0-2-1)				22
III	22MAT31 Statistics and Numerical Methods (3-1-0-4)	22ITC32 Introduction to Python (3-0-2-4)	22CHT31 Chemical Process Calculations (3-1-0-4)	22CHT32 Applied Organic Chemistry (3-0-0-3)	22CHT33 Fluid Mechanics (2-1-0-3)	22MNT31 Environment al Science (2-0-0-0)	22CHL31 Applied Organic Chemistry Laboratory (0-0-2-1)	22CHL32 Fluid Mechanics Laboratory (0-0-2-1)	22EGL31 Communicati on Skill Development Laboratory (0-0-2-1)			21
IV	22CHC41 Materials of Construction for Process Industries (3-0-0-3)	22CHC42 Chemical Engineering Thermodynamics (3-0-2-4)	22CHT41 Mass Transfer I (3-1-0-4)	22CHT42 Process Heat Transfer (2-1-0-3)	22CHT43 Mechanical Operations (2-1-0-3)	22CHL41 Process Heat Transfer Laboratory (0-0-2-1)	22CHL42 Mechanical Operations Laboratory (0-0-2-1)	22GEL41 Professional Skills Training I (0-0-0-2)				21
V	22CHT51 Mass Transfer II (2-1-0-3)	22CHT52 Chemical Reaction Engineering I (2-1-0-3)	22CHT53 Process Dynamics and Control (2-1-0-3)	22CHC51 Chemical Equipment Design and Drawing (3-0-2-4)	Professional Elective I (3-0-0-3)	Open Elective I (3-1/0-0/2-4)	22CHL51 Mass Transfer Laboratory (0-0-2-1)	22CHL52 Process Dynamics and Control Laboratory (0-0-2-1)	22GEL51 Professional Skills Training II (0-0-0-2)			24
VI	22CHT61 Chemical Reaction Engineering II (2-1-0-3)	22CHC61 Process Modeling and Simulation (2-0-2-3)	Professional Elective II (3-0-0-3)	Open Elective II (3-1/0-0/2-4)	22GET31 Universal Human Values (2-0-0-2	22CHL61 Chemical Reaction Engineering Laboratory (0-0-2-1)	22CHL62 Process Computations Laboratory (0-0-2-1)	22CHP61 Project Work I (0-0-10-5)	22GEP61 Comprehensi ve Test and Viva (0-0-0-2)	22GEI61 Industrial Training (0-0-0-1)		25
VII	22CHT71 Process Engineering Economics and Management (3-0-0-3)	22CHT72 Transprt Phenomena (3-1-0-4)	Professional Elective III (3-0-0-3)	Professiona l Elective IV (3-0-0-3)	Open Elective III (3-0-0-3)	22CHP71 Project Work II Phase I (0-0-12-6)						22
VIII	Professional Elective V (3-0-0-3)	Open Elective IV (3-0-0-3)	22CHP81 Project Work II Phase I (0-0-8-4)									10

MAPPING OF COURSES WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	22EGT11	Communication Skills I						✓			✓	✓	✓	✓		
1	22MAC11	Matrices and Ordinary Differential Equations	✓	✓	✓		✓									
1	22PHT17	Physics for Chemical Engineering	✓	✓	✓						✓	✓	✓		✓	✓
1	22CHT11	Chemical Process Industries	✓	✓										✓	✓	
1	22CSC11	Problem Solving and Programming in C	✓	✓	✓	✓	✓					✓		✓		
1	22MET13	Basics of Mechanical and Electrical Engineering	✓	✓										✓	✓	
1	22PHL17	Physics Laboratory for Chemical Engineering	✓	✓	✓	✓					✓	✓		✓	✓	✓
1	22MEL12	Basics of Mechanical and Electrical Engineering Laboratory	✓	✓	✓	✓					✓	✓		✓	✓	
1	22VEC11	Yoga and Values for Holistic Development						✓		✓	✓					
1	22MNT11	Student Induction Program														
2	22EGT21	Communication Skills II						✓			✓	✓	✓	✓		
2	22MAC22	Multivariable Calculus and Partial Differential Equations	✓	✓	✓		✓									
2	22CYT27	Chemistry for Chemical Engineers	✓	✓	✓	✓									✓	✓
2	22CHT21	Chemical Process Plant Safety	✓	✓			✓	✓	✓					✓	✓	✓
2	22CSC21	Fundamentals of Data Structures	✓	✓	✓	✓										
2	22MET21	Engineering Drawing	✓	✓	✓		✓					✓		✓	✓	✓
2	22MEL21	Engineering Practices Laboratory	✓		✓	✓	✓	✓			✓	✓		✓	✓	✓
2	22CYL23	Chemistry Laboratory for Chemical Engineering	✓	✓	✓	✓			✓						✓	✓
3	22MAT31	Statistics and Numerical Methods	✓		✓	✓	✓	✓			✓	✓		✓	✓	✓
3	22ITC32	Introduction to Python	✓	✓	✓	✓										

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
3	22CHT31	Chemical Process Calculations	✓	✓	✓	✓								✓	✓	✓
3	22CHT32	Applied Organic Chemistry	✓	✓	✓			✓	✓					✓	✓	✓
3	22CHT33	Fluid Mechanics	✓	✓	✓	✓								✓	✓	✓
3	22MNT31	Environmental Science	✓	✓	✓	✓	✓				✓	✓		✓		✓
3	22CHL31	Applied Organic Chemistry Laboratory	✓	✓				✓	✓	✓	✓	✓		✓	✓	✓
3	22CHL32	Fluid Mechanics Laboratory	✓	✓	✓			✓	✓	✓	✓	✓		✓	✓	
3	22EGL31	English for Work Place Communication Laboratory									✓	✓		✓		
4	22CHC41	Materials of Construction for Process Industries	✓	✓	✓	✓										
4	22CHC42	Chemical Engineering Thermodynamics	✓	✓	✓	✓								✓	✓	✓
4	22CHT41	Mass Transfer I	✓	✓	✓	✓		✓	✓					✓	✓	
4	22CHT42	Process Heat Transfer	✓	✓	✓	✓		✓						✓	✓	
4	22CHT43	Mechanical Operations	✓	✓	✓	✓	✓		✓		✓	✓		✓	✓	
4	22CHL41	Process Heat Transfer Laboratory	✓	✓	✓	✓	✓				✓	✓		✓	✓	
4	22CHL42	Mechanical Operations Laboratory									✓	✓		✓		
4	22GEL41	Professional Skills Training I						✓	✓	✓	✓	✓				
5	22CHT51	Mass Transfer- II	✓	✓	✓	✓							✓	✓	✓	✓
5	22CHT52	Chemical Reaction Engineering – I	✓	✓	✓									✓	✓	✓
5	22CHT53	Process Instrumentation Dynamics and Control	✓	✓										✓	✓	✓
5	22CHC51	Chemical Equipment Design and Drawing	✓	✓			✓							✓	✓	✓
5	22CHL51	Mass Transfer Laboratory	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓
5	22CHL52	Process Instrumentation Dynamics and Control Laboratory	✓	✓							✓			✓	✓	

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
6	22CHT61	Chemical Reaction Engineering II	✓	✓	✓	✓	✓							✓	✓	✓
6	22CHC61	Process Modeling and Simulation	✓	✓	✓									✓	✓	
6	22CHL61	Chemical Reaction Engineering Laboratory	✓	✓							✓	✓		✓	✓	✓
6	22CHL62	Process Computations Laboratory	✓	✓	✓	✓					✓	✓		✓	✓	✓
7	22CHT71	Process Engineering Economics and Management	✓	✓	✓								✓		✓	
7	22CHT72	Transport Phenomena	✓	✓	✓	✓								✓	✓	✓
5	22CHE01	Organic Synthesis	✓	✓									✓		✓	
5	22CHE02	Fertilizer Technology	✓	✓											✓	✓
5	22CHE03	Polymer Technology	✓	✓											✓	✓
5	22CHE04	Air Pollution Control	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓
5	22CHE05	Ores and Mineral Processing	✓	✓										✓	✓	✓
6	22CHE06	Bio Chemical Engineering	✓	✓					✓					✓	✓	✓
6	22CHE07	Machine Learning for Process Engineers	✓	✓	✓	✓	✓							✓	✓	✓
6	22CHE08	Pulp and Paper Technology	✓	✓	✓				✓	✓				✓	✓	✓
6	22CHE09	Industrial Wastewater Treatment	✓	✓	✓			✓	✓					✓	✓	✓
6	22CHE10	Modern Separation Processes	✓	✓	✓	✓		✓	✓					✓	✓	✓
7	22CHE11	Instrumental Methods of Analysis	✓	✓		✓								✓	✓	✓
7	22CHE12	Surface Coating Technology	✓	✓	✓				✓						✓	✓
7	22CHE13	Energy Technology	✓	✓	✓	✓		✓	✓					✓	✓	✓
7	22CHE14	Fluid Movers	✓	✓	✓			✓	✓					✓	✓	✓
7	22CHE15	Process Plant Safety	✓	✓			✓	✓	✓					✓	✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	22CHE16	Momentum, Heat and Mass Transport	✓	✓	✓	✓								✓	✓	✓
7	22CHE17	Corrosion Science and Engineering	✓	✓	✓	✓								✓	✓	✓
7	22CHE18	Advanced Process Control	✓	✓	✓	✓	✓							✓	✓	✓
7	22CHE19	Natural Gas Engineering	✓	✓			✓	✓	✓						✓	✓
7	22CHE20	Battery and Fuel Cell Technology	✓	✓										✓	✓	✓
7	22CHE21	Piping Engineering	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓
7	22GEE02	Total Quality Management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	22CHE22	Nano materials and composite materials for Chemical Engineers	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓
7	22CHE23	Petroleum Refinery Engineering	✓	✓	✓	✓								✓	✓	✓
7	22GEE01	Fundamentals of Research	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	22CHE24	Fundamentals of Computational Fluid Dynamics	✓	✓	✓	✓	✓							✓	✓	✓
8	22CHE25	Recent Trends in Chemical Engineering	✓	✓											✓	✓
8	22CHE26	Process Optimization	✓	✓	✓	✓	✓							✓	✓	
8	22CHE27	Nuclear Engineering for Chemical Engineers	✓	✓					✓						✓	✓
8	22CHE28	Pharmaceutical Process Technology	✓	✓				✓						✓	✓	✓

MAPPING OF COURSES WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
5	22CEX01	Remote Sensing and its Applications	✓	✓	✓	✓		✓			✓			✓		
5	22MEX01	Renewable Energy Sources	✓		✓	✓	✓	✓	✓	✓	✓					
5	22MTO01	Design of Mechatronics Systems	✓	✓	✓	✓	✓							✓		
5	22MTX01	Data Acquisition and Virtual Instrumentation	✓	✓	✓	✓	✓							✓		
5	22MTX02	Factory Automation	✓	✓	✓	✓	✓				✓	✓		✓		
5	22AUX01	Automotive Engineering	✓	✓	✓			✓	✓		✓	✓		✓		
5	22ECX01	Basics of Electronics in Automation Appliances	✓	✓	✓	✓		✓	✓	✓			✓	✓		
5	22ECX02	Image Processing	✓	✓	✓	✓	✓				✓	✓		✓		
5	22EEO01	Solar and Wind Energy Systems	✓	✓	✓			✓	✓					✓		
5	22EEO02	Electrical Wiring and Lighting	✓	✓	✓	✓	✓							✓		
5	22EEO03	Programmable Logic Controller and SCADA	✓	✓	✓	✓		✓			✓			✓		
5	22EEO04	Analog and Digital Electronics	✓	✓	✓	✓	✓							✓		
5	22EEO05	Power Electronics and Drives	✓	✓	✓	✓	✓	✓			✓					
5	22EEO06	Sensors and Actuators	✓	✓	✓			✓						✓		
5	22EIO01	Measurements and Instrumentation	✓	✓	✓	✓	✓									
5	22EIO02	Biomedical Instrumentation and Applications	✓	✓	✓	✓	✓	✓		✓						
5	22EIO03	Industrial Automation	✓	✓	✓	✓	✓									
5	22CSX01	Fundamentals of Databases	✓	✓	✓											
5	22CSX02	Data science for Engineers	✓	✓	✓	✓	✓									
5	22CSX03	Enterprise Application Development Using Java	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
5	22CSO01	Computational science for Engineers	✓	✓	✓											
5	22CSO02	Formal Languages and Automata Theory	✓	✓	✓											

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
5	22ITO01	Artificial Intelligence	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
5	22ITX01	Next Generation Databases	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
5	22CDO01	Fundamentals of User Experience Design	✓	✓	✓	✓	✓				✓	✓	✓			
5	22ADO01	Data Warehousing and Data Mining	✓	✓	✓											
5	22ALO01	Business Intelligence	✓	✓	✓											
5	22CHO01	Industrial Enzymology	✓	✓	✓							✓	✓	✓		
5	22CHO02	Waste to Energy Conversion	✓	✓												
5	22CHO03	Applied Nanotechnology	✓	✓	✓	✓	✓	✓	✓	✓				✓		
5	22FTX01	Baking Technology	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		
5	22FTO01	Food Processing Technology	✓	✓	✓	✓		✓				✓		✓		
5	22MAO01	Mathematical Foundations for Machine Learning	✓	✓	✓	✓	✓									
5	22MAO02	Numerical Computing	✓	✓	✓											
5	22MAO03	Stochastic Processes and Queuing Theory	✓	✓	✓											
5	22MAO04	Statistics for Engineers	✓	✓	✓											
5	22PHO01	Thin Film Technology	✓	✓	✓						✓	✓		✓		
5	22PHO02	High Energy Storage Devices	✓	✓	✓						✓	✓		✓		
5	22PHO03	Structural and Optical Characterization of Materials	✓	✓	✓						✓	✓		✓		
5	22CYO01	Instrumental Methods of Analysis	✓	✓	✓	✓										
5	22CYO02	Chemistry Concepts for Competitive Examinations	✓	✓	✓											
5	22CYO03	Organic Chemistry for Industry	✓	✓	✓	✓										
5	22MBO01	Cost Accounting for Engineers										✓	✓	✓		
6	22CEO01	Disaster Management	✓	✓	✓			✓	✓					✓		
6	22MEX02	Design of Experiments	✓	✓	✓	✓	✓				✓					
6	22GEO04	Innovation and Business Model Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
6	22MTO02	Robotics	✓	✓	✓	✓	✓							✓		
6	22MTO03	3D Printing and Design	✓	✓			✓							✓		
6	22AUO01	Automotive Electronics	✓	✓	✓	✓								✓		
6	22ECX03	PCB Design and Fabrication	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		
6	22EEO07	Energy Conservation and Management	✓	✓	✓		✓		✓	✓	✓			✓		
6	22EEO08	Microprocessors and Microcontrollers Interfacing	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		
6	22EEO09	Electrical Safety	✓	✓	✓				✓	✓			✓	✓		
6	22EEO10	VLSI System Design	✓	✓	✓	✓	✓				✓		✓	✓		
6	22EEO11	Automation for Industrial Applications	✓	✓	✓	✓			✓		✓			✓		
6	22EIO04	PLC Programming with High Level Languages	✓	✓	✓	✓	✓									
6	22EIO05	Virtual Instrumentation	✓	✓	✓	✓	✓									
6	22CSX04	Foundations of Machine Learning	✓	✓	✓											
6	22CSX05	Web Engineering	✓	✓	✓											
6	22ITX02	Advanced Java Programming	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
6	22ITO02	Internet of Things	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
6	22ITO03	Fundamentals of Software Development	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
6	22ITO04	Mobile Application Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
6	22CDX01	Fundamentals of User Interactive Design	✓	✓	✓	✓										
6	22ADX01	Data Visualization	✓	✓	✓											
6	22ALX01	Data Exploration and Visualization Techniques	✓	✓	✓											
6	22CHO04	Air Pollution Monitoring and Control	✓	✓	✓			✓	✓							
6	22CHO05	Paints and Coatings	✓	✓	✓				✓							
6	22CHO06	Powder Technology	✓	✓	✓			✓	✓					✓		

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
6	22FTX02	Processing of milk and milk products	✓	✓	✓		✓	✓		✓	✓	✓		✓		
6	22FTX03	Processing of Fruits and Vegetables	✓	✓	✓		✓	✓		✓	✓	✓		✓		
6	22MAO05	Graph Theory and its Applications	✓	✓	✓											
6	22MAX01	Data Analytics using R Programming	✓	✓	✓	✓	✓									
6	22MAO06	Operations Research	✓	✓	✓											
6	22MAO07	Number Theory and Cryptography	✓	✓	✓		✓									
6	22PHO04	Synthesis, Characterization and Biological Applications of Nanomaterials	✓	✓	✓						✓	✓		✓		
6	22PHO05	Techniques of Crystal Growth	✓	✓	✓						✓	✓		✓		
6	22CYO04	Corrosion Science and Engineering	✓	✓	✓	✓										
6	22CYO05	Chemistry of Cosmetics in Daily Life	✓	✓	✓											
6	22CYO06	Nanocomposite Materials	✓	✓	✓	✓										
6	22MBO02	Economic Analysis for Decision Making					✓					✓	✓			
7	22CEO02	Introduction to Smart Cities	✓	✓	✓	✓	✓									
7	22CEO03	Environmental Health and Safety	✓	✓	✓			✓	✓							
7	22MEO01	Fundamentals of Ergonomics	✓	✓	✓	✓	✓	✓	✓					✓		
7	22MEO02	Principles of Management and Industrial Psychology	✓					✓				✓	✓			
7	22MEO03	Waste Heat Recovery System and Storage	✓	✓	✓	✓			✓							
7	22GEO05	Entrepreneurship Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
7	22MTO04	Drone System Technology	✓	✓	✓	✓	✓							✓		
7	22AUO02	Vehicle Maintenance	✓	✓			✓		✓					✓		
7	22ECO01	Wearable Devices	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		
7	22ECX04	Electronic Hardware and Troubleshooting	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	22EEO12	Electric Vehicle	✓	✓	✓	✓		✓	✓		✓			✓		
7	22EEO13	E-Waste Management	✓	✓	✓	✓		✓	✓					✓		
7	22EEO14	Embedded System Design	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		
7	22EEO15	Energy Storage Systems and Controllers	✓	✓	✓			✓			✓		✓	✓		
7	22EEO16	AI Techniques for Engineering Applications	✓	✓	✓	✓										
7	22EIO06	Introduction to Distributed Control Systems	✓	✓	✓	✓	✓			✓		✓				
7	22EIO07	Instrumentation in Aircraft Navigation and Control	✓	✓	✓	✓	✓									
7	22EIO08	Industry 4.0 with Industrial IoT	✓	✓	✓	✓	✓			✓						
7	22EIO09	Industrial Data Communication	✓	✓	✓	✓	✓	✓								
7	22EIO10	Wireless Instrumentation	✓	✓	✓	✓	✓		✓							
7	22EIO11	Instrumentation Techniques in Agriculture	✓	✓	✓	✓	✓									
7	22CSO03	Nature Inspired optimization techniques	✓	✓	✓											
7	22ITO05	Fundamentals of Cloud Computing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
7	22ITO06	Introduction to Ethical Hacking	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
7	22CDO02	Introduction to Mobile Game Design	✓	✓	✓	✓										
7	22CDO03	Introduction to Graphics Design	✓	✓	✓	✓										
7	22ADO02	Neural Networks and Deep Learning	✓	✓	✓	✓										
7	22ALO02	Industrial Machine Learning	✓	✓	✓											
7	22CHO07	Hydrogen Energy	✓	✓										✓		
7	22CHO08	Rubber Technology	✓	✓				✓	✓					✓		
7	22FTO02	Principles of Food safety	✓	✓	✓			✓	✓	✓		✓		✓		
7	22FTO03	Fundamentals of Food Packaging and Storage	✓	✓	✓	✓	✓	✓		✓		✓		✓		
7	22MAO08	Non-Linear Optimization	✓	✓	✓											

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	22MAO09	Optimization for Engineers	✓	✓	✓											
7	22CYO07	Waste and Hazardous Waste Management	✓	✓	✓	✓			✓							
7	22CYO08	Chemistry in Every day Life	✓	✓	✓	✓										
7	22MBO03	Marketing Analytics										✓	✓	✓		
8	22CEO04	Infrastructure Planning and Management	✓	✓	✓		✓									
8	22CEO05	Environmental Laws and Policy	✓	✓			✓									
8	22MEO04	Safety Measures for Engineers	✓					✓	✓	✓						
8	22MEO05	Energy Conservation in Thermal Equipments	✓		✓		✓	✓	✓					✓		
8	22MEO06	Climate Change and New Energy Technology	✓		✓			✓	✓	✓						
8	22MTO05	Micro and Nano Electromechanical Systems	✓	✓	✓	✓								✓		
8	22AUO03	Public Transport Management	✓	✓				✓	✓	✓				✓		
8	22AUO04	Autonomous Vehicles	✓	✓	✓	✓	✓	✓	✓					✓		
8	22ECO02	Optical Engineering	✓	✓	✓	✓		✓	✓	✓	✓			✓		
8	22EEO17	Smart Grid Technologies	✓	✓	✓	✓	✓			✓				✓		
8	22EEO18	Biomass Energy Systems	✓	✓	✓			✓	✓				✓	✓		
8	22EIO12	Environmental Sensors	✓	✓	✓	✓	✓		✓							
8	22EIO13	Pollution Control and Management	✓	✓	✓	✓	✓	✓		✓						
8	22CSO04	Machine Translation	✓	✓	✓											
8	22CSO05	Fundamentals of Blockchain	✓	✓	✓											
8	22ITO07	Business Continuity Planning	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
8	22CDX02	Virtual Reality and Augmented Reality	✓	✓	✓	✓										
8	22ADO03	Business Analytics	✓	✓	✓	✓										
8	22ALO03	Machine Learning for Smart Cities	✓	✓	✓	✓										
8	22CHO09	Industrial Accident Prevention and Management	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓		

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
8	22CHO10	Electrochemical Engineering	✓	✓	✓											
8	22CHO11	Smart and Functional Materials	✓	✓					✓	✓	✓			✓		
8	22FTO04	Food Ingredients	✓	✓	✓			✓		✓		✓		✓		
8	22FTO05	Food and Nutrition	✓	✓	✓			✓				✓		✓		
8	22CYO09	Chemistry of Nutrition for Women Health	✓	✓	✓											
		General Open Elective Courses														
ALL	22GEO01	German Language Level 1								✓	✓	✓		✓		
ALL	22GEO02	Japanese Language Level 1								✓	✓	✓		✓		
5	22GEO03	Design Thinking for Engineers	✓	✓	✓	✓										
6	22GEO04	Innovation and Business Model Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
ALL	22GEO05	German Language Level 2								✓	✓	✓		✓		
ALL	22GEO06	German Language Level 3								✓	✓	✓		✓		
ALL	22GEO07	German Language Level 4								✓	✓	✓		✓		
ALL	22GEO08	Japanese Language Level 2								✓	✓	✓		✓		
ALL	22GEO09	Japanese Language Level 3								✓	✓	✓		✓		
ALL	22GEO10	Japanese Language Level 4								✓	✓	✓		✓		
ALL	22GEO11	French Language Level 1								✓	✓	✓		✓		
ALL	22GEO12	French Language Level 2								✓	✓	✓		✓		
ALL	22GEO13	French Language Level 3								✓	✓	✓		✓		
ALL	22GEO14	Spanish Language Level 1								✓	✓	✓		✓		
ALL	22GEO15	Spanish Language Level 2								✓	✓	✓		✓		
ALL	22GEO16	Spanish Language Level 3								✓	✓	✓		✓		
7	22GEO17	Entrepreneurship Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
5 / 6	22GEX01	NCC Studies (Army Wing) - I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
5 / 6	22GEX02	NCC Studies (Air Wing) - 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
5	22MBO01	Cost Accounting for Engineers										✓	✓	✓		
6	22MBO02	Economic Analysis for Decision Making					✓					✓	✓			
7	22MBO03	Marketing Analytics										✓	✓	✓		

B.TECH. CHEMICAL ENGINEERING CURRICULUM – R2022
(For the candidates admitted in the academic year 2022-23)

SEMESTER – I										
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22EGT11	Communication Skills I	3	0	0	3	40	60	100	HS
22MAC11	Matrices and Ordinary Differential Equations	3	1*	2*	4	50	50	100	BS
22PHT17	Physics for Chemical Engineering	3	0	0	3	40	60	100	BS
22CHT11	Chemical Process Industries	3	0	0	3	40	60	100	PC
22CSC11	Problem Solving and Programming in C	3	0	2	4	100	0	100	ES
22MET13	Basics of Mechanical and Electrical Engineering	3	0	0	3	40	60	100	ES
Practical / Employability Enhancement									
22PHL17	Physics Laboratory for Chemical Engineering	0	0	2	1	60	40	100	BS
22MEL12	Basics of Mechanical and Electrical Engineering Laboratory	0	0	2	1	60	40	100	ES
22VEC11	Yoga and Values for Holistic Development	--	--	--	1	100	0	100	HS
22MNT11	Student Induction Program	--	--	--	0	100	0	100	MC
Total Credits to be earned					**23**				

SEMESTER – II									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22EGT21	Communication Skills II	3	0	0	3	40	60	100	HS
22MAC22	Multivariable Calculus and Partial Differential Equations	3	1*	2*	4	50	50	100	BS
22CYT27	Chemistry for Chemical Engineering	3	0	0	3	40	60	100	BS
22CHT21	Chemical Process Plant Safety	3	0	0	3	40	60	100	PC
22CSC21	Fundamentals of Data Structures	3	0	2	4	50	50	100	ES
22MET11	Engineering Drawing	2	1	0	3	40	60	100	ES
22TAM01	Heritage of Tamils	1	0	0	1	100	0	100	HS
Practical / Employability Enhancement									
22MEL11	Engineering Practices Laboratory	0	0	2	1	60	40	100	BS
22CYL23	Chemistry Laboratory for Chemical Engineering	0	0	2	1	60	40	100	BS
Total Credits to be earned					**23**				

*Alternate weeks

B.TECH. CHEMICAL ENGINEERING CURRICULUM – R2022
(For the candidates admitted in the academic year 2022-23)

SEMESTER – III									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22MAT31	Statistics and Numerical Methods	3	1	0	4	40	60	100	BS
22ITC32	Introduction to Python	3	0	2	4	100	0	100	ES
22CHT31	Chemical Process Calculations	3	1	0	4	40	60	100	PC
22CHT32	Applied Organic Chemistry	3	0	0	3	40	60	100	PC
22CHT33	Fluid Mechanics	2	1	0	3	40	60	100	PC
22GET31	Universal Human Values	2	0	0	2	100	0	100	HS
22TAM02	Tamils and Technology	1	0	0	1	100	0	100	HS
Practical / Employability Enhancement									
22CHL31	Applied Organic Chemistry Laboratory	0	0	2	1	60	40	100	PC
22CHL32	Fluid Mechanics Laboratory	0	0	2	1	60	40	100	PC
Total Credits to be earned					**23**				

SEMESTER – IV									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22CHT41	Mass Transfer I	3	1	0	4	40	60	100	PC
22CHT42	Process Heat Transfer	2	1	0	3	40	60	100	PC
22CHT43	Mechanical Operations	2	1	0	3	40	60	100	PC
22CHT44	Materials of Construction for Process Industries	3	0	0	3	40	60	100	ES
22CHC41	Chemical Engineering Thermodynamics	3	0	2	4	50	50	100	PC
Practical / Employability Enhancement									
22CHL41	Process Heat Transfer Laboratory	0	0	2	1	60	40	100	PC
22CHL42	Mechanical Operations Laboratory	0	0	2	1	60	40	100	PC
22EGL31	Communication Skills Development Laboratory	0	0	2	1	60	40	100	HS
22GCL41 / 22GCI41	Professional Skills Training I / Industrial Training I*	--	--	--	2	100	0	100	EC
Total Credits to be earned					**22**				

*80 hours of training

B.TECH. CHEMICAL ENGINEERING CURRICULUM – R2022
(For the candidates admitted in the academic year 2022-23)

SEMESTER – V									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22CHT51	Mass Transfer II	2	1	0	3	40	60	100	PC
22CHT52	Chemical Reaction Engineering I	2	1	0	3	40	60	100	PC
22CHT53	Process Instrumentation Dynamics and Control	2	1	0	3	40	60	100	PC
22CHC51	Chemical Equipment Design and Drawing	3	0	2	4	50	50	100	PC
	Professional Elective - I	3	0	0	3	40	60	100	PE
	Open Elective – I	3	1/0	0/2	4	40/ 50	60/ 50	100	OE
Practical / Employability Enhancement									
22CHL51	Mass Transfer Laboratory	0	0	2	1	60	40	100	PC
22CHL52	Process Instrumentation Dynamics and Control Laboratory	0	0	2	1	60	40	100	PC
22GCL51 /22GCI51	Professional Skills Training II / Industrial Training II *	--	--	--	2	100	0	100	EC
Total Credits to be earned					**24**				

*80 hours of training

SEMESTER – VI									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22CHT61	Chemical Reaction Engineering II	2	1	0	3	40	60	100	PC
22CHC61	Process Modeling and Simulation	2	0	2	3	50	50	100	PC
	Professional Elective - II	3	0	0	3	40	60	100	PE
	Open Elective - II	3	1/0	0/2	4	40/ 50	60/ 50	100	OE
22MNT31	Environmental Science	2	0	0	0	100	0	100	MC
Practical / Employability Enhancement									
22CHL61	Chemical Reaction Engineering Laboratory	0	0	2	1	60	40	100	PC
22CHL62	Process Computations Laboratory	0	0	2	1	60	40	100	PC
22CHP61	Project Work I	0	0	8	4	50	50	100	EC
22GEP61	Comprehensive Test and Viva	--	--	--	2	100	0	100	EC
22GCI61	Industrial Training $^{\$}$	--	--	--	1	100	0	100	EC
Total Credits to be earned					**22**				

$40 hours of training

B.TECH. CHEMICAL ENGINEERING CURRICULUM – R2022
(For the candidates admitted in the academic year 2022-23)

SEMESTER – VII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
22CHT71	Process Engineering Economics and Management	3	1	0	4	40	60	100	HS
	Professional Elective – III	3	0	0	3	40	60	100	PC
	Professional Elective – IV	3	0	0	3	40	60	100	PE
	Professional Elective – V	3	0	0	3	40	60	100	PE
	Open Elective - III	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22CHP71	Project Work II Phase I	0	0	10	5	50	50	100	EC
Total Credits to be earned					**21**				

SEMESTER – VIII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
	Professional Elective - VI	3	0	0	3	40	60	100	PE
	Open Elective - IV	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22CHP81	Project Work II Phase II	0	0	8	4	50	50	100	EC
Total Credits to be earned					**10**				

Total Credits : 168

LIST OF PROFESSIONAL ELECTIVE COURSES (PEs) (For the candidates admitted in the academic year 2022-23)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Domain/ Stream**
Semester - V							
Elective – I							
1.	22CHE01	Organic Synthesis	3	0	0	3	AC&RE
2.	22CHE02	Fertilizer Technology	3	0	0	3	CT
3.	22CHE03	Polymer Technology	3	0	0	3	CT
4.	22CHE04	Air Pollution Control	3	0	0	3	E&E
5.	22CHE05	Ores and Mineral Processing	3	0	0	3	TO&PPO
Semester - VI							
Elective – II							
6.	22CHE06	Bio Chemical Engineering	3	0	0	3	AC&RE
7.	22CHE07	Machine Learning for Process Engineers	3	0	0	3	CSMS&C
8.	22CHE08	Pulp and Paper Technology	3	0	0	3	CT
9.	22CHE09	Industrial Waste Water Treatment	3	0	0	3	E&E
10.	22CHE10	Modern Separation Processes	3	0	0	3	TO&PPO
Semester - VII							
Elective - III							
11.	22CHE11	Instrumental Methods of Analysis	3	0	0	3	AC&RE
12.	22CHE12	Surface Coating Technology	3	0	0	3	CT
13.	22CHE13	Energy Technology	3	0	0	3	E&E
14.	22CHE14	Fluid Movers	3	0	0	3	TO&PPO
15.	22CHE15	Process Plant Safety	3	0	0	3	CT
16.	22GEE02	Total Quality Management	3	0	0	3	GE
Elective – IV							
17.	22CHE16	Momentum, Heat and Mass Transport	3	0	0	3	TO&PPO
18.	22CHE17	Corrosion Science and Engineering	3	0	0	3	AC&RE
19.	22CHE18	Advanced Process Control	3	0	0	3	CSMS&C
20.	22CHE19	Natural Gas Engineering	3	0	0	3	CT

21.	22CHE20	Battery and Fuel Cell Technology	3	0	0	3	E&E
22.	22GEE01	Fundamentals of Research	3	0	0	3	GE
		Elective –V					
23.	22CHE21	Piping Engineering	3	0	0	3	TO&PPO
24.	22CHE22	Nano materials and Composite materials for Chemical Engineers	3	0	0	3	AC&RE
25.	22CHE23	Petroleum Refinery Engineering	3	0	0	3	CT
		Semester – VIII					
		Elective - VI					
26.	22CHE24	Fundamentals of Computational Fluid Dynamics	3	0	0	3	CSMS&C
27.	22CHE25	Recent Trends in Chemical Engineering	3	0	0	3	GE
28.	22CHE26	Process Optimization	3	0	0	3	CSMS&C
29.	22CHE27	Nuclear Engineering for Chemical Engineers	3	0	0	3	CT
30.	22CHE28	Pharmaceutical Process Technology	3	0	0	3	CT

Domain:AC&RE –Applied Chemistry & Reaction Engineering, CSMS&C-Chemical Systems Modeling & Simulation & Control, CT-Chemical Technology, E&E-Energy & Environment, TO & PPO-Transport Operations & Process Plant Operation, GE - General Engineering

B.TECH. CHEMICAL ENGINEERING CURRICULUM – R2022
(For the candidates admitted in the academic year 2023-24)

SEMESTER – I

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Cate gory
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22EGT11	Communication Skills I	3	0	0	3	40	60	100	HS
22MAC11	Matrices and Ordinary Differential Equations	3	1*	2*	4	50	50	100	BS
22PHT17	Physics for Chemical Engineering	3	0	0	3	40	60	100	BS
22CSC11	Problem Solving and Programming in C	3	0	2	4	100	0	100	ES
22MET11	Engineering Drawing	2	1	0	3	40	60	100	ES
22TAM01	Heritage of Tamils	1	0	0	1	100	0	100	HS
Practical / Employability Enhancement									
22PHL17	Physics Laboratory for Chemical Engineering	0	0	2	1	60	40	100	BS
22GCL12	Foundation Laboratory – Electrical, IoT and Web	0	0	6	3	100	0	100	ES
22VEC11	Yoga and Values for Holistic Development	1	0	1	1	100	0	100	HS
22MNT11	Student Induction Program	--	--	--	0	100	0	100	MC
Total Credits to be earned					**23**				

SEMESTER – II

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Cate gory
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22EGT21	Communication Skills II	3	0	0	3	40	60	100	HS
22MAC22	Multivariable Calculus and Partial Differential Equations	3	1*	2*	4	50	50	100	BS
22CYT27	Chemistry for Chemical Engineering	3	0	0	3	40	60	100	BS
22CSC21	Fundamentals of Data Structures	3	0	2	4	50	50	100	ES
22CHT11	Chemical Process Industries	3	0	0	3	40	60	100	PC
22TAM02	Tamils and Technology	1	0	0	1	100	0	100	HS
Practical / Employability Enhancement									
22GCL11	Foundation Laboratory – Manufacturing, Design and Robotics	0	0	6	3	100	0	100	BS
22CYL23	Chemistry Laboratory for Chemical Engineering	0	0	2	1	60	40	100	BS
Total Credits to be earned					**22**				

***Alternate weeks**

B.TECH. CHEMICAL ENGINEERING CURRICULUM – R2022
(For the candidates admitted in the academic year 2023-24)

SEMESTER – III										
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Cate gory
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22MAT31	Statistics and Numerical Methods	3	1	0	4	40	60	100	BS
22ITC32	Introduction to Python	3	0	2	4	100	0	100	ES
22CHT31	Chemical Process Calculations	3	1	0	4	40	60	100	PC
22CHT32	Applied Organic Chemistry	3	0	0	3	40	60	100	PC
22CHT33	Fluid Mechanics	2	1	0	3	40	60	100	PC
22MNT31	Environmental Science	2	0	0	0	100	0	100	MC
Practical / Employability Enhancement									
22CHL31	Applied Organic Chemistry Laboratory	0	0	2	1	60	40	100	PC
22CHL32	Fluid Mechanics Laboratory	0	0	2	1	60	40	100	PC
22EGL31	Communication Skills Development Laboratory	0	0	2	1	60	40	100	HS
Total Credits to be earned					21				

SEMESTER – IV										
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Cate gory
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22CHT41	Mass Transfer I	3	1	0	4	40	60	100	PC
22CHT42	Process Heat Transfer	2	1	0	3	40	60	100	PC
22CHT43	Mechanical Operations	2	1	0	3	40	60	100	PC
22CHT44	Materials of Construction for Process Industries	3	0	0	3	40	60	100	ES
22CHC41	Chemical Engineering Thermodynamics	3	0	2	4	50	50	100	PC
Practical / Employability Enhancement									
22CHL41	Process Heat Transfer Laboratory	0	0	2	1	60	40	100	PC
22CHL42	Mechanical Operations Laboratory	0	0	2	1	60	40	100	PC
22GCL41/ 22GCI41	Professional Skills Training I / Industrial Training I *	--	--	--	2	100	0	100	EC
Total Credits to be earned					21				

*80 hours of training

B.TECH. CHEMICAL ENGINEERING CURRICULUM – R2022
(For the candidates admitted in the academic year 2023-24)

SEMESTER – V									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22CHT51	Mass Transfer II	2	1	0	3	40	60	100	PC
22CHT52	Chemical Reaction Engineering I	2	1	0	3	40	60	100	PC
22CHT53	Process Instrumentation Dynamics and Control	2	1	0	3	40	60	100	PC
22CHC51	Chemical Equipment Design and Drawing	3	0	2	4	50	50	100	PC
	Professional Elective - I	3	0	0	3	40	60	100	PE
	Open Elective – I	3	1/0	0/2	4	40/ 50	60/ 50	100	OE
Practical / Employability Enhancement									
22CHL51	Mass Transfer Laboratory	0	0	2	1	60	40	100	PC
22CHL52	Process Instrumentation Dynamics and Control Laboratory	0	0	2	1	60	40	100	PC
22GCL51 / 22GCI51	Professional Skills Training II / Industrial Training II *	--	--	--	2	100	0	100	EC
Total Credits to be earned					24				

*80 hours of training

SEMESTER – VI									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22CHT61	Chemical Reaction Engineering II	2	1	0	3	40	60	100	PC
22CHC61	Process Modeling and Simulation	2	0	2	3	50	50	100	PC
	Professional Elective - II	3	0	0	3	40	60	100	PE
	Open Elective - II	3	1/0	0/2	4	40/ 50	60/ 50	100	OE
22GET31	Universal Human Values	2	0	0	2	100	0	100	HS
Practical / Employability Enhancement									
22CHL61	Chemical Reaction Engineering Laboratory	0	0	2	1	60	40	100	PC
22CHL62	Process Computations Laboratory	0	0	2	1	60	40	100	PC
22CHP62	Project Work I	0	0	10	5	50	50	100	EC
22GEP61	Comprehensive Test and Viva	--	--	--	2	100	0	100	EC
22GCI61	Industrial Training	--	--	--	1	100	0	100	EC
Total Credits to be earned					25				

B.TECH. CHEMICAL ENGINEERING CURRICULUM – R2022
(For the candidates admitted in the academic year 2023-24)

SEMESTER – VII									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22CHT71	Process Engineering Economics and Management	3	0	0	3	40	60	100	HS
22CHT72	Transport Phenomena	3	1	0	4	40	60	100	PC
	Professional Elective – III	3	0	0	3	40	60	100	PE
	Professional Elective – IV	3	0	0	3	40	60	100	PE
	Open Elective - III	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22CHP72	Project Work II Phase I	0	0	12	6	50	50	100	EC
Total Credits to be earned					22				

SEMESTER – VIII									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
	Professional Elective - V	3	0	0	3	40	60	100	PE
	Open Elective - IV	3	0	0	3	40	60	100	OE
Practical / Employability Enhancement									
22CHP81	Project Work II Phase II	0	0	8	4	50	50	100	EC
Total Credits to be earned					10				

Total Credits : 168

LIST OF PROFESSIONAL ELECTIVE COURSES (PEs) (For the candidates admitted in the academic year 2023-24)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Domain/ Stream**
Semester - V							
Elective – I							
1.	22CHE01	Organic Synthesis	3	0	0	3	AC&RE
2.	22CHE02	Fertilizer Technology	3	0	0	3	CT
3.	22CHE03	Polymer Technology	3	0	0	3	CT
4.	22CHE04	Air Pollution Control	3	0	0	3	E&E
5.	22CHE05	Ores and Mineral Processing	3	0	0	3	TO&PPO
Semester - VI							
Elective – II							
6.	22CHE06	Bio Chemical Engineering	3	0	0	3	AC&RE
7.	22CHE07	Machine Learning for Process Engineers	3	0	0	3	CSMS&C
8.	22CHE08	Pulp and Paper Technology	3	0	0	3	CT
9.	22CHE09	Industrial Waste Water Treatment	3	0	0	3	E&E
10.	22CHE10	Modern Separation Processes	3	0	0	3	TO&PPO
Semester - VII							
Elective - III							
11.	22CHE11	Instrumental Methods of Analysis	3	0	0	3	AC&RE
12.	22CHE12	Surface Coating Technology	3	0	0	3	CT
13.	22CHE13	Energy Technology	3	0	0	3	E&E
14.	22CHE14	Fluid Movers	3	0	0	3	TO&PPO
15.	22CHE15	Process Plant Safety	3	0	0	3	CT
16.	22GEE02	Total Quality Management	3	0	0	3	GE
Elective – IV							
17.	22CHE16	Momentum, Heat and Mass Transport	3	0	0	3	TO&PPO
18.	22CHE17	Corrosion Science and Engineering	3	0	0	3	AC&RE
19.	22CHE18	Advanced Process Control	3	0	0	3	CSMS&C
20.	22CHE19	Natural Gas Engineering	3	0	0	3	CT
21.	22CHE20	Battery and Fuel Cell Technology	3	0	0	3	E&E

22.	22GEE01	Fundamentals of Research	3	0	0	3	GE
23.	22CHE21	Piping Engineering	3	0	0	3	TO&PPO
24.	22CHE22	Nano materials and composite materials for Chemical Engineers	3	0	0	3	AC&RE
25.	22CHE23	Petroleum Refinery Engineering	3	0	0	3	CT
Semester – VIII							
Elective - V							
26.	22CHE24	Fundamentals of Computational Fluid Dynamics	3	0	0	3	CSMS&C
27.	22CHE25	Recent Trends in Chemical Engineering	3	0	0	3	GE
28.	22CHE26	Process Optimization	3	0	0	3	CSMS&C
29.	22CHE27	Nuclear Engineering for Chemical Engineers	3	0	0	3	CT
30.	22CHE28	Pharmaceutical Process Technology	3	0	0	3	CT

Domain:AC&RE –Applied Chemistry & Reaction Engineering, CSMS&C-Chemical Systems Modeling & Simulation & Control, CT-Chemical Technology, E&E-Energy & Environment, TO & PPO-Transport Operations & Process Plant Operation, GE - General Engineering

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OEs) (Offered by the Department of Chemical Engineering)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22CHO01	Industrial Enzymology	3	1	0	4	V
2.	22CHO02	Waste to Energy Conversion	3	1	0	4	V
3.	22CHO03	Applied Nanotechnology	3	1	0	4	V
4.	22CHO04	Air Pollution Monitoring and Control	3	1	0	4	VI
5.	22CHO05	Paints and Coatings	3	1	0	4	VI
6.	22CHO06	Powder Technology	3	1	0	4	VI
7.	22CHO07	Hydrogen Energy	3	0	0	3	VII
8.	22CHO08	Rubber Technology	3	0	0	3	VII
9.	22CHO09	Industrial Accident Prevention and Management	3	0	0	3	VIII
10.	22CHO10	Electrochemical Engineering	3	0	0	3	VIII
11.	22CHO11	Smart and Functional Materials	3	0	0	3	VIII

OPEN ELECTIVE COURSES OFFERED BY OTHER DEPARTMENTS (OE)

S.No	Course Code	Course Title	L	T	P	C	Offering Dept.	Sem.
1.	22CEX01	Remote Sensing and its Applications	3	0	2	4	CIVIL	V
2.	22CEO01	Disaster Management	3	1	0	4	CIVIL	VI
3.	22CEO02	Introduction to Smart Cities	3	0	0	3	CIVIL	VII
4.	22CEO03	Environmental Health and Safety	3	0	0	3	CIVIL	VII
5.	22CEO04	Infrastructure Planning and Management	3	0	0	3	CIVIL	VIII
6.	22CEO05	Environmental Laws and Policy	3	0	0	3	CIVIL	VIII
7.	22MEX01	Renewable Energy Sources	3	0	2	4	MECH	V
8.	22MEX02	Design of Experiments	3	0	2	4	MECH	VI
9.	22MEO01	Fundamentals of Ergonomics	3	0	0	3	MECH	VII
10.	22MEO02	Principles of Management and Industrial Psychology	3	0	0	3	MECH	VII
11.	22MEO03	Waste Heat Recovery System and Storage	3	0	0	3	MECH	VII
12.	22MEO04	Safety Measures for Engineers	3	0	0	3	MECH	VIII
13.	22MEO05	Energy Conservation in Thermal Equipments	3	0	0	3	MECH	VIII

S.No	Course Code	Course Title	L	T	P	C	Offering Dept.	Sem.
14.	22MEO06	Climate Change and New Energy Technology	3	0	0	3	MECH	VIII
15.	22MTO01	Design of Mechatronics Systems	3	1	0	4	MTS	V
16.	22MTX01	Data Acquisition and Virtual Instrumentation	3	0	2	4	MTS	V
17.	22MTX02	Factory Automation	3	0	2	4	MTS	V
18.	22MTO02	Robotics	3	1	0	4	MTS	VI
19.	22MTO03	3D Printing and Design	3	1	0	4	MTS	VI
20.	22MTO04	Drone System Technology	3	0	0	3	MTS	VII
21.	22MTO05	Micro and Nano Electromechanical Systems	3	0	0	3	MTS	VIII
22.	22AUX01	Automotive Engineering	3	0	2	4	AUTO	V
23.	22AUO01	Automotive Electronics	3	1	0	4	AUTO	VI
24.	22AUO02	Vehicle Maintenance	3	0	0	3	AUTO	VII
25.	22AUO03	Public Transport Management	3	0	0	3	AUTO	VII
26.	22AUO04	Autonomous Vehicles	3	0	0	3	AUTO	VIII
27.	22ECX01	Basics of Electronics in Automation Appliances	3	0	2	4	ECE	V
28.	22ECX02	Image Processing	3	0	2	4	ECE	V
29.	22ECX03	PCB Design and Fabrication	3	0	2	4	ECE	VI
30.	22ECO01	Wearable Devices	3	0	0	3	ECE	VII
31.	22ECX04	Electronic Hardware and Troubleshooting	2	0	2	3	ECE	VII
32.	22ECO02	Optical Engineering	3	0	0	3	ECE	VIII
33.	22EEO01	Solar and Wind Energy Systems	3	1	0	4	EEE	V
34.	22EEO02	Electrical Wiring and Lighting	3	1	0	4	EEE	V
35.	22EEO03	Programmable Logic Controller and SCADA	3	1	0	4	EEE	V
36.	22EEO04	Analog and Digital Electronics	3	1	0	4	EEE	V
37.	22EEO05	Power Electronics and Drives	3	1	0	4	EEE	V
38.	22EEO06	Introduction to Sensors and Actuators	3	1	0	4	EEE	V
39.	22EEO07	Energy Conservation and Management	3	1	0	4	EEE	VI
40.	22EEO08	Microprocessors and Microcontrollers Interfacing	3	1	0	4	EEE	VI
41.	22EEO09	Electrical Safety	3	1	0	4	EEE	VI
42.	22EEO10	VLSI System Design	3	1	0	4	EEE	VI
43.	22EEO11	Automation for Industrial Applications	3	1	0	4	EEE	VI

S.No	Course Code	Course Title	L	T	P	C	Offering Dept.	Sem.
44.	22EEO12	Electric Vehicle	3	0	0	3	EEE	VII
45.	22EEO13	E-Waste Management	3	0	0	3	EEE	VII
46.	22EEO14	Embedded Systems and IOT	3	0	0	3	EEE	VII
47.	22EEO15	Energy Storage Systems and Controllers	3	0	0	3	EEE	VII
48.	22EEO16	AI Techniques in Engineering Applications	3	0	0	3	EEE	VII
49.	22EEO17	Smart Grid Technologies	3	0	0	3	EEE	VIII
50.	22EEO18	Biomass Energy Systems	3	0	0	3	EEE	VIII
51.	22EIO01	Measurements and Instrumentation	3	1	0	4	EIE	V
52.	22EIO02	Biomedical Instrumentation and Applications	3	1	0	4	EIE	V
53.	22EIO03	Industrial Automation	3	1	0	4	EIE	V
54.	22EIO04	PLC Programming with High Level Languages	3	1	0	4	EIE	VI
55.	22EIO05	Virtual Instrumentation	3	1	0	4	EIE	VI
56.	22EIO06	Introduction to Distributed Control Systems	3	0	0	3	EIE	VII
57.	22EIO07	Instrumentation in Aircraft Navigation and Control	3	0	0	3	EIE	VII
58.	22EIO08	Industry 4.0 with Industrial IoT	3	0	0	3	EIE	VII
59.	22EIO09	Industrial Data Communication	3	0	0	3	EIE	VII
60.	22EIO10	Wireless Instrumentation	3	0	0	3	EIE	VII
61.	22EIO11	Instrumentation Techniques in Agriculture	3	0	0	3	EIE	VII
62.	22EIO12	Environmental Sensors	3	0	0	3	EIE	VIII
63.	22EIO13	Pollution Control and Management	3	0	0	3	EIE	VIII
64.	22CSX01	Fundamentals of Database	3	0	2	4	CSE	V
65.	22CSX02	Data Science for Engineers	3	0	2	4	CSE	V
66.	22CSX03	Enterprise Application Development Using Java	3	0	2	4	CSE	V
67.	22CSO01	Computational Science for Engineers	3	1	0	4	CSE	V
68.	22CSO02	Formal Languages and Automata Theory	3	1	0	4	CSE	V
69.	22CSX04	Foundations of Machine Learning	3	0	2	4	CSE	VI
70.	22CSX05	Web Engineering	3	0	2	4	CSE	VI
71.	22CSO03	Nature Inspired Optimization Techniques	3	0	0	3	CSE	VII
72.	22CSO04	Machine Translation	3	0	0	3	CSE	VIII
73.	22CSO05	Fundamentals of Blockchain	3	0	0	3	CSE	VIII

S.No	Course Code	Course Title	L	T	P	C	Offering Dept.	Sem.
74.	22ITO01	Artificial Intelligence	3	1	0	4	IT	V
75.	22ITX01	Next Generation Databases	3	0	2	4	IT	V
76.	22ITX02	Advanced Java Programming	3	0	2	4	IT	V / VI
77.	22ITX03	Java Programming	3	0	2	4	IT	V
78.	22ITO02	Internet of Things	3	1	0	4	IT	VI
79.	22ITO03	Fundamentals of Software Development	3	1	0	4	IT	VI
80.	22ITO04	Mobile Application Development	3	1	0	4	IT	VI
81.	22ITO05	Fundamentals of Cloud Computing	3	0	0	3	IT	VII
82.	22ITO06	Introduction to Ethical Hacking	3	0	0	3	IT	VII
83.	22ITO07	Business Continuity Planning	3	0	0	3	IT	VIII
84.	22CDO01	Fundamentals of User Experience Design	3	1	0	4	CSD	V
85.	22CDX01	Fundamentals of User Interactive Design	3	0	2	4	CSD	VI
86.	22CDO02	Introduction to Mobile Game Design	3	0	0	3	CSD	VII
87.	22CDO03	Introduction to Graphics Design	3	0	0	3	CSD	VII
88.	22CDO04	Virtual Reality and Augmented Reality	3	0	0	3	CSD	VIII
89.	22ADO01	Data Warehousing and Data Mining	3	1	0	4	AD	V
90.	22ADX01	Data Visualization	3	0	2	4	AD	VI
91.	22ADO02	Neural Networks and Deep Learning	3	0	0	3	AD	VII
92.	22ADO03	Business Analytics	3	0	0	3	AD	VIII
93.	22ALO01	Business Intelligence	3	1	0	4	AIML	V
94.	22ALX01	Data Exploration and Visualization Techniques	3	0	2	4	AIML	VI
95.	22ALO02	Industrial Machine Learning	3	0	0	3	AIML	VII
96.	22ALO03	Machine Learning for Smart Cities	3	0	0	3	AIML	VIII
97.	22FTX01	Baking Technology	3	0	2	4	FT	V
98.	22FTO01	Food Processing Technology	3	1	0	4	FT	V
99.	22FTX02	Processing of milk and milk products	3	0	2	4	FT	VI
100.	22FTX03	Processing of Fruits and Vegetables	3	0	2	4	FT	VI
101.	22FTO02	Principles of Food safety	3	0	0	3	FT	VII
102.	22FTO03	Fundamentals of Food Packaging and Storage	3	0	0	3	FT	VII
103.	22FTO04	Food Ingredients	3	0	0	3	FT	VIII

S.No	Course Code	Course Title	L	T	P	C	Offering Dept.	Sem.
104.	22FTO05	Food and Nutrition	3	0	0	3	FT	VIII
105.	22MAO01	Mathematical Foundations of Machine Learning	3	1	0	4	Maths	V
106.	22MAO02	Numerical Computing	3	1	0	4	Maths	V
107.	22MAO03	Stochastic Processes and Queuing Theory	3	1	0	4	Maths	V
108.	22MAO04	Statistics for Engineers and Data Scientists	3	1	0	4	Maths	V
109.	22MAO05	Graph Theory and its Applications	3	1	0	4	Maths	VI
110.	22MAX01	Data Analytics Using R Programming	3	0	2	4	Maths	VI
111.	22MAO06	Operations Research	3	1	0	4	Maths	VI
112.	22MAO07	Number Theory and Cryptography	3	1	0	4	Maths	VI
113.	22MAO08	Non-Linear Optimization	3	0	0	3	Maths	VII
114.	22MAO09	Optimization for Engineers	3	0	0	3	Maths	VII
115.	22PHO01	Thin Film Technology	3	1	0	4	Physics	V
116.	22PHO02	High Energy Storage Devices	3	1	0	4	Physics	V
117.	22PHO03	Structural and optical Characterization of Materials	3	1	0	4	Physics	V
118.	22PHO04	Synthesis, Characterization And Biological Applications Of Nanomaterial	3	1	0	4	Physics	VI
119.	22PHO05	Techniques of Crystal Growth	3	1	0	4	Physics	VI
120.	22CYO01	Instrumental Methods of Analysis	3	1	0	4	Chemistry	V
121.	22CYO02	Chemistry Concepts for Competitive Examinations	3	1	0	4	Chemistry	V
122.	22CYO03	Organic Chemistry for Industry	3	1	0	4	Chemistry	V
123.	22CYO04	Corrosion Science and Engineering	3	1	0	4	Chemistry	VI
124.	22CYO05	Chemistry of Cosmetics in Daily Life	3	1	0	4	Chemistry	VI
125.	22CYO06	Nano composite Materials	3	1	0	4	Chemistry	VI
126.	22CYO07	Waste and Hazardous Waste Management	3	0	0	3	Chemistry	VII
127.	22CYO08	Chemistry in Everyday Life	3	0	0	3	Chemistry	VII
128.	22CYO09	Chemistry of Nutrition for Women Health	3	0	0	3	Chemistry	VIII

GENERAL OPEN ELECTIVE
(Common to All BE/BTech branches)

SNo	Course Code	**Course Title**	L	T	P	C	Offering Department	Semester
1.	22GEO01	German Language Level 1	4	0	0	4	ECE	ALL
2.	22GEO02	Japanese Language Level 1	4	0	0	4	ECE	ALL
3.	22GEO03	Design Thinking for Engineers	3	1	0	4	CSE	5
4.	22GEO04	Innovation and Business Model Development	3	1	0	4	MTS	6
5.	22GEO05	German Language Level 2	4	0	0	4	ECE	ALL
6.	22GEO06	German Language Level 3	3	0	0	3	ECE	ALL
7.	22GEO07	German Language Level 4	3	0	0	3	ECE	ALL
8.	22GEO08	Japanese Language Level 2	4	0	0	4	ECE	ALL
9.	22GEO09	Japanese Language Level 3	3	0	0	3	ECE	ALL
10.	22GEO10	Japanese Language Level 4	3	0	0	3	ECE	ALL
11.	22GEO11	French Language Level 1	4	0	0	4	ECE	ALL
12.	22GEO12	French Language Level 2	4	0	0	4	ECE	ALL
13.	22GEO13	French Language Level 3	3	0	0	3	ECE	ALL
14.	22GEO14	Spanish Language Level 1	4	0	0	4	ECE	ALL
15.	22GEO15	Spanish Language Level 2	4	0	0	4	ECE	ALL
16.	22GEO16	Spanish Language Level 3	3	0	0	3	ECE	ALL
17.	22GEO17	Entrepreneurship Development	3	0	0	3	MTS	7
18.	22GEO18	Fundamentals of Hindi Language	4	0	0	4	ENG	5
19.	22GEX01	NCC Studies (Army Wing) - I	3	0	2	4	EEE	5 / 6
20.	22GEX02	NCC Studies (Air Wing) - 1	3	0	2	4	IT	5 / 6
21.	22MBO01	Cost Accounting for Engineers	3	1	0	4	MBA	5
22.	22MBO02	Economic Analysis for Decision Making	3	1	0	4	MBA	6
23.	22MBO03	Marketing Analytics	3	1	0	4	MBA	7

OPEN ELECTIVE COURSES OFFERED BY OTHER DEPARTMENTS (OE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**OFFERED BY**
		SEMESTER V					
1.	22CEX01	Remote Sensing and its Applications	3	0	2	4	CIVIL
2.	22MEX01	Renewable Energy Sources	3	0	2	4	MECH
3.	22MTO01	Design of Mechatronics Systems	3	1	0	4	MTS
4.	22MTX01	Data Acquisition and Virtual Instrumentation	3	0	2	4	MTS
5.	22MTX02	Factory Automation	3	0	2	4	MTS
6.	22AUX01	Automotive Engineering	3	0	2	4	AUTO
7.	22ECX01	Basics of Electronics in Automation Appliances	3	0	2	4	ECE
8.	22ECX02	Image Processing	3	0	2	4	ECE
9.	22EEO01	Solar and Wind Energy Systems	3	1	0	4	EEE
10.	22EEO02	Electrical Wiring and Lighting	3	1	0	4	EEE
11.	22EEO03	Programmable Logic Controller and SCADA	3	1	0	4	EEE
12.	22EEO04	Analog and Digital Electronics	3	1	0	4	EEE
13.	22EEO05	Power Electronics and Drives	3	1	0	4	EEE
14.	22EEO06	Sensors and Actuators	3	1	0	4	EEE
15.	22EIO01	Measurements and Instrumentation	3	1	0	4	EIE
16.	22EIO02	Biomedical Instrumentation and Applications	3	1	0	4	EIE
17.	22EIO03	Industrial Automation	3	1	0	4	EIE
18.	22CSX01	Fundamentals of Databases	3	0	2	4	CSE
19.	22CSX02	Data science for Engineers	3	0	2	4	CSE
20.	22CSX03	Enterprise Application Development Using Java	3	0	2	4	CSE
21.	22CSO01	Computational science for Engineers	3	1	0	4	CSE
22.	22CSO02	Formal Languages and Automata Theory	3	1	0	4	CSE
23.	22ITO01	Artificial Intelligence	3	1	0	4	IT
24.	22ITX01	Next Generation Databases	3	0	2	4	IT
25.	22GEX02	NCC Studies (Air Wing) - 1	3	0	2	4	IT

26.	22CDO01	Fundamentals of User Experience Design	3	1	0	4	CSD
27.	22ADO01	Data Warehousing and Data Mining	3	1	0	4	AIDS
28.	22ALO01	Business Intelligence	3	1	0	4	AIML
29.	22CHO01	Industrial Enzymology	3	1	0	4	CHEM
30.	22CHO02	Waste to Energy Conversion	3	1	0	4	CHEM
31.	22CHO03	Applied Nanotechnology	3	1	0	4	CHEM
32.	22FTX01	Baking Technology	3	0	2	4	FT
33.	22FTO01	Food Processing Technology	3	1	0	4	FT
34.	22MAO01	Mathematical Foundations for Machine Learning	3	1	0	4	MATHS
35.	22MAO02	Numerical Computing	3	1	0	4	MATHS
36.	22MAO03	Stochastic Processes and Queuing Theory	3	1	0	4	MATHS
37.	22MAO04	Statistics for Engineers	3	1	0	4	MATHS
38.	22PHO01	Thin Film Technology	3	1	0	4	PHYSICS
39.	22PHO02	High Energy Storage Devices	3	1	0	4	PHYSICS
40.	22PHO03	Structural and Optical Characterization of Materials	3	1	0	4	PHYSICS
41.	22CYO01	Instrumental Methods of Analysis	3	1	0	4	CHEMISTRY
42.	22CYO02	Chemistry Concepts for Competitive Examinations	3	1	0	4	CHEMISTRY
43.	22CYO03	Organic Chemistry for Industry	3	1	0	4	CHEMISTRY
		SEMESTER VI					
44.	22CEO01	Disaster Management	3	1	0	4	CIVIL
45.	22MEX02	Design of Experiments	3	0	2	4	MECH
46.	22MTO02	Robotics	3	1	0	4	MTS
47.	22MTO03	3D Printing and Design	3	1	0	4	MTS
48.	22AUO01	Automotive Electronics	3	1	0	4	ECE
49.	22ECX03	PCB Design and Fabrication	3	0	2	4	ECE
50.	22EEO07	Energy Conservation and Management	3	1	0	4	EEE
51.	22EEO08	Microprocessors and Microcontrollers Interfacing	3	1	0	4	EEE
52.	22EEO09	Electrical Safety	3	1	0	4	EEE
53.	22EEO10	VLSI System Design	3	1	0	4	EEE
54.	22EEO11	Automation for Industrial Applications	3	1	0	4	EEE

55.	22EIO04	PLC Programming with High Level Languages	3	1	0	4	EIE
56.	22EIO05	Virtual Instrumentation	3	1	0	4	EIE
57.	22CSX04	Foundations of Machine Learning	3	0	2	4	CSE
58.	22CSX05	Web Engineering	3	0	2	4	CSE
59.	22ITX02	Advanced Java Programming	3	0	2	4	IT
60.	22ITO02	Internet of Things	3	1	0	4	IT
61.	22ITO03	Fundamentals of Software Development	3	1	0	4	IT
62.	22ITO04	Mobile Application Development	3	1	0	4	IT
63.	22CDX01	Fundamentals of User Interactive Design	3	0	2	4	CSD
64.	22ADX01	Data Visualization	3	0	2	4	AIDS
65.	22ALX01	Data Exploration and Visualization Techniques	3	0	2	4	AIML
66.	22CHO04	Air Pollution Monitoring and Control	3	1	0	4	CHEM
67.	22CHO05	Paints and Coatings	3	1	0	4	CHEM
68.	22CHO06	Powder Technology	3	1	0	4	CHEM
69.	22FTX02	Processing of milk and milk products	3	0	2	4	FT
70.	22FTX03	Processing of Fruits and Vegetables	3	0	2	4	FT
71.	22MAO05	Graph Theory and its Applications	3	1	0	4	MATHS
72.	22MAX01	Data Analytics using R Programming	3	0	2	4	MATHS
73.	22MAO06	Operations Research	3	1	0	4	MATHS
74.	22MAO07	Number Theory and Cryptography	3	1	0	4	MATHS
75.	22PHO04	Synthesis, Characterization and Biological Applications of Nanomaterials	3	1	0	4	PHYSICS
76.	22PHO05	Techniques of Crystal Growth	3	1	0	4	PHYSICS
77.	22CYO04	Corrosion Science and Engineering	3	1	0	4	CHEMISTRY
78.	22CYO05	Chemistry of Cosmetics in Daily Life	3	1	0	4	CHEMISTRY
79.	22CYO06	Nanocomposite Materials	3	1	0	4	CHEMISTRY
		SEMESTER VII					
80.	22CEO02	Introduction to Smart Cities	3	0	0	3	CIVIL
81.	22CEO03	Environmental Health and Safety	3	0	0	3	CIVIL
82.	22MEO01	Fundamentals of Ergonomics	3	0	0	3	MECH

83.	22MEO02	Principles of Management and Industrial Psychology	3	0	0	3	MECH
84.	22MEO03	Waste Heat Recovery System and Storage	3	0	0	3	MECH
85.	22MTO04	Drone System Technology	3	0	0	3	MTS
86.	22AUO02	Vehicle Maintenance	3	0	0	3	AUTO
87.	22ECO01	Wearable Devices	3	0	0	3	ECE
88.	22ECX04	Electronic Hardware and Troubleshooting	2	0	2	3	ECE
89.	22EEO12	Electric Vehicle	3	0	0	3	EEE
90.	22EEO13	E-Waste Management	3	0	0	3	EEE
91.	22EEO14	Embedded System Design	3	0	0	3	EEE
92.	22EEO15	Energy Storage Systems and Controllers	3	0	0	3	EEE
93.	22EEO16	AI Techniques for Engineering Applications	3	0	0	3	EEE
94.	22EIO06	Introduction to Distributed Control Systems	3	0	0	3	EIE
95.	22EIO07	Instrumentation in Aircraft Navigation and Control	3	0	0	3	EIE
96.	22EIO08	Industry 4.0 with Industrial IoT	3	0	0	3	EIE
97.	22EIO09	Industrial Data Communication	3	0	0	3	EIE
98.	22EIO10	Wireless Instrumentation	3	0	0	3	EIE
99.	22EIO11	Instrumentation Techniques in Agriculture	3	0	0	3	EIE
100.	22CSO03	Nature Inspired optimization techniques	3	0	0	3	CSE
101.	22ITO05	Fundamentals of Cloud Computing	3	0	0	3	IT
102.	22CDO02	Introduction to Mobile Game Design	3	0	0	3	CSD
103.	22CDO03	Introduction to Graphics Design	3	0	0	3	CSD
104.	22ADO02	Neural Networks and Deep Learning	3	0	0	3	AIDS
105.	22ALO02	Industrial Machine Learning	3	0	0	3	AIML
106.	22CHO07	Hydrogen Energy	3	0	0	3	CHEM
107.	22CHO08	Rubber Technology	3	0	0	3	CHEM
108.	22FTO02	Principles of Food safety	3	0	0	3	FT
109.	22FTO03	Fundamentals of Food Packaging and Storage	3	0	0	3	FT
110.	22MAO08	Non-Linear Optimization	3	0	0	3	MATHS
111.	22MAO09	Optimization for Engineers	3	0	0	3	MATHS

112.	22CYO07	Waste and Hazardous Waste Management	3	0	0	3	CHEMISTRY
113.	22CYO08	Chemistry in Every day Life	3	0	0	3	CHEMISTRY
		SEMESTER VIII					
114.	22CEO04	Infrastructure Planning and Management	3	0	0	3	CIVIL
115.	22CEO05	Environmental Laws and Policy	3	0	0	3	CIVIL
116.	22MEO04	Safety Measures for Engineers	3	0	0	3	MECH
117.	22MEO05	Energy Conservation in Thermal Equipments	3	0	0	3	MECH
118.	22MEO06	Climate Change and New Energy Technology	3	0	0	3	MECH
119.	22MTO05	Micro and Nano Electromechanical Systems	3	0	0	3	MTS
120.	22AUO03	Public Transport Management	3	0	0	3	ECE
121.	22AUO04	Autonomous Vehicles	3	0	0	3	ECE
122.	22ECO02	Optical Engineering	3	0	0	3	EEE
123.	22EEO17	Smart Grid Technologies	3	0	0	3	EEE
124.	22EEO18	Biomass Energy Systems	3	0	0	3	EEE
125.	22EIO12	Environmental Sensors	3	0	0	3	EIE
126.	22EIO13	Pollution Control and Management	3	0	0	3	EIE
127.	22CSO04	Machine Translation	3	0	0	3	CSE
128.	22CSO05	Fundamentals of Blockchain	3	0	0	3	CSE
129.	22ITO06	Introduction to Ethical Hacking	3	0	0	3	IT
130.	22ITO07	Business Continuity Planning	3	0	0	3	IT
131.	22CDX02	Virtual Reality and Augmented Reality	3	0	0	3	CSD
132.	22ADO03	Business Analytics	3	0	0	3	AIDS
133.	22ALO03	Machine Learning for Smart Cities	3	0	0	3	AIML
134.	22CHO09	Industrial Accident Prevention and Management	3	0	0	3	CHEM
135.	22CHO10	Electrochemical Engineering	3	0	0	3	CHEM
136.	22CHO11	Smart and Functional Materials	3	0	0	3	CHEM
137.	22FTO04	Food Ingredients	3	0	0	3	FT
138.	22FTO05	Food and Nutrition	3	0	0	3	FT
139.	22CYO09	Chemistry of Nutrition for Women Health	3	0	0	3	CHEMISTRY

GENERAL OPEN ELECTIVE
(Common to All BE/BTech branches)

SNo	Course Code	**Course Title**	L	T	P	C	Offering Department	Semester
24.	22GEO01	German Language Level 1	4	0	0	4	ECE	ALL
25.	22GEO02	Japanese Language Level 1	4	0	0	4	ECE	ALL
26.	22GEO03	Design Thinking for Engineers	3	1	0	4	CSE	5
27.	22GEO04	Innovation and Business Model Development	3	1	0	4	MTS	6
28.	22GEO05	German Language Level 2	4	0	0	4	ECE	ALL
29.	22GEO06	German Language Level 3	3	0	0	3	ECE	ALL
30.	22GEO07	German Language Level 4	3	0	0	3	ECE	ALL
31.	22GEO08	Japanese Language Level 2	4	0	0	4	ECE	ALL
32.	22GEO09	Japanese Language Level 3	3	0	0	3	ECE	ALL
33.	22GEO10	Japanese Language Level 4	3	0	0	3	ECE	ALL
34.	22GEO11	French Language Level 1	4	0	0	4	ECE	ALL
35.	22GEO12	French Language Level 2	4	0	0	4	ECE	ALL
36.	22GEO13	French Language Level 3	3	0	0	3	ECE	ALL
37.	22GEO14	Spanish Language Level 1	4	0	0	4	ECE	ALL
38.	22GEO15	Spanish Language Level 2	4	0	0	4	ECE	ALL
39.	22GEO16	Spanish Language Level 3	3	0	0	3	ECE	ALL
40.	22GEO17	Entrepreneurship Development	3	0	0	3	MTS	7
41.	22GEX01	NCC Studies (Army Wing) - I	3	0	2	4	EEE	5 / 6
42.	22GEX02	NCC Studies (Air Wing) - 1	3	0	2	4	IT	5 / 6
43.	22MBO01	Cost Accounting for Engineers	3	1	0	4	MBA	5
44.	22MBO02	Economic Analysis for Decision Making	3	1	0	4	MBA	6
45.	22MBO03	Marketing Analytics	3	1	0	4	MBA	7

22EGT11 - COMMUNICATION SKILLS I							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All B.E./B.Tech. Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**I**	**HS**	**3**	**0**	**0**	**3**

Preamble	This course is designed to impart required levels of Communication Skills and Proficiency in English language necessary for different professional contexts.	
Unit – I	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Parts of speech **-** Tenses**-** Types of sentences**:** Assertive, Imperative, Interrogative & Exclamatory **–**Affirmative & Negative **-** Gerunds & Infinitives **-Vocabulary:**Affixes **-** Synonyms & Antonyms **-Listening:**Types of listening **-**Barriers to listening **-** Listening to short talks **-** TV shows **- Speaking:** Verbal & Non-verbal communication **-** Pair conversation **-** Role play **- Reading:** Types of Reading**–** Intensive: scanning, word by word, survey **- Writing:** Dialogue writing, Informal Letters **-** Paragraph writing		
Unit – II	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Voices **-** Impersonal passives **-Vocabulary:** Homonyms, Homophones & Homographs **-Listening:** Importance of listening **-** Listening to announcements & radio broadcasts **-Speaking:** Persuasive & Impromptu talks**-**Narrating a story **- Reading:** Reading comprehension **-** Articles from Newspapers/Magazines **-** Cloze exercises **-Writing:** Essay writing, Jumbled sentences		
Unit – III	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Prepositions**-Vocabulary:** Compound Nouns **- Listening:** Listening to TED Talks, Commentaries **-Speaking:** SelfIntroduction **- Reading:** Extensive: speed, skimming**-** Identifying lexical & contextual meanings **- Writing:** Instructions & Warnings **-** Formal letters: Seeking permission for Industrial visits & Inviting guests		
Unit – IV	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Articles & Determiners **- Vocabulary:** Technical Vocabulary **-** Analogy **-** Unscrambling words **-** Logical reasoning **- Listening:** Listening to conversations -**Speaking:** Tongue twisters **-** Skill Sharing **-** Note-taking **- Reading:** Note making **-** Paraphrasing & Summarizing **- Writing:** Recommendations & Suggestions **-** Business letters: Enquiry,Calling for quotations & placing orders		
Unit – V	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Cause and effect expressions **- Vocabulary:** Abbreviations & acronyms, Definitions **Listening:** Listening to eminent personalities **- Speaking:** Commonly mispronounced words **-** Welcome address, Chief guest address & Vote of thanks **- Reading -** IELTS type passages **- Writing:** Preparing transcript for a speech **-** Interpreting news articles & advertisements		
		Total:45

TEXT BOOK:

1.	Sanjay Kumar & Pushp Lata, “Communication Skills”, 2nd Edition, Oxford University Press, New Delhi, 2018.

REFERENCES:

1.	Ashraf Rizvi,"Effective Technical Communication", 2nd Edition, McGraw-Hill India, 2017.
2.	S. P. Dhanavel, "English and Communication Skills for Students of Science and Engineering", Orient BlackSwan Publishers, Hyderabad, 2009.
3.	Jack C. Richards and Chuck Sandy, “Passages” Student’s Book 1, 3rdEdition, Cambridge University Press, New York, 2014.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	use language effectively by acquiring vocabulary and syntax in context	Applying (K3)
CO2	listen and comprehend different spoken discourses from a variety of situations	Applying (K3)
CO3	speak confidently in different professional contexts and with peers	Creating (K6)
CO4	comprehend different genres of texts by adopting various reading strategies	Understanding (K2)
CO5	write legibly and flawlessly at varied professional contexts proficiently with appropriate choice of words and structures	Creating (K6)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		37	30			33	100
CAT2		30	30			40	100
CAT3		33	34			33	
ESE		17	63			20	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22MAC11 - MATRICES AND ORDINARY DIFFERENTIAL EQUATIONS							
(Common to all Engineering and Technology branches)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**BS**	**3**	**1***	**2***	**4**

Preamble	To provide the skills to the students for solving different real time problems by applying matrices and ordinary differential equations.	
Unit – I	**Matrices:**	**9**
Introduction – Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen vectors (without proof) – Cayley – Hamilton theorem (Statement and applications only) - Orthogonal matrices – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic form – Nature of Quadratic forms - Reduction of quadratic form to canonical form by orthogonal transformation – Applications of Eigen values and Eigen vectors: Stretching of an elastic membrane.		
Unit – II	**Ordinary Differential Equations:**	**9**
Introduction – Solutions of First order differential equations: Exact differential equations – Leibnitz's Linear Equation – Bernoulli's equation –Clairaut's equation - Applications: Law of natural growth and decay.		
Unit – III	**Ordinary Differential Equations of Higher Order:**	**9**
Linear differential equations of second and higher order with constant coefficients - Particular Integrals for the types: e^{ax} – cosax / sinax – x^n – $e^{ax}x^n$, e^{ax} sinbx and e^{ax} cosbx – x^n sinax and x^n cosax – Differential Equations with variable coefficients: Euler-Cauchy's equation – Legendre's equation.		
Unit – IV	**Applications of Ordinary Differential Equations:**	**9**
Method of variation of parameters – Simultaneous first order linear equations with constant coefficients – Applications of differential equations: Simple harmonic motion – Electric circuits (Differential equations and associated conditions need to be given).		
Unit – V	**Laplace Transform:**	**9**
Laplace Transform: Conditions for existence – Transform of elementary functions – Basic properties – Derivatives and integrals of transforms –Transforms of derivatives and integrals – Transform of unit step function – Transform of periodic functions. Inverse Laplace transform: Inverse Laplace transform of elementary functions – Partial fraction method – Convolution theorem (Statement only) – Applications: Solution of linear ODE of second order with constant coefficients.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Introduction to MATLAB
2.	Computation of eigen values and eigen vectors
3.	Plotting and visualizing single variable functions
4.	Solving first and second order ordinary differential equations
5.	Solution of Simultaneous first order ODEs
6.	Solving second order ODE by variation of parameters
7.	Determining Laplace and inverse Laplace transform of basic functions
8.	Solution of Second order ODE by employing Laplace transforms

Lecture:45, Tutorials and Practical:15, Total:60

TEXT BOOK:

1.	Ramana B V, "Higher Engineering Mathematics", 1st Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2018.

REFERENCES/ MANUAL / SOFTWARE:

1.	Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.
2.	Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics For First Year B.E/B.Tech", Reprint Edition 2014, S.Chand and Co., New Delhi.

3.	Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M.,"Engineering Mathematics - I", 2nd Edition, Pearson India Education, New Delhi, 2018.
4.	Grewal B.S.,“Higher Engineering Mathematics" 44thEdition, Khanna Publishers,New Delhi, 2018.
5.	MATLAB – Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	solve engineering problems which needs matrix computations.	Applying (K3)
CO2	identify the appropriate method for solving first order ordinary differential equations.	Applying (K3)
CO3	solve higher order linear differential equations with constant and variable coefficients.	Applying (K3)
CO4	apply the concept of ordinary differential equations for modeling and finding solutions to engineering problems.	Applying (K3)
CO5	apply Laplace Transform to find solutions of Linear Ordinary Differential Equations	Applying (K3)
CO6	understand the basics of MATLAB, solve ordinary differential equations and compute Laplace transforms using MATLAB.	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2											
CO2	3	3	2											
CO3	3	3	2											
CO4	3	3	2											
CO5	3	3	3											
CO6					3									

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	70	-	-	-	100
CAT2	10	20	70	-	-	-	100
CAT3	10	20	70	-	-	-	100
ESE	10	20	70	-	-	-	100

* ±3% may be varied (CAT 1,2,3 - 50 marks & ESE – 100 marks)

***Alternate week**

22PHT17 - PHYSICS FOR CHEMICAL ENGINEERING							
Programme & Branch	**B.Tech-Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**BS**	**3**	**0**	**0**	**3**

Preamble	This course aims to impart the knowledge on elasticity, viscosity, surface tension, ultrasonics, ferrous metals, non-ferrous metals, ceramics and composites and select materials characterization techniques. It also describes the applications of aforementioned topics in chemical engineering.	
Unit – I	**Properties of Matter:**	**9**
Beams – Bending of beams – Expression for bending moment– Depression at free end of cantilever – Young's modulus by uniform bending method –Surface energy and surface tension – Determination of surface tension by Jaeger's method– Viscous force – Viscosity – Coefficient of viscosity – Determination of coefficient of viscosity for a liquid by Poiseuille's method.		
Unit – II	**Ultrasonics:**	**9**
Properties of ultrasonic waves – Generation of ultrasonic waves – Magnetostrictive generator – Piezoelectric generator – Determination of velocity of ultrasonics in a liquid– Acoustic grating –Non-destructive testing – Flaw detection –Applications of ultrasonic technology in chemical industry(qualitative) – Ultrasonic degradation of wastewater.		
Unit – III	**Ferrous and Non-Ferrous Metals:**	**9**
Ferrous Metals–Iron ore – Manufacture of pig iron and cast iron – Composition and classification of pig iron and cast iron – Effect of impurities on cast iron– Non-Ferrous metals– Aluminum and Aluminum alloys – Nickel and Nickel alloys – Lead and Lead alloys.		
Unit – IV	**Ceramics and Composites:**	**9**
Ceramics – Classification of ceramics–Glasses – Clay products – Refractories – Abrasives – Cements – Advanced ceramics – General properties and applications –Composites–Fibre Phase – Matrix Phase – Classification of composites based on matrix materials– Polymer-matrix composites– Metal-matrix composites–Ceramic-matrix composites.		
Unit – V	**Materials Characterization:**	**9**
Importance of materials characterization – X-ray diffraction analysis (powder method) –Scanning electron microscope – Transmission electron microscope (qualitative)–Fourier transform infrared spectroscopy – UV-visible spectroscopy –Thermo gravimetric analysis – Differential scanning calorimetry.		
		Total:45

TEXT BOOK:

1.	Avadhanulu M.N., Kshirsagar P.G. and Arun Murthy T.V.S., "A Textbook of Engineering Physics", 11th Edition, S. Chand & Company Pvt. Ltd., New Delhi, 2019. (Units I,II)
2.	William D. Callister Jr. and David G. Rethwisch, "Callister"s Materials Science and Engineering", (Adapted by R.Balasubramaniam), 2nd Edition, Wiley India Pvt Ltd., New Delhi, 2014. (Units III,IV)
3.	Sam Zhang, Lin Li and Ashok Kumar, "Materials Characterization Techniques", 1st Edition, CRC Press, Boca Raton, 2008. (Unit V)

REFERENCES:

1.	Gaur R.K. and Gupta S.L., "Engineering Physics", 8th Edition, Dhanpat Rai and Sons, New Delhi, 2009.
2.	Raghavan V., "Materials Science and Engineering", 6th Edition, PHI Learning Pvt. Ltd., Delhi, 2015.
3.	Tamilarasan K. and Prabu K., "Materials Science", 1st Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	make use of the concepts of elasticity and bending moment of a beam of to compute Young's modulus and also to determine the surface tension and viscosity of liquids.	Applying (K3)
CO2	describe the production of ultrasonic wave, working of acoustic grating and non-destructive testing using ultrasonic waves and the applications of ultrasonic waves in chemical engineering.	Understanding (K2)
CO3	apply the basic concepts of phase diagram to comprehend the properties and applications of the select ferrous metals, and non-ferrous metals and their alloys.	Applying (K3)
CO4	describe the composition and the properties of select ceramics and composites and to realize their applications trough appropriate properties.	Understanding (K2)
CO5	apply the concepts of X-ray diffraction, matter waves andinteraction of light with matterand thermogram to describe the principle and working of select material characterization techniques.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2						2	2		2	2	2
CO2	3	2	2						2	2		2	2	2
CO3	3	2	2						2	2		2	2	2
CO4	3	2	2						2	2		2	2	2
CO5	3	2	2						2	2		2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	60	20				100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	10	60	30				100

* ±3% may be varied (CAT 1,2,3 - 50 marks & ESE – 100 marks)

22CSC11 - PROBLEM SOLVING AND PROGRAMMING IN C

(Common to All Engineering and Technology branches except CSE, IT,CSD, AIDS & AIML)

Programme & Branch	**All BE/BTech Engineering & Technology branches , except CSE, IT, CSD, AIDS & AIML**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**BS**	**3**	**0**	**2**	**4**

Preamble	The course aims to provide exposure to problem-solving through programming. It introduces all the fundamental concepts of C Programming. This course provides adequate knowledge to solve problems using C	
Unit – I	**IntroductiontoCand Operators:**	**9**
The structure of a C program – Compiling and executing C program – C Tokens – Character set in C – Keywords – identifiers- Basic data Types – Variables – constants – Input / Output statements – Operators		
Unit – II	**ControlStatements and Arrays:**	**9**
Decision-making and looping statements, Arrays: Declaring, initializing and accessing arrays – operations on arrays – Two-dimensional arrays and their operations.		
Unit – III	**Functions:**	**9**
Functions: Introduction- Using functions, function declaration and definition – function call – return statement – passing parameters to functions: basic data types and arrays – storage classes – recursive functions		
Unit – IV	**Strings and Pointers:**	**9**
Strings:Introduction – operations on strings: finding length, concatenation, comparing and copying – string and character manipulation functions, Arrays of strings. Pointers : declaring pointer variables – pointer expression and arithmetic, pointers and 1D arrays, pointers and strings		
Unit – V	**User-defined Data Types and File Handling:**	**9**
User-defined data types: Structure: Introduction – nested structures– arrays of structure – structure and functions -unions – enumerated data type. File Handling : Introduction - opening and closing files – reading and writing data to files -Manipulating file position indicator : fseek(), ftell() and rewind()		

LIST OF EXPERIMENTS / EXERCISES:

1.	Programs for demonstrating the use of different types of format Specifiers
2.	Programsfordemonstratingtheuseofdifferenttypesofoperatorslikearithmetic,logical,relational,andternaryoperators
3.	Programsfor demonstrating the use of using decisionmakingstatements
4.	Programsfor demonstrating the use of repetitivestructures
5.	Programsfordemonstratingone-dimensional arrays
6.	Programsfordemonstrating two-dimensional arrays
7.	Programstodemonstratemodularprogrammingconceptsusingfunctions
8.	Programs to demonstrate recursive functions.
9.	Programstodemonstratestrings(Usingbuilt-inanduser-definedfunctions)
10.	Programstoillustratetheuseofpointers
11.	Programstoillustratetheuseofstructures and unions
12.	Programs to implement file Handling

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Reema Thareja, “Programming in C ”, 2nd Edition, Oxford University Press, New Delhi, 2018.

REFERENCES/ MANUAL / SOFTWARE:	
1.	Yashavant Kanetkar, "Let us C", 16th Edition, BPB Publications, 2018.
2.	Sumitabha Das, “Computer Fundamentals and C Programming”, 1st Edition, McGraw Hill, 2018.
3.	Balagurusamy E., "Programming in ANSI C", 7th Edition, McGraw Hill Education, 2017.
4.	Behrouz A. Forouzan & Richard F.Gilberg, “Computer Science A Structured Programming Approach Using C”, 3rd Edition, Cengage,2017.
5.	https://www.cprogramming.com/tutorial/c-tutorial.html

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	develop simple programs using input/output statements and operators	Applying (K3), Precision (S3)
CO2	identifytheappropriateloopingandcontrolstatementsinCanddevelopapplicationsusingthesestatements	Applying (K3), Precision (S3)
CO3	develop simple C programs using the concepts of arrays and modular programming	Applying (K3), Precision (S3)
CO4	apply the concepts of pointers and develop C programs using strings and pointers	Applying (K3), Precision (S3)
CO5	Makeuseofuser-defineddatatypesand fileconceptstosolvegiven problems	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1				1	1		1		
CO2	3	2	2	2	1				1	1		1		
CO3	3	2	2	2	1				1	1		1		
CO4	3	2	2	2	1				1	1		1		
CO5	3	2	2	2	1				1	1		1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	30	60				100
CAT3	10	30	60				100
ESE	10	30	60				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22MET21 ENGINEERINGDRAWING							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1/2**	**ES**	**3**	**0**	**0**	**3**

Preamble	To impart knowledge on orthographic, isometric projections, sectional views and development of surfaces by solving different application oriented problems.	
Unit – I	**GeneralPrinciplesofOrthographicProjection:**	**9**
Importance of Graphics in Engineering Applications - Use of Drafting Instruments - BIS Conventions and Specifications - Size, Layout andFolding of Drawing Sheets - Lettering and Dimensioning - Projections of Points, Lines and Planes - General Principles of OrthographicProjection - First Angle Projection - Layout of Views - Projection of Points Located in all Quadrant and Straight Lines Located in the FirstQuadrant-Determination ofTrueLengths andTrueInclinations and Location ofTraces-Projection ofPolygonalSurface andCircular Lamina Inclined to bothReference Planes.		
Unit – II	**Projections ofSolid:**	**9**
Projections ofSimpleSolidsLikePrisms,Pyramids,CylinderandCone whentheAxis isinclined toOneReferencePlane byChange of Position Method.		
Unit – III	**Sectioningof Solids:**	**9**
SectioningofSolids-Prisms,Pyramids,Cylinder andConeinSimpleVerticalPosition byCuttingPlanesinclinedto the ReferencePlane andPerpendicular to theother-ObtainingTrueShapeofSection.		
Unit – IV	**DevelopmentofSurfaces:**	**9**
Development ofLateralSurfacesofSimple SolidsLikePrisms,Pyramids,CylindersandCones -Development ofSimpleTruncatedSolidsInvolvingPrisms, Pyramids, Cylinders andCones.		
Unit – V	**IsometricProjectionandIntroduction toAutoCAD:**	**9**
PrinciplesofIsometricProjection- IsometricScale –IsometricProjections ofSimple andTruncatedSolidsLikePrisms,Pyramids,Cylinders andCones-Conversion ofIsometricProjectionintoOrthographicProjection –IntroductiontoAutoCAD.		
		Total:45

TEXT BOOK:

1.	Natarajan.K.V. “A Textbook of Engineering Graphics”,35th Edition, Dhanalakshmi Publishers, Chennai, 2022,

REFERENCES:

1.	Venugopal K. and Prabhu Raja V., “Engineering Graphics”, 16th Edition, New Age International Publishers, Chennai, 2022.
2.	Basant Agrawal, Agrawal C.M., “Engineering Drawing”, 3rd Edition, McGraw Hill Education, 2019.
3.	Parthasarathy N.S., Vela Murali. “Engineering Drawing”, 1st Edition, Oxford University Press, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	interpret international standardsofdrawingsandsketchtheprojections ofpoints, lines andplanes	Applying(K3)
CO2	drawthe projections of3D primitive objectslikeprisms,pyramids, cylinders andcones	Applying(K3)
CO3	constructthevarioussectionalviewsof solids likeprisms, pyramids,cylindersandcones	Applying(K3)
CO4	developthelateral surfacesofsimpleandtruncatedsolids	Applying (K3)
CO5	sketchtheisometricprojectionsofsimpleandtruncatedsolidsandconvertisometricdrawi nginto orthographicprojection	Applying(K3)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2			2					3		2	2	3
CO2	3	2	1		2					3		2	2	3
CO3	3	2	1		2					3		2	2	3
CO4	3	2	1		2					3		2	2	3
CO5	3	2	1		2					3		2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	10	80				100
CAT2	10	10	80				100
CAT3	10	10	80				100
ESE	10	10	80				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

<table>
<tr><td colspan="8">22TAM01- Tamils and Technology</td></tr>
<tr><td colspan="8">(Common to All Engineering and Technology Branches)</td></tr>
<tr><td>Programme & Branch</td><td>All BE / BTech Branches</td><td>Sem.</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td></tr>
<tr><td>Prerequisites</td><td>Nil</td><td>1 / 2</td><td>HS</td><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Preamble</td><td colspan="7">தமிழர்களின் மொழி, இலக்கியம், ஓவியங்கள், சிற்பக்கலைகள், நாட்டுப்புறக் கலைகள், வீர விளையாட்டுக்கள், திணைக் கோட்பாடுகள், இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பைப்பற்றிய அறிவை வழங்குவதே இந்த பாடத்தின் நோக்கமாகும்.</td></tr>
<tr><td>அலகு – I</td><td colspan="6">மொழி மற்றும் இலக்கியம்</td><td>3</td></tr>
<tr><td colspan="8">இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.</td></tr>
<tr><td>அலகு – II</td><td colspan="6">மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை</td><td>3</td></tr>
<tr><td colspan="8">நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் சிலை - இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.</td></tr>
<tr><td>அலகு – III</td><td colspan="6">நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுக்கள்</td><td>3</td></tr>
<tr><td colspan="8">தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.</td></tr>
<tr><td>அலகு – IV</td><td colspan="6">தமிழர்களின்திணைக் கோட்பாடுகள்</td><td>3</td></tr>
<tr><td colspan="8">தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு- சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும் கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.</td></tr>
<tr><td>அலகு – V</td><td colspan="6">இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு</td><td>3</td></tr>
<tr><td colspan="8">இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறபகுதிகளில் தமிழ் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.</td></tr>
<tr><td colspan="8">Total: 15</td></tr>
<tr><td colspan="8">TEXT BOOK:</td></tr>
<tr><td>1.</td><td colspan="7">ஆ. பூபாலன்,தமிழர் மரபு,VRB Publishers Pvt Ltd, 2022.</td></tr>
<tr><td colspan="8">REFERENCES:</td></tr>
<tr><td>1.</td><td colspan="7">தமிழகவரலாறு- மக்களும்பண்பாடும்- கேகேபிள்ளை (வெளியீடுதமிழ்நாடுபாடநூல்மற்றும்கல்வியியல்பணிகள்கழகம்)</td></tr>
<tr><td>2.</td><td colspan="7">கணினித்தமிழ் - முனைவர்இல. சுந்தரம் (விகடன்பிரசுரம்)</td></tr>
<tr><td>3.</td><td colspan="7">கீழடி - வைகைநதிக்கரையில்சங்ககாலநகரநாகரிகம்.(தொல்லியல்துறைவெளியீடு)</td></tr>
<tr><td>4.</td><td colspan="7">பொருநை - ஆற்றங்கரைநாகரிகம் (தொல்லியல்துறைவெளியீடு)</td></tr>
<tr><td colspan="8"></td></tr>
</table>

COURSE OUTCOMES: படிப்பைமுடித்தவுடன், மாணவர்கள்		BT Mapped (Highest Level)
CO1	தமிழ் மொழி மற்றும் இலக்கியத்தில் மதிப்புமிக்க கருத்துக்களை விளக்க முடியும்.	Understanding (K2)
CO2	தமிழர்களின்சிற்பம்மற்றும்அவர்களின்ஓவியங்கள்பற்றிவிளக்கமுடியும்.	Understanding (K2)
CO3	தமிழர்களின்நாட்டுப்புறமற்றும்தற்காப்புக்கலைகளைப்பற்றிசுருக்கமாகக்கூறமுடியும்.	Understanding (K2)
CO4	தமிழர்களின்திணைக் கோட்பாடுகளைப்பற்றி விளக்கமுடியும்.	Understanding (K2)
CO5	இந்தியதேசியஇயக்கம்மற்றும்இந்தியபண்பாட்டிற்குத்தமிழர்களின்பங்களிப்புபற்றிவிளக்கமுடியும்.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3		3	2	2		3		
CO2						3		3	2	2		3		
CO3						3		3	2	2		3		
CO4						3		3	2	2		3		
CO5						3		3	2	2		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	NA						

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks)

22TAM01- HERITAGE OF TAMILS								
(Common to All Engineering and Technology Branches)								
Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 / 2**	**HS**	**1**	**0**	**0**	**1**

Preamble	The objective of this course is to impart knowledge about Tamil language, literature, paintings, sculptures, folk arts, heroic games, doctrines, contribution of Tamils to Indian culture.	
UNIT I	**Language and Literature**	**3**
Language families in india - dravidian languages – tamil as a classical language - classical literature in tamil – secular nature of sangam literature – distributive justice in sangam literature - management principles in thirukural - tamil epics and impact of buddhism & jainism in tamil land - bakthi literature azhwars and nayanmars - forms of minor poetry - development of modern literature in tamil - contribution of bharathiyar and bharathidhasan.		
UNIT II	**Heritage - Rock Art Paintings to Modern Art – Sculpture**	**3**
Hero stone to modern sculpture - bronze icons - tribes and their handicrafts - art of temple car making - - massive terracotta sculptures, village deities, thiruvalluvar statue at kanyakumari, making of musical instruments - mridhangam, parai, veenai, yazh and nadhaswaram - role of temples in social and economic life of tamils.		
UNIT III	**Folk and Martial Arts**	**3**
Therukoothu – karagattam - villu pattu - kaniyan koothu – oyillattam - leather puppetry – silambattam – valari - tiger dance - sports and games of tamils.		
UNIT IV	**Thinai Concept of Tamils**	**3**
Flora and fauna of tamils & aham and puram concept from tholkappiyam and sangam literature - aram concept of tamils - education and literacy during sangam age - ancient cities and ports of sangam age - export and import during sangam age - overseas conquest of cholas.		
UNIT V	**Contribution of Tamils to Indian National Movement and Indian Culture**	**3**
Contribution of tamils to indian freedom struggle - the cultural influence of tamils over the other parts of india – self-respect movement - role of siddha medicine in indigenous systems of medicine – inscriptions & manuscripts – print history of tamil books.		
		Total: 15

TEXT BOOK:	
1.	S.Muthuramalingam, M.Saravanakumar, Heritage of Tamils, Yes Dee Publishing Pvt Ltd, 2023.
REFERENCES:	
1.	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukarasu) (Published by : International Institute of Tamil Studies).
2.	The Contribution of Tamil of the Tamils to Indian Culture(Dr.M.Valarmathi)(Puplished by International Institute of Tamil Studies).
3.	Keeladi – ‘Sangam City C ivilzation on the banks of river Vaigai; (Jointly Published by: Department of Archaeology & Tamilnadu Text Book and Educational Services Corporation, Tamilnadu).

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain valuable concepts in language and literature of tamils.	Understanding (K2)
CO2	illustrate about the tamils sculpture and their paintings.	Understanding (K2)
CO3	summarize about the tamils folk and martial arts.	Understanding (K2)
CO4	explain the thinai concept of tamils.	Understanding (K2)
CO5	explain the contribution of Tamils to the Indian National Movement and Indian culture.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3		3	2	2		3		
CO2						3		3	2	2		3		
CO3						3		3	2	2		3		
CO4						3		3	2	2		3		
CO5						3		3	2	2		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	NA						

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks)

22PHL17 - PHYSICS LABORATORY FOR CHEMICAL ENGINEERING

Programme & Branch	B.Tech – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	BS	0	0	2	1

Preamble	This course aims to impart hands on training in the determination of the physical parameters such as Young's modulus, rigidity modulus, velocity of ultrasonic waves, compressibility of water, frequency of alternating current, specific resistance, band gap of a semiconductor, wavelength of laser, Hall coefficient, thickness of a thin film and knowledge on the working of UJT, and also to impart skills on writing coding/developing project / product related to societal requirement.

LIST OF EXPERIMENTS / EXERCISES:

1.	Determination of the Young's modulus of a given material by uniform bending method.
2.	Determination of the rigidity modulus of a metallic wire using torsional pendulum.
3.	Determination of the velocity of ultrasonic waves in a liquid and the compressibility of theliquid using ultrasonic interferometer.
4.	Determination of the frequency of alternating current using electrically vibrating tuning fork (Melde's apparatus).
5.	Determination of the specific resistance of a metallic wire using Carey-Foster's bridge.
6.	Determination of the band gap of a given semiconducting material using post-office box.
7.	Determination of the wavelength of a given semiconductor laser.
8.	Determination of the Hall coefficient of a material using Hall effect arrangement / Observation of the I-V characteristics of a uni junction transistor.
9.	Determination of the thickness of a thin film using air-wedge arrangement.
10.	Writing coding for any one of the above experiments / developing a project/ a product.

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Physics Laboratory Manual / Record, Department of Physics, 1st Edition, 2020.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	determine the Young's modulus of a material using the concepts of elasticity and bending moment of a beam and to determine the rigidity modulus of a metallic wire using the concepts of twisting couple. Todetermine the velocity of ultrasound in liquid and the frequency of AC using the concept of formation of standing waves.	Applying (K3), Precision (S3)
CO2	determine the specific resistance of a metallic wire and the band gap of semiconducting material using the concept of electrical conductivity. To determine the wavelength of a semiconductor laser using the concept of diffraction of light.	Applying (K3), Precision (S3)
CO3	determine Hall coefficient of a material using the concept of Hall effect or to obtain the V-I characteristics of a UJT using the concept of region with negative resistance. To determine the thickness of a thin film using the concept of interference and also to write coding/ do project/ develop product.	Applying (K3), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3					2	2		2	2	1
CO2	3	2	2	3					2	2		2	2	1
CO3	3	2	2	3					2	2		2	2	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22GCL12 – FOUNDATION LAB – ELECTRICAL, IOT AND WEB							
(Common to all BE/BTech branches)							
Programme& Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 /2**	**ES**	**0**	**0**	**6**	**3**

Preamble	This course is designed to provide a foundational knowledge on engineering with hands-on experience on the house wiring, Internet of Things and Web Technologies.

LIST OF EXPERIMENTS / EXERCISES:

	PART A – Electrical Installation (30 Hours)
1.	Develop wiring diagrams using software tools.
2.	Identify and select suitable components for Energy Measurement and Circuit Protection
3.	Design a wiring circuit integrating Energy Meter, MCB and RCCB
4.	Develop a wiring circuit for incandescent lamp and fluorescent lamp
5.	Develop and Investigate Simple and Staircase Wiring for Residential Applications
6.	Design the Wiring Circuits for Calling Bell System and Dimmable Light
7.	Create wiring circuits for power loads
8.	Measurement of Earth Resistance and its connections.
	PART B – Internet of Things (30 Hours)
1.	Design a Single layer PCB layout designing
2.	Fabricate Single layer PCB printing
3.	Assembling, soldering and desoldering practice on single layer PCB
4.	GPIO programming in ESP8266
5.	Sensor and actuator interfacing with internet enabled microcontroller device
6.	Sensor and actuator calibration
7.	Integration of microcontroller based system with Cloud platform
	PART C – Web Technologies (30 Hours)
1.	Design a website for an application using HTML and CSS.
2.	Convert the designed website into responsive website using Bootstrap.
3.	Add dynamism to the website by using JavaScript and embed the Social Media components to the website.
4.	Incorporate database interaction to the website.
5.	Deploy the developed website in the server.
	Total:90

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	Eric T.Freeman,Elisabeth Robson, ”Head First JavaScript Programming A Brain-Friendly Guide”, 1st Edition, O’Reilly , 2014.
3.	Eric T.Freeman,Elisabeth Robson, ”Head First HTML and CSS”,2nd Edition, O’Reilly , 2012
4.	Lynn Beighley,”Head First SQL”,1st Editin, O’Reilly,2007.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	design electrical wiring circuits for buildings based on their requirement	Applying(K3), Precision (S3)
CO2	develop IoT based solutions and PCB for real world use cases.	Applying (K3), Precision (S3)
CO3	design and host an interactive dynamic website.	Applying(K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1					1					
CO2	3	2	2	1					1					
CO3	3	2	2	1					1					

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22VEC11 - YOGA AND VALUES FOR HOLISTIC DEVELOPMENT							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All B.E./B.Tech. Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 / 2**	**HS**	**1**	**0**	**1**	**1**

Preamble	Yoga or yogasanas are considered as art and science of healthy living by our ancient gurus. It is method to bring harmony of body and mind for general wellbeing. Yoga is considered as one of the greatest gifts to the world by Indians for healthy living. Students in particular are benefitted by learning yoga.	
Unit – I	**Introduction:**	**2**
The Origins of Yoga – Definitions - Concepts - Aims and objectives of Yoga – Yoga is a Science and Art – Rules and Regulations of Asanas – Classifications of Yogasanas – Patanjali's Ashtanga Yoga – Pranayama – Mudras & Bandhas - Shatkarma (Cleansing Practice) - Streams of Yoga – Modern Trends in yoga.		
Unit – II	**Yoga and Mind:**	**2**
The Nature of Mind - Five Elements and the Mind - Meditation and the Mind - Functions of the Mind - Role of Yoga in Psychological problems: Mood Disorders, Major Depressive Disorder, Cyclothymic Disorder.		
Unit – III	**Yoga and Values, Diet:**	**2**
Human Values – Social Values – Role of Yoga in Personality Integration - Concepts of Natural Diet - Naturopathy Diet – Eliminative Diet – Soothing Diet – Constructive Diet.		
Unit – IV	**Asanas:**	**2**
Prayer - Starting & Closing - Preparatory practices – Loosening Practices – Meaning, Definitions and Objectives of Asanas - Principles of Practicing Asanas. Asanas: Standing – Sitting – Prone – Supine – Suryanamaskar.		
Unit – V	**Pranayama and Meditation:**	**2**
Breathing Practices for awareness - Definitions and Objectives of Pranayama - Principles of Practicing Pranayama. Pranayama: Nadi Shuddhi - Kapalabathi – Sitali – Sitkari – Bhranari – Ujjayi – Relaxation Techniques – Meditation.		
		Lecture: 10, Practical: 10, Total:20

TEXT BOOK:

1.	Swami satyananda saraswathi, "Asana pranayama mudra bandha", Bihar school of yoga, 4th Edition, 1969.
2.	Swami mukthi Bodhanandha, "Hatha yoga pradipika", Bihar school of yoga, 4th Edition, 1985.

REFERENCES:

1.	B.K.S. Iyenkar, "Yoga the path of holistic health", DK Limited, 2nd Edition, 1969.
2.	Selvarasu, "Kriya cleansing in yoga", Aruvi yoga, 3rd Edition, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	realize the importance of yoga in physical health.	Applying (K3)
CO2	realize the importance of yoga in mental health.	Applying (K3)
CO3	realize the role of yoga in personality development and diet.	Applying (K3)
CO4	do the loosening practices, Asanas and realize its benefits.	Applying (K3)
CO5	do the practice of Pranayama, meditation and realize its benefits	Applying (K3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	-	-	-	-	-	-
CAT2	-	-	-	-	-	-	-
CAT3	20	30	50	-	-	-	100
ESE	-	-	-	-	-	-	-

* ±3% may be varied (CAT3 – 100 marks)

22EGT21 - COMMUNICATION SKILLS II							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All B.E./B.Tech. Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Communication SkillsI**	**2**	**HS**	**3**	**0**	**0**	**3**

Preamble	This course is designed to equip students with the necessary skills to listen, read, write and speak so as to develop their linguistic and communicative competencies.	
Unit – I	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Sentence Patterns **-** Simple, Compound& Complex sentences **-Vocabulary:** Portmanteau words **-** One word substitution **-Listening:** Speeches from company CEOs **-** TV debates **Speaking:** Just-a-minutetalk **-** Group discussion **-Reading:** Reading for Gist **- Writing:** Job application letter with resume **–** Transcoding		
Unit – II	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Concord **- Vocabulary:** Phrasal verbs **-** Idioms & Phrases - **Listening:** Listening to celebrity talks - **Speaking:** Talking about celebrities - Practicing Pronunciation through web tools - **Reading:** Company correspondence, technical texts/working principles of a machine - **Writing:** Description: Person, Place**,** Process, Product and Picture		
Unit – III	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Discourse markers **-** Transitional words and phrases**- Vocabulary:** Commonly confused words **- Listening:** Listening to guest lectures **- Speaking:** Technical & Non-technical presentations **-**Workshop presentations **-Reading:** Reputed company profiles, Business Plans **- Writing:** a dream job/company **-** Letter to the Editor **–**Biography& Autobiography**-** Checklist		
Unit – IV	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Degrees of Comparison **-** Punctuations **–** Fragments & run**-**ons **- Vocabulary:** British & American **-**Spelling & words **- Listening:** Listening to global accents **-** listening to motivational speeches **-** S**peaking:** Narrating personal milestones **-** Sports commentaries **-** Movie Enactment **- Reading:** Narrative passages **- Writing:** E mail **-** Agenda & Minutes of Meeting **-** Special & Technical reports		
Unit – V	**Grammar, Vocabulary, Listening, Speaking, Reading & Writing**	**9**
Grammar: Purpose and Function **-** If clause **-** Error detection **- Vocabulary:** Coding & Decoding **-** Alphabet test **- Listening:** Listening to sample HR Interviews **- Speaking:** Introduction to phonetics - Stress, rhythm &Intonation **–**Guided & unguided speeches/conversations **-** Giving feedback **–** Debate **-Reading:** Key Note speeches **-** Newspaper reports **-** short technical texts from journals **Writing:** Circulars **-** Critical Appreciation of a non-detailed text **-** Technical proposals		
		Total:45

TEXT BOOK:

1.	Sanjay Kumar & Pushp Lata, “Communication Skills”, 2nd Edition, Oxford University Press, New Delhi, 2018.

REFERENCES:

1.	Meenakshi Raman and Sangeeta Sharma. “Technical Communication- Principles and Practice”. 4th Edition, Oxford University Press, New Delhi, 2022.
2.	Murphy Raymond, "English Grammar in Use", 5th Edition, Cambridge University Press, New York, 2019.
3.	Jack C. Richards and Chuck Sandy, “Passages” Student’s Book 2, 3rdEdition, Cambridge University Press, New York, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	use functional grammar for improving communication skills	Applying (K3)
CO2	listen and comprehend different accents andinfer implied meanings	Applying (K3)
CO3	speak clearly, initiate and sustain a discussion and negotiate using appropriate communicative strategies	Creating(K6)
CO4	read different genres of texts, infer implied meanings and critically analyzeand evaluate them	Understanding (K2)
CO5	produce different types of narrative, descriptive expository texts and understand creative, critical, analytical and evaluative writing	Creating(K6)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		37	30			33	100
CAT2		7	50			43	100
CAT3		17	50			33	100
ESE		15	45			40	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

<table>
<tr><td colspan="8">22MAC22 - MULTIVARIABLE CALCULUS AND PARTIAL DIFFERENTIAL EQUATIONS</td></tr>
<tr><td colspan="8">(Common to AUTO and CHEMICAL branches)</td></tr>
<tr><td>Programme & Branch</td><td>B.E & Automobile Engineering</td><td>Sem.</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td></tr>
<tr><td>Prerequisites</td><td>Nil</td><td>2</td><td>BS</td><td>3</td><td>1*</td><td>2*</td><td>4</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Preamble</td><td colspan="7">To impart the knowledge of partial derivatives, evaluation of real integrals, vector calculus to the students and solving the partial differential equations related to engineering.</td></tr>
<tr><td>Unit – I</td><td colspan="6">Functions of Several Variables:</td><td>9</td></tr>
<tr><td colspan="8">Functions of two or more variables – Partial derivatives – Total differential – Taylor’s series for functions of two variables – Applications: Maxima and minima – Constrained maxima and minima – Lagrange’s multiplier method.</td></tr>
<tr><td>Unit – II</td><td colspan="6">Multiple Integrals:</td><td>9</td></tr>
<tr><td colspan="8">Double integration in cartesian coordinates – Change of order of integration – Application: Area between two curves – Triple integration in cartesian coordinates – Volume as triple integrals.</td></tr>
<tr><td>Unit – III</td><td colspan="6">Vector Calculus:</td><td>9</td></tr>
<tr><td colspan="8">Directional derivative – Gradient of a scalar point function – Divergence of a vector point function – Curl of a vector – Solenoidal and Irrotational vectors – Vector Integration: Introduction – Green’s, Stoke’s and Gauss divergence theorems (without proof) – Verification of the above theorems and evaluation of integrals using them.</td></tr>
<tr><td>Unit – IV</td><td colspan="6">Partial Differential Equations:</td><td>9</td></tr>
<tr><td colspan="8">Introduction – Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Lagrange’s linear equation – Solution of homogeneous linear partial differential equations of higher order with constant coefficients.</td></tr>
<tr><td>Unit – V</td><td colspan="6">Applications of Partial Differential Equations:</td><td>9</td></tr>
<tr><td colspan="8">Classification of second order quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two dimensional heat equation (excluding insulated edges).</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="8">LIST OF EXPERIMENTS / EXERCISES:</td></tr>
<tr><td>1.</td><td colspan="7">Finding ordinary and partial derivatives.</td></tr>
<tr><td>2.</td><td colspan="7">Computing extreme values of function of two variables.</td></tr>
<tr><td>3.</td><td colspan="7">Evaluating double and triple integrals.</td></tr>
<tr><td>4.</td><td colspan="7">Finding the area between two curves.</td></tr>
<tr><td>5.</td><td colspan="7">Computing gradient, divergence and curl of point functions.</td></tr>
<tr><td>6.</td><td colspan="7">Solving second order partial differential equations.</td></tr>
<tr><td>7.</td><td colspan="7">Solving One dimensional wave equation.</td></tr>
<tr><td>8.</td><td colspan="7">Solving Two dimensional heat equation.</td></tr>
<tr><td colspan="8" align="right">Lecture:45, Tutorials and Practical:15, Total:60</td></tr>
<tr><td colspan="8">TEXT BOOK:</td></tr>
<tr><td>1.</td><td colspan="7">Ramana B V, “Higher Engineering Mathematics”, 1st Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2018.</td></tr>
<tr><td colspan="8">REFERENCES/ MANUAL / SOFTWARE:</td></tr>
<tr><td>1.</td><td colspan="7">Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.</td></tr>
<tr><td>2.</td><td colspan="7">Kandasamy P., Thilagavathy K. and Gunavathy K., “Engineering Mathematics For First Year B.E/B.Tech”, Reprint Edition 2014, S.Chand and Co., New Delhi</td></tr>
<tr><td>3.</td><td colspan="7">Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., " Engineering Mathematics – I ", 2nd Edition, Pearson India Education, New Delhi, 2018.</td></tr>
<tr><td>4.</td><td colspan="7">Grewal B.S,“Higher Engineering Mathematics" 44thEdition, Khanna Publishers,New Delhi, 2018.</td></tr>
<tr><td colspan="8"></td></tr>
</table>

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	compute the total derivatives and extreme values of multivariable functions.	Applying (K3)
CO2	evaluate multiple integrals and apply them to compute the area and volume of the regions.	Understanding (K2)
CO3	apply the concepts of derivatives and line integrals of vector functions in engineering problems.	Applying (K3)
CO4	formulate and solve higher order partial differential equations.	Applying (K3)
CO5	apply Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.	Applying (K3)
CO6	demonstrate MATLAB programming to understand the concepts of functions of two variables, vector operators, multiple integrals and solve Partial differential equations.	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2											
CO2	3	3	2											
CO3	3	3												
CO4	3	2	1											
CO5	3	3	3											
CO6					3									

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60	-	-	-	100
CAT2	10	30	60	-	-	-	100
CAT3	10	30	60	-	-	-	100
ESE	5	30	65	-	-	-	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

***Alternate Week**

22CYT27 – CHEMISTRY FOR CHEMICAL ENGINEERING							
Programme & Branch	**B.Tech& Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**BS**	**3**	**0**	**0**	**3**

Preamble	This course explores the basic principles of water treatment, electrochemistry, corrosion, fuels & combustion and polymers. It aims to impart the fundamentals of chemistry towards innovations in chemical engineering and also for societal applications.	
Unit – I	**WATERTECHNOLOGY**	**9**
Introduction - types of water - hardness of water- expression of hardness (simple problems) - units of hardness –estimation of hardness of water by EDTA method – determination of alkalinity - disadvantages of using hard water in Industries - boiler troubles - scale and sludge, boiler corrosion, caustic embrittlement, priming and foaming - softening of water: i) Internal treatment process - carbonate and calgon conditioning ii) External treatment method - demineralization process iii) Treatment of water for municipal water supply (Removal of suspended particles and disinfection methods, Break-point of chlorination).		
Unit – II	**ELECTROCHEMISTRY**	**9**
Introduction - cells - types - representation of galvanic cell – electrode potential – Nernst equation (derivation of cell EMF) – calculation of cell EMF from single electrode potential – reference electrodes: construction, working and applications of standard hydrogen electrode, standard calomel electrode, glass electrode – EMF series and its applications - potentiometric titrations (redox) – conductometric titrations – mixture of weak and strong acid vs strong base.		
Unit – III	**CORROSIONANDITSCONTROL**	**9**
Corrosion: Introduction - chemical corrosion – Pilling-Bedworth rule - electrochemical corrosion and it's types – galvanic corrosion – differential aeration corrosion with examples - galvanic series - factors influencing rate of corrosion – measurement of corrosion (wt. loss method only). **Control methods** – sacrificial anodic protection method - corrosion inhibitors - protective coatings - pretreatment of metal surface – metallic coating: electroplating, electroless plating and hot dipping (tinning and galvanizing) methods – non-metallic coating: anodizing - organic coating: paints, constituents and functions - ceramic coatings.		
Unit – IV	**FUELSANDCOMBUSTION**	**9**
Introduction – classification of fuels - characteristics of a good fuel - combustion - calorific values – gross and net calorific values - theoretical calculation of calorific value by Dulong‘s formula - flue gas analysis by Orsat‘s method - solid fuels - coal and its varieties – proximate analysis – significance – metallurgical coke - Otto-Hoffman byproduct method - liquid fuel - refining of petroleum – manufacture of synthetic petrol - hydrogenation of coal - bergius process - knocking: spark ignition engine - octane number, compression ignition engine - cetane number - power alcohol and biodiesel - gaseous fuel - water gas - introduction of Bharat Stage Emission Standard (BSES) system.		
Unit – V	**POLYMERS**	**9**
Introduction – terminology - classification - polymerization - types of polymerization (definition only)- structure and property relationship of polymers (mechanical, thermal) - plastics- difference between thermoplastics and thermosetting plastics - compounding of plastics-plastic moulding methods - compression, injection, extrusion and blow moulding methods – industrial polymers: preparation, properties and applications of PVC, PAN, polyurethane, polyesters – biodegradable polymers - classification and applications.		
		Total:45

TEXT BOOK:	
1.	Wiley Editorial Board, ”Wiley Engineering Chemistry”, 2nd Edition, Wiley India Pvt. Ltd, New Delhi, Reprint 2019.
REFERENCES:	
1.	Palanna O., “Engineering Chemistry”, McGraw Hill Education, New Delhi, 2018.
2.	Payal B. Joshi, Shashank Deep, “Engineering Chemistry”, Oxford University Press, New Delhi, 2019.
3.	Palanisamy P.N., Manikandan P., Geetha A.& Manjula Rani K., “Applied Chemistry”, 6th Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	applythesuitablewatersofteningmethodstoavoidboilertroubles.	Applying (K3)
CO2	applytheprincipleofelectrochemistryforvariousapplications.	Applying (K3)
CO3	makeuse ofcorrosioncontrolmethodstosolvecorrosion relatedissues.	Applying (K3)
CO4	apply the concepts of fuels and combustion for engineering applications	Applying (K3)
CO5	make use of concept of polymerization and fabrication process to explain the typesofpolymers,plastics andfabricationmethods of plastics	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1									2	2
CO2	3	2	1	1									2	2
CO3	3	2	1	1									2	2
CO4	3	2	1	1									2	2
CO5	3	2	1	1									2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHT21 – CHEMICAL PROCESSPLANT SAFETY							
Programme & Branch	**B.Tech& Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**PC**	**3**	**0**	**0**	**3**

Preamble	The course outlines the workplace safety and associated terms applicable to the Process Industries	
Unit - I	**Safety Principles**	**9**
Need for safety, Safety programs, Training & Education; Personal protective Equipment, Safety codes: NFPA, IS, API, and OSHA standards; Colour codes for pipe lines. Materials Safety Data sheets;		
Unit - II	**Hazards and Occupational Health**	**9**
Hazards- fire, explosion and radiation; Designs to prevent fire and explosion hazards; Relief Valves; Occupational diseases – Types, Causes and effects, Safety in storage and handling of chemicals		
Unit - III	**Safety in Operations and Processes**	**9**
Safety in operations and processes. Runaway reactions, unstable products; Safety Studies – HAZOPS, HAZAN, Fault tree, Event tree and risk analysis, Working at Height, Lock out-Tag out, Hot Work Permit, Emergency Planning and Response		
Unit - IV	**Industrial Accidents**	**9**
Industrial accidents –types, causes, effects, costs, prevention, investigation and analysis, accident proneness, case studies: The Flixborough UK - Cyclohexane Disaster, Seveso Accident, The Chernobyl Nuclear Disaster, Bhopal Gas Tragedy; Field visits		
Unit - V	**Legal Aspects of Industrial Safety**	**9**
Safety Laws - Factories act, ESI act and Workmen’s compensation act; Promotion of safety - Role of Government, Management, Safety organizations, and Trade unions; Rules and requirements governing Chemical industries in India.		
		Total:45

TEXT BOOK:

1.	Daniel A. Crowl, Joseph F. Louvar, "Chemical Process Safety: Fundamentals with Applications", 3rd Edition, Prentice Hall, India, 2011.

REFERENCES:

1.	Roy E. Sanders, "Chemical Process Safety: Learning from case histories", 4th Edition, Butterworth Heinemann, United State of America, 2015.
2.	Raju K.S.N, "Chemical Process Industry Safety", 1st Edition, McGraw Hill International Edition, New Delhi, 2017.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	recall the industrial safety programs and the safety standards	Understanding (K2)
CO2	recognize the industrial hazards and apply the safety procedure to prevent fire and explosion hazards	Applying (K3)
CO3	describe safety in operation and processes through HAZOP and HAZAN studies	Applying (K3)
CO4	examine major industrial accidents, their consequences and describe the preventive methods	Applying (K3)
CO5	summarize use of the legal aspects of industrial safety	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1				3	3	2	1	2		2	1	1
CO2	2	1				3	3	2	1	2		2	1	1
CO3	2	2	1			3	3	2	1	2		2	1	1
CO4	2	2		1		3	3	2	1	2		2	1	1
CO5	1					3	3	2	1	2		2	1	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	20	40	40				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1 & 2 – 60 marks & ESE – 100 marks)

22CSC21 – FUNDAMENTALS OF DATA STRUCTURES							
(Common to Automobile, Civil, Mechanical, Chemical, Food Technology Branches)							
Programme & Branch	Automobile, Civil, Mechanical, Chemical, Food Technology	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Programming in C**	**2**	**PC**	**3**	**0**	**2**	**4**

Preamble	This course is indented to introduce the concept of elementary data structures and notion of algorithms to novice learner from cross disciplines in Engineering and Technology.	
Unit – I	**List:**	**9**
Data Structures - Abstract Data Types (ADT) - List ADT and Array Implementation -Linked List- Singly Linked List- Insertion - Deletion - Copying Singly Linked List - Doubly Linked List- Insertion -Deletion.		
Unit – II	**Stack and Queues:**	**9**
Stack ADT – Array and Linked List implementation of Stacks - Application: Balancing Parenthesis – Infix to Postfix - Postfix Expression Evaluation - Queue ADT – Array and Linked List implementation of Queues - Applications		
Unit – III	**Trees:**	**9**
Trees-Preliminaries – Binary Trees –Binary Tree Traversals - The Search Tree ADT – Binary Search Trees– Operations : Find – FindMin – FindMax – Insertion – Deletion- Expression Tree		
Unit – IV	**Graphs:**	**9**
Graphs – Definitions – Graph Traversals: Breadth First Search – Depth First Search - Shortest-Path Algorithms: Unweighted Shortest Paths – Dijkstra's Algorithm – Minimum Spanning Tree – Prim's Algorithm- Kruskal's Algorithm		
Unit – V	**Sorting and Hashing:**	**9**
Sorting - Preliminaries – Insertion Sort – Quicksort – Merge sort – Hashing – General Idea – Hash Function – Separate Chaining – Open Addressing		

LIST OF EXPERIMENTS / EXERCISES:

1.	Implementation of C programs using pointers
2.	Implementation of singly linked list and its operations
3.	Implementation of doubly linked list and its operations
4.	Implementation of Stack and its operations
5.	Implementation of Queue and its operations
6.	Implementation of Stack and Queue using Singly Linked List
7.	Evaluate the Post-fix Expression using Stack ADT
8.	Implementation of Binary Search Tree traversals
9.	Implementation of Insertion sort and Quick sort
10.	Implementation of hash function

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Weiss M. A., "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education Asia, New Delhi, 2016.

REFERENCES/ MANUAL / SOFTWARE:

1.	Horowitz Sahni, Andreson Freed, "Fundamentals of Data Structures in C", 2nd Edition, Universities Press, Hyderabad, 2011.
2.	Langsam Y.M., Augenstein J. and Tenenbaum A. M., "Data Structures using C and C++", 2nd Edition, Pearson Education, 2015.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply List ADT for solving the given problems	Applying (K3)
CO2	make use of arrays and linked lists to create Stack and Queue ADTs.	Applying (K3)
CO3	utilize Tree ADT to develop simple application	Applying (K3)
CO4	make use of Graph ADT for standard problems	Applying (K3)
CO5	illustrate the use of standard sorting and Hashing Techniques	Applying (K3)

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	60	30				100
CAT2	5	35	60				100
CAT3	5	35	60				100
ESE	5	35	60				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHT11 CHEMICAL PROCESS INDUSTRIES

Programme & Branch	B.Tech-Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	3	0	0	3

Preamble	This course will educate students about manufacturing process of various chemical products	
Unit – I	**Introduction to Chemical Industry**	**9**
Fundamental and derived units, System of units and conversions Classification of unit operations and unit processes - Construction of block diagrams and process flow diagrams Manufacture of Sulfur, Sulfur dioxide and sulfuric acid by Contact process		
Unit – II	**Fertilizer Industries**	**9**
Manufacture of ammonia, urea by carbamide process, ammonium phosphate, ammonium sulphate, single and triple super phosphate, potassium nitrate, potassium sulphate and potassium chloride- compound fertilizers		
Unit – III	**Inorganic Alkalis and Acids Industries**	**9**
Manufacture ofcaustic soda and chlorine, sodium chloride, soda ash by Le Blanc Process, Sodium Bicarbonate, Hydrochloric acid, phosphoric acid, nitric acid		
Unit – IV	**Polymer Industries**	**9**
Polymerization technology - Manufacture of polypropylene, polystyrene, PVC, nylons 6, nylons 66, polyesters, ABS and SBR, vulcanization of rubber		
Unit – V	**Miscellaneous Chemical Industries and Sustainable Practices**	**9**
Manufacture of Sugar, Paper and Pulp – Kraft Process, Cement, Glass, Pollution control practices – Effect of exposure, UN recommended practices, Case Studies		
		Total:45

TEXT BOOK:

1.	Gopala Rao M. and Marshall Sittig, “DRYDEN'S Outlines of Chemical Technology ", 3rd Edition, East-West Press, New Delhi, 2008.

REFERENCES:

1.	George T.Austin, “Shreve's Chemical Process Industries”,5th Edition,Tata McGraw-Hill, New Delhi, 2012.
2.	Mark W.V. and Bhatia S.C., “Chemical Process Industries”,Volume-I and II, 2nd Edition,CBS Publishers and Distributors, New Delhi, 2007.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain unit operations and processes with the process flow diagram for manufacture of sulfur based products	Understanding (K2)
CO2	illustrate the manufacturing process of chemical fertilizers using flow diagram	Understanding (K2)
CO3	describe the production of inorganic acids, alkalis, and by-products	Understanding (K2)
CO4	summarize the manufacturing process of polymer and allied productsthrough process flow sheets	Understanding (K2)
CO5	explain the process flow diagram for the production of sugar, cement, pulp and paper and discuss various pollution control practices in process industries	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1			1	1						1	3	1
CO2	3	1			1	1						1	3	1
CO3	3	1			1	1						1	3	1
CO4	3	1			1	1						1	3	1
CO5	3	1			1	1	1					1	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	80					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22TAM02 - தமிழரும் தொழில்நுட்பமும்								
(Common to All Engineering and Technology Branches)								
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**	
Prerequisites	**Nil**	**2/3**	**HS**	**1**	**0**	**0**	**1**	

முன்னுரை	தமிழ் கலாச்சாரத்தோடு ஒன்றிய தொழில் நுட்பங்களை பற்றிப் எடுத்துரைத்தல்	
அலகு – I	**நெசவு மற்றும் பானை தொழில்நுட்பம்**	**3**
சங்க காலத்தில் நெசவு தொழில்–பானைத் தொழில்நுட்பம் கருப்பு சிவப்பு பாண்டங்கள் –பாண்டகளில் கீறல் குறியீடுகள்		
அலகு – II	**வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்**	**3**
சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப்பொருட்களில் வடிவமைப்பு – சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச்சிற்பங்களும், கோவில்களும் – சோழர் காலத்து பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள்–மாதிரிகட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னை இந்தோ-சாரோசெனிக் கட்டிடக் கலை.		
அலகு – III	**உற்பத்தித் தொழில்நுட்பம்**	**3**
கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச்சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல்– மணி உருவாக்கும் தொழிற்சாலைகள் –கல்மணிகள் – கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் –சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.		
அலகு – IV	**வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம்**	**3**
அணை,ஏரி,குளங்கள்,மதகு–சோழர்காலகுமிழித்தூம்பின்முக்கியத்துவம்–கால்நடைபராமரிப்பு–கால்நடைகளுக்காகவடிவமைக்கப்பட்டகிணறுகள்–வேளாண்மைமற்றும்வேளாண்மைசார்ந்தசெயல்பாடுகள்–கடல்சார்அறிவு–மீன்வளம்–முத்துமற்றும்முத்துக்குளித்தல்–பெருங்கடல்குறித்தபண்டையஅறிவு–அறிவுசார்சமூகம்.		
அலகு – V	**அறிவியல் தமிழ் மற்றும் கணினித்தமிழ்**	**3**
அறிவியல் தமிழின் வளர்ச்சி – கணினிதத்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் சொற்குவைத் திட்டம்.		
		Total:15

TEXT BOOK:	
1.	தமிழக வரலாறு- மக்களும் பண்பாடும்- கே கே பிள்ளை (வெளியீடு தமிழ்நாடு பாடநூல் மற்றும் கல்வியில் பணிகள் கழகம்),உலகத் தமிழாராய்ச்சி நிறுவனம், சென்னை,2002
2.	கணினித்தமிழ் முனைவர் இல. சுந்தரம், விகடன் பிரசுரம், 2016

REFERENCES:	
1.	கீழடி-வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம்.(தொல்லியல் துறை வெளியீடு)
2.	பொருநை-ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
3.	Social Life of Tamils (Dr.K.K.Pillay) A joint Publication of TNTB & ESC and RMRL – (in print)
4.	Social Life of the Tamils – The Classical Period (Dr.S.Sigaravelu) (Published by: International Institute of Tamil Studies).
5.	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukarasu) (Published by : International Institute of Tamil Studies)

6.	The Contribution of the Tamil to Indian Culture (Dr.M.Valarmathi) (Puplished by International Institute of Tamil Studies).
7.	Keeladi – 'Sangam City Civilzation on the banks of river Vaigai; (Jointly Published by: Department of Archaeology & Tamilnadu Text Book and Educational Services Corporation, Tamilnadu)
8.	Studies in the History of India with Special Reference to Tamilnadu (Dr.K.K.Pillay) (Published by: The Author)
9.	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamilnadu Textbook and Educational Services Corporation, Tamilnadu)
10.	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

COURSE OUTCOMES: படிப்பைமுடித்தவுடன், மாணவர்கள்		BT Mapped (Highest Level)
CO1	தமிழ் கலாச்சாரம்மற்றும் தமிழ் சமூகத்தினுடையநெசவு மற்றும் பானை தொழில்நுட்பம்பற்றி விளக்க முடியும்.	Understanding (K2)
CO2	தமிழர்களின்வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்ப ஆற்றல் பற்றிவிளக்கமுடியும்.	Understanding (K2)
CO3	தமிழர்களின்உற்பத்தித் தொழில்நுட்பம்பற்றிசுருக்கமாகக்கூறமுடியும்.	Understanding (K2)
CO4	தமிழர்களின்வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம்பற்றி விளக்கமுடியும்.	Understanding (K2)
CO5	தமிழர்களின் அறிவியல் தமிழ் மற்றும் கணினித்தமிழ் பற்றிவிளக்கமுடியும்.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3		3	2	2		3		
CO2						3		3	2	2		3		
CO3						3		3	2	2		3		
CO4						3		3	2	2		3		
CO5						3		3	2	2		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	NA						

*** ±3% may be varied (CAT 1,2,3 – 50 marks)**

22TAM02 - TAMILS AND TECHNOLOGY							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2/3**	**HS**	**1**	**0**	**0**	**1**

Preamble	This course aims to impart the essential knowledge on the tamil culture and related technology	
UNIT – I	**WEAVING AND CERAMIC TECHNOLOGY**	**3**
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.		
UNIT – II	**DESIGN AND CONSTRUCTION TECHNOLOGY**	**3**
Designing and Structural construction House & Designs in household materials during Sangam Age – Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram – Sculptures and Temples of Mamallapuram – Great Temples of Cholas and other worship places – Temples of Nayaka Period – Type study (Madurai Meenakshi Temple) – Thirumalai Nayakar Mahal – Chetti Nadu Houses, Indo – Saracenic architecture at Madras during British Period.		
UNIT – III	**MANUFACTURING TECHNOLOGY**	**3**
Art of Ship Building – Metallurgical studies – Iron industry – Iron smelting, steel – Copper and gold – Coins as source of history – Minting of Coins – Beads making – industries Stone beads – Glass beads –Terracotta beads –Shell beads/ bone beats – Archeological evidences – Gem stone types described in Silappathikaram.		
UNIT – IV	**AGRICULTURE AND IRRIGATION TECHNOLOGY**	**3**
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry – Wells designed for cattle use – Agriculture and Agro Processing – Knowledge of Sea – Fisheries – Pearl – Conche diving – Ancient Knowledge of Ocean – Knowledge Specific Society.		
UNIT – V	**SCIENTIFIC TAMIL & TAMIL COMPUTING**	**3**
Development of Scientific Tamil – Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.		
		Total:15

TEXT BOOK:

1.	Social Life of Tamils (Dr.K.K.Pillay) A joint Publication of TNTB & ESC and RMRL – (in print)
2.	Social Life of the Tamils – The Classical Period (Dr.S.Sigaravelu) (Published by: International Institute of Tamil Studies).

REFERENCES:

1.	தமிழகவரலாறு - மக்களும்பண்பாடும் - கேகேபிள்ளை (வெளியீடுதமிழ்நாடுபாடநூல்மற்றும்கல்வியில்பணிகள்கழகம்), உலகத்தமிழாராய்ச்சிநிறுவனம், சென்னை, 2002
2.	கணினித்தமிழ்முனைவர்இல. சுந்தரம், விகடன்பிரசுரம், 2016
3.	கீழடிவைகைநதிக்கரையில்சங்ககாலநகரநாகரிகம்.(தொல்லியல்துறைவெளியீடு)
4.	பொருநைஆற்றங்கரைநாகரிகம் (தொல்லியல்துறைவெளியீடு
5.	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukarasu) (Published by : International Institute of Tamil Studies)
6.	The Contribution of the Tamils to Indian Culture (Dr.M.Valarmathi)(Puplished by International Institute of Tamil Studies).
7.	Keeladi – ‘Sangam City Civilzation on the banks of river Vaigai; (Jointly Published by: Department of Archaeology & Tamilnadu Text Book and Educational Services Corporation, Tamilnadu)
8.	Studies in the History of India with Special Reference to Tamilnadu (dr.K.K.Pillay) (Published by : The Author)
9.	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamilnadu Textbook and Educational Services Corporation, Tamilnadu)
10.	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain weaving and ceramic technology in tamil culture and tamil society.	Understanding (K2)
CO2	Illustrate about the design and construction technology.	Understanding (K2)
CO3	summarize about the manufacturing technology.	Understanding (K2)
CO4	explain the agriculture and irrigation technology.	Understanding (K2)
CO5	explain the significance of tamil in scientific and computing.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3		3	2	2		3		
CO2						3		3	2	2		3		
CO3						3		3	2	2		3		
CO4						3		3	2	2		3		
CO5						3		3	2	2		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	NA						

*** ±3% may be varied (CAT 1,2,3 – 50 marks)**

22CYL23 –CHEMISTRY LABORATORY FOR CHEMICAL ENGINEERING							
Programme & Branch	**B.Tech& Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**BS**	**0**	**0**	**3**	**1**

Preamble	This course aims to impart hands on training in the determination of the water quality parameters such as hardness, alkalinity, chloride, DO, COD, iron, chromium and to develop the skills in handling different basicinstrumentsandalsoaimstoimpartthe basic conceptsofvolumetric,conductometricandpHmeterexperimentsand thereby,toimprovetheanalyticalcapability.

LIST OF EXPERIMENTS / EXERCISES:

1.	Assessment of the given water sample for the suitability of drinking / industrial purpose by estimating the carbonate, non-carbonate and total hardness by EDTA method.
2.	Estimation ofCa^{2+}andMg^{2+} ions present in drinking waterseparatelybycomplexometric method.
3.	Estimationofalkalinityof river and borewell water collected from different places.
4.	Estimation of chloride ion in the given water sample using Argentometric method.
5.	Determination of dissolved oxygen in the given wastewater sample.
6.	Determination of COD in the given wastewater sample.
7.	Determination of molecular weight of a polymer / liquid by Ostwald viscometer.
8.	Determination of corrosion rate of iron in acidic medium.
9.	Estimation of sulphur present in fuel using electro-analytical techniques.
10.	Comparison of the acidity of the given samples using pHmeter.
11.	Estimation of sodium using Flame photometer (Demonstration).
12.	Estimation of iron using spectrophotometer (Demonstration).
	Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Palanisamy P.N., Manikandan P., Geetha A. and Manjula Rani K., "Chemistry Laboratory Manual", 1st Edition, Rajaganapathy Publishers, Erode, 2022.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	estimate the temporary & permanent hardness, Ca^{2+} &Mg^{2+}hardness and alkalinity of the given water sample.	Applying (K3), Precision (S3)
CO2	demonstrate the water quality parameters of water sample by estimating Chloride, DO and COD.	Applying (K3), Precision (S3)
CO3	determine the corrosion rate of iron, sulphur content in coal, acidic strength of samples and demonstrate the viscometer for the determination of molecular weight of a polymer.	Applying (K3), Precision (S3)

Mapping of Cos with POs and PSOs

COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	3			3						2	2
CO2	3	2	1	3			3						2	2
CO3	3	2	1	3			2						2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22GCL11 –FOUNDATION LAB – MANUFACTURING, DESIGN AND ROBOTICS							
(Common to All BE/BTech branches)							
Programme& Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1 / 2**	**ES**	**0**	**0**	**6**	**3**

Preamble	This course is designed to provide foundational knowledge on engineering with hands-on experience on developing a prototype model with the basic knowledge of Computer-aided Design, Manufacturing Processes, 3D Printing Technology, Robotics and Embedded Control.

LIST OF EXPERIMENTS / EXERCISES:

	PART A – Manufacturing (30 Hours)
1.	Selection of product, free hand sketching and detailing
2.	Construction of model using Arc/TIG/MIG/Gas/Spot welding operations
3.	Enhancing the model with sheet metal
4.	Creating the parts of the model using lathe
5.	Creating the parts of the model using milling and drilling machines
	PART B – Product Design and Development (30 Hours)
1.	Free hand sketching and detailing of the component
2.	3D part modeling of the component using CAD software
3.	Engineering Analysis of the component model
4.	Generate the component using 3D printer
5.	Value addition to the produced component using CNC milling machine, CNC laser cutting machine and CNC router
	PART C – Robotics (30 Hours)
1.	Design of electronic circuit and its debugging
2.	Interfacing of sensors, actuators and wireless communion modules with microcontroller
3.	Assembly of Tracker Robot with accessories
4.	Development of control strategies for motion control, path planning and obstacle avoidance
5.	Demonstration and testing of Robot in static environment
	Total:90

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual
2.	AutoCAD 2020 and SOLID WORKS 2018 Software

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	develop the prototype model using mechanical operations like welding, forming and machining processes	Applying (K3), Precision (S3)
CO2	sketch 3D model and enhance the prototype using modern machines like 3D printer, CNC milling machine, CNC Laser cutter and CNC Router	Applying (K3), Precision (S3)
CO3	design and develop the autonomous robot for real-time applications	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3		2				3	2		2		
CO2	3	3	3		3				3	2		2		
CO3	3	3	3		2				3	2		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

22MAT31 STATISTICS AND NUMERICAL METHODS

Programme & Branch	BTech & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**3**	**BS**	**3**	**1**	**0**	**4**

Preamble	To impart knowledge in testing of samples, ANOVA and interpolation. Also develop the skills to apply numerical algorithms to identify roots of algebraic and transcendental equations and solve linear and ordinary differential equations.	
Unit – I	**Testing of Hypothesis:**	**9+3**
Introduction– Critical region and level of significance – Types of Errors– Large sample tests: Z-test for single mean and difference of means – Small sample tests: Student’s t-test for testing significance of single mean and difference of means – F-test for comparison of variances – Chi-square test: Test of goodness of fit – Test of independence of attributes.		
Unit – II	**Design of Experiments:**	**9+3**
Introduction **–** Analysis of variance – One way classification: Completely Randomized Design – Two way classifications: Randomized Block Design – Three way classification: Latin Square Design.		
Unit – III	**Solution to Algebraic and Transcendental Equations:**	**9+3**
Method of false position – Newton-Raphson method – Solution of linear system of equations – Direct methods: Gauss elimination method and Gauss - Jordan method – Iterative methods: Gauss Jacobi and Gauss-Seidel methods.		
Unit – IV	**Interpolation, Numerical Differentiation and Integration::**	**9+3**
Interpolation: Interpolation with equal intervals: Newton‘s forward and backward difference formulae – Interpolation with unequal intervals: Lagrange’s interpolation formula – Newton’s divided difference formula. Numerical Differentiation: Differentiation using Newton‘s forward, backward and divided difference formulae – Numerical integration: Trapezoidal rule – Simpsons 1/3rd rule.		
Unit – V	**Numerical Solution of First order Ordinary Differential Equations:**	**9+3**
Single step methods**:** Taylor series method – Euler method – Modified Euler method – Fourth order Runge-Kutta method – Multi step methods: Milne’s predictor corrector method – Adam’s Bashforth method.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Veerarajan T, Ramachandran T., “Statistics and Numerical Methods”, 1st Edition, McGraw Hill Education, Chennai, 2019.

REFERENCES:

1.	Walpole R.E., Myers R.H., Myers S.L. and Ye K., "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2012.
2.	Jay L. Devore., “Probability and Statistics for Engineering and the Sciences”, 9th Edition, Cengage Learning, USA, 2016.
3.	Steven C. Chapra, Raymond P. Canale., “Numerical Methods for Engineers”, 7th Edition, McGraw-Hill Education, 2014.
4.	Ramana B V, “Higher Engineering Mathematics”, 1st Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply statistical tests for solving engineering problems involving small and large sample tests.	Applying (K3)
CO2	use appropriate experimental designs to analyze the experimental data with the knowledge of ANOVA.	Applying (K3)
CO3	apply various numerical techniques to solve algebraic and transcendental equations.	Applying (K3)
CO4	compute the derivatives, definite integral values numerically and perform the interpolation on given data using standard numerical techniques.	Applying (K3)
CO5	compute the solution of first order ordinary differential equations by numerical techniques..	Applying (K3)

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3									3	
CO2	3	2	3	3									3	
CO3	3	3	2										1	
CO4	3	2												
CO5	3	3	1											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		25	75				100
CAT2		25	75				100
CAT3		25	75				100
ESE		25	75				100

* ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)

22ITC32–INTRODUCTION TO PYTHON							
(Offered by Department of Information Technology)							
Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**C programming**	**4**	**ES**	**3**	**0**	**2**	**4**

Preamble	This course deals with core python programming. It gives a comprehensive introduction to problem solving using python constructs and libraries.	
Unit – I	**Introduction:**	**9**
Problem solving strategies – program design tools – Types of errors – Testing and Debugging- Basics: Literals – variables and identifiers – data types - input operation – comments – reserved words – indentation – Operators and Expressions – Decision Control Statements: Introduction – conditional statement – iterative statements – Nested Loops – break, continue and pass statements – else in loops.		
Unit – II	**Lists, Tuples and Dictionary:**	**9**
Lists: Access, update, nested, cloning, operations, methods , comprehensions, looping - Tuple: Create, utility, access, update, delete, operations, assignments, returning multiple values, nested tuples, index and count method - Dictionary: Create, access, add and modify, delete, sort, looping, nested, built-in methods – list vs tuple vs dictionary.		
Unit – III	**Strings and Regular Expressions:**	**9**
Strings: Concatenation , append, multiply on strings – Immutable – formatting operator – Built-in string methods and functions – slice operation – functions – operators – comparing – iterating – string module – Regular Expressions **–** match, search, sub, findall and finditer functions – flag options.		
Unit – IV	**Functions and Modules:**	**9**
Functions: Introduction - definition – call – variable scope and lifetime – return statement – function arguments – lambda function – documentation strings – programming practices recursive function- Modules: Modules – packages – standard library methods – function redefinition.		
Unit – V	**Object Orientation:**	**9**
Class and Objects: Class and objects – class methods and self – constructor – class and object variables – destructor – public and private data member. NumPy : NumPy Arrays – Computation on NumPy Arrays. Matplotlib : Line plots – Scatter Plots		

LIST OF EXPERIMENTS / EXERCISES:

1.	Programs using conditional and looping statements
2.	Implementation of list and tuple operations
3.	Implementation of dictionary operations
4.	Perform various string operations
5.	Use regular expressions for validating inputs
6.	Demonstration of different types of functions and parameter passing
7.	Develop programs using classes and objects
8.	Perform computation on Numpy arrays
9.	Draw different types of plots using Matplotlib

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Reema Thareja., "Python Programming using problem solving approach", 3rd impression, Oxford University Press., New Delhi, 2017.

REFERENCES/ MANUAL / SOFTWARE:

1.	Nageswara Rao, "Core Python Programming", 2nd Edition, DreamTech Press, New Delhi, 2018.
2.	Jake Vander Plas ," Python Data Science Handbook Essential Tools for Working with Data", O'Reilly publishers,1st Edition,2016.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	use basic python constructs to build simple programs	Applying (K3)
CO2	apply list, tuple and dictionary to handle variety of data.	Applying (K3)
CO3	apply strings and regular expression for searching and retrieval	Applying (K3)
CO4	solve the problems using functions and modules.	Applying (K3)
CO5	apply object oriented concepts and perform data science operations using python	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	15	75				100
CAT2	10	15	75				100
CAT3	10	15	75				100
ESE	10	15	75				100

* ±3% may be varied (CAT 1, 2,3 – 50 marks & ESE – 100 marks)

22CHT31 - CHEMICAL PROCESS CALCULATIONS

Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**3**	**PC**	**3**	**1**	**0**	**4**

Preamble	This course provides basic knowledge of materials and energy balance calculation in chemical industries.

Unit - I	**Basics of Process Calculation:**	**9+3**

Compositions of mixtures and solutions – mass fraction, mole fraction, molality, molarity, normality; Calculations of pressure, volume and temperature using ideal gas law. Application of Dalton's law and Amagat's law for gas mixture calculation.

Unit - II	**Material Balance for Unit Operation**	**9+3**

Material balance calculations- distillation, evaporation, crystallization, drying, extraction and mixing; Humidification and Dehumidification **-** Calculation of absolute, molal, relative, percentage and saturation humidity; use of Psychrometric chart.

Unit - III	**Material Balance for Unit Process**	**9+3**

Stoichiometric principles - limiting and excess reactants, conversion, yield and selectivity; Material balance with reactions, theoretical and excess air for combustion of solid, liquid and gaseous fuels; Composition of flue gas and analysis.

Unit – IV	**Recycle and Bypass Operations**	**9+3**

Material balance for unit operations with bypass, recycle and purging. Material balance for unit processes with bypass, recycle and purging.

Unit – V	**Energy Balance**	**9+3**

Heat requirement calculations for solids, liquids, and gases using molal and mean molal heat capacity; Enthalpy change - reaction, formation, combustion, solution, mixing; Effect of temperature on heat of reaction; Adiabatic flame temperature.

Lecture: 45, Tutorial: 15,Total:60

TEXT BOOK:

1.	Narayanan K.V., Lakshmikutty B., "Stoichiometry and Process Calculations", 2nd Edition, Prentice Hall of India, New Delhi, 2016.

REFERENCES:

1.	Himmelblau D.M. , "Basic Principles and Calculations in Chemical Engineering", 8th Edition, Prentice Hall of India, New Delhi, 2013.
2.	Venkataramani V., Anantharaman N. and Meera Sheriffa Begum K.M. , "Process Calculations", 2nd Edition, Prentice Hall of India, New Delhi, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the basic laws for calculating the compositions of mixtures and solutions	Applying (K3)
CO2	solve material balance equations for diverse unit operation	Applying (K3)
CO3	apply stoichiometric principles to various unit processes	Analyzing (K4)
CO4	solve material balance equations for bypass, purge and recycle operations	Applying (K3)
CO5	solve energy balance equations to determine the enthalpy change and adiabatic flame temperature of the given processes	Analyzing (K4)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		1								2	3	2
CO2	3	3	1	2								2	3	2
CO3	3	3	1	2								2	3	2
CO4	3	3	1	2								2	3	2
CO5	3	3	1	2								2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	30	70				100
CAT2	-	20	40	40			100
CAT3	-	20	40	40			100
ESE	-	20	56	24			100

* ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)

22CHT32 - APPLIED ORGANIC CHEMISTRY

Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**3**	**PC**	**3**	**0**	**0**	**3**

Preamble	To gain knowledge about basic organic compounds and understand the reaction mechanism of various organic reactions	
Unit - I	**Basic Principles**	**9**
Classification of organic compounds - Aliphatic, Aromatic compounds - saturated and unsaturated compounds - Functional groups – aldehyde, ketone, amine, amide, acids, Shapes and Structural representation of organic compounds, Isomerism, Steric-hindrance, Inductive effect and Resonance structures. Separation and Purification of organic compounds.		
Unit - II	**Organic Reactions**	**9**
Mechanism of Electrophilic reaction and applications – Friedel craft reaction, RiemerTiemann Reaction, Beckmann rearrangements; Mechanism of Nucleophilic reactions and applications -Aldol condensation, Perkins reaction, Benzion condensation; Mechanism of Free radical reactions and applications - Halogenations of Alkanes, Addition of HBr on Alkenes in presence of peroxide, Thermal halogenations reaction.		
Unit - III	**Carbohydrates and Protein**	**9**
Classification of carbohydrates, Mono saccharides – Glucose and Fructose, Disaccharides – Sucrose and maltose -Polysaccharides – Starch and Cellulose – Structural aspects. Industrial uses of starch and cellulose. Amino Acids and Proteins – classification and properties.		
Unit - IV	**Oils, Fats, Soaps and Detergents**	**9**
Oil and Fat – Occurrence and Extraction, Physical and chemical characteristics, Analysis of oil/fat and Uses, hydrogenation of oil. Soap and Detergent – raw material, manufacture of soap and detergent, biodegradability, mechanism of cleaning action ofsoap. Classification of detergents.		
Unit - V	**Synthesis of Dyes and Drugs**	**9**
Classification, Synthesis and applications of Dyes – Congo red. Triphenylmethane dyes, Malachite green, Para Rosaniline, Alizarin, Eosin. Synthesis and applications of drugs – Sulphanilamide, Sulphapyridine, Chloroquine, penicillin, erythromycin.		
		Total:45

TEXT BOOK:

1. Tiwari K.S, Vishnoi N.K, “A text book of organic chemistry”, 4th Edition, Vikas Publication, India, 2014.

REFERENCES:

1. Graham Solomons T.W., Craig B. Fryhle, Scott A. Snyder, "Organic Chemistry", 11th Edition, John Wiley & Sons Inc, New York, 2013.
2. Jonathan Clayden, Nick Greeves, Stuart Warren, "Organic Chemistry", 2nd Edition, Oxford University Press Inc, United State of America, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer about the organic compounds and separate the compounds using simple techniques	Understanding (K2)
CO2	interpret the mechanism of the organic reactions	Understanding (K2)
CO3	classify the carbohydrates, amino acids with characteristics	Understanding (K2)
CO4	summarize the extraction and analysis of oils and synthesis of soaps and detergents	Understanding (K2)
CO5	outline the synthesis of dyes and drugs	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1			1	1					2	2	1
CO2	3	3	1			1	1					2	3	2
CO3	3	3	2			1	1					2	3	2
CO4	3	2	1			1	1					2	2	2
CO5	3	3	2			1	1					2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	80	20				100
CAT2	-	80	20				100
CAT3	-	80	20				100
ESE	-	80	20				100

* ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)

22CHT33 FLUID MECHANICS							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**3**	**PC**	**2**	**1**	**0**	**3**

Preamble	This course provides knowledge about the fundamentals of momentum transfer, metering and transportation of fluids	
Unit - I	**Fluid Statics and Fluid Flow Phenomena**	**6+3**
Nature of fluids: Liquids and Gases - Properties of fluids – Fluid Statics: Hydrostatic Equilibrium – Application of Fluid Statics: Manometers- Continuous gravity decanter- Centrifugal decanter- Fluid Flow Phenomena: Types of fluid flow- Boundary layers.		
Unit - II	**Flow of Incompressible fluids in Pipes**	**6+3**
Basic equation of fluid flow: Mass balance equation- Mechanical energy equation – Shear stress and Skin friction - Laminar flow- Turbulent flow – Friction factor chart – Friction from changes in velocity: Sudden Expansion and Contractions - Fitting losses.		
Unit - III	**Flow of compressible fluids in Pipes**	**6+3**
Definitions and Basic equations: Continuity equation- Mechanical energy equation- Ideal gas equation- Compressible flow processes- Isentropic flow through nozzles- Adiabatic friction flow- Isothermal friction flow.		
Unit - IV	**Flow Past Immersed Bodies**	**6+3**
Drag and Drag coefficients – Flow through packed bed: Determination of pressure drop using Ergun equation - Motion of particles through fluids- Fluidization: Types of fluidization - Conditions for fluidization- Minimum fluidization velocity - Expansion of fluidized beds- Applications of fluidization.		
Unit - V	**Transportation and Metering of Fluids**	**6+3**
Pipe- Fittings and Valves- Pumps: Positive displacement and centrifugal pumps- Performance characteristics- Fans, Blowers and Compressors- Measurement of flowing fluids: Venturimeter- Orificemeter- Rotameter- Vortex meters- Turbine meters- Coriolis meters- Magnetic meters- Pitot tube- notches and weirs.		
		Lecture:30, Tutorial:15, Total:45

TEXT BOOK:

1.	McCabe W.L, Smith J.C. and Harriot P, "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill Education, United States of America, 2017.

REFERENCES:

1.	Noel de Nevers, “Fluid Mechanics for Chemical Engineers”, 3rd Edition, McGraw-Hill Chemical Engineering Series, 2004.
2.	Frank M White, "Fluid Mechanics", 8th Edition, McGraw Hill International Edition, United State of America, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	make use of basic equations to calculate pressure and pressure drop based on properties of fluids	Understanding (K2)
CO2	apply the principles of flow behavior for incompressible fluids	Applying (K3)
CO3	apply the principles of flow behavior for compressible fluids	Applying (K3)
CO4	identify the hydrodynamic behavior of packed and fluidized bed	Applying (K3)
CO5	classify pumps, fans, blowers, compressors and flow meters used in process industries	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	1								1	3	2
CO2	3	3	2	1								1	3	2
CO3	3	3	3	2								1	3	2
CO4	3	3	3	2								1	3	2
CO5	3	3	3	2								1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	70	30	-	-	-	100
CAT2	-	60	40	-	-	-	100
CAT3	-	60	40	-	-	-	100
ESE	-	60	40	-	-	-	100

* ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)

22MNT31 - ENVIRONMENTAL SCIENCE							
(Common to All BE/BTech branches)							
Programme & Branch	**All B.E/B.Tech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3/6**	**MC**	**2**	**0**	**0**	**0**

Preamble	This course provides an approach to understand the various natural resources, ecosystem, bio-diversity, pollution control & monitoring methods for sustainable life and also to provide knowledge and to create awareness for engineering students on biological sciences.	
Unit – I	**Environmental Studies and Natural Resources**	**5**
Introduction to Environmental Science – uses, over-exploitation and conservation of forest, water, mineral, food, energy and land resources–case studies		
Unit – II	**Ecosystem and Biodiversity**	**5**
Ecosystems: concept and components of an ecosystem -structural and functional features – Functional attributes (Food chain and Food web only). Biodiversity: Introduction – Classification – Bio geographical classification of India- Values of biodiversity – Threats and Conservation of biodiversity - case studies.		
Unit – III	**Environmental Pollution**	**5**
Environmental Pollution: Definition – causes, effects and control measures of: (a) Air pollution - Climate change, global warming, acid rain, ozone layer depletion (b)Water pollution (c) Soil pollution - Role of an individual in prevention of pollution - case studies.		
Unit – IV	**Environmental Monitoring**	**5**
Sustainability -three pillars of sustainability- factors affecting environmental sustainability-approaches for sustainable development - Introduction to EIA - objectives of EIA - environment protection act – air (prevention and control of pollution) act – water (prevention and control of pollution) act.		
Unit – V	**Introduction to Biological Science**	**5**
Functions of Carbohydrates, lipids, proteins and nucleic acids - Cells and its organelles - plasma membrane, mitochondria and nucleus- Heredity and DNA - organization of DNA in cells - Genes and chromosomes- Cell division -Types of cell division- mitosis & meiosis - Cell cycle and molecules that control cell cycle.		
		Total:25

TEXT BOOK:

1.	Anubha Kaushik, and Kaushik C.P., “Environmental Science and Engineering”, 6th Multicolour Edition, New Age International Pvt. Ltd., New Delhi, 2018, for Unit-I, II, III, IV.
2.	Rastogi.SC, “Cells and Molecular Biology”, 2nd Edition, reprint, New Age International (P) Limited Publishers, New Delhi, 2008, for Unit-V.

REFERENCES:

1.	Palanisamy P.N., Manikandan P., Geetha A., Manjula Rani K., Kowshalya V.N., “Environmental Science”, Pearson Education, New Delhi, Revised Edition 2019.
2.	Mukhtar Ahmad, “Text book of modern biochemistry", Volume I & II, Oxford & IBH Publishing Co. Pvt. LTD, Delhi, 1995.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	illustrate the various natural resources and role of individual for its conservation	Understanding (K2)
CO2	elaborate the features of ecosystem and biodiversity to find the need for conservation.	Understanding (K2)
CO3	manipulate the sources, effects and control methods of various environmental pollution.	Applying (K3)
CO4	make use of the knowledge of EIA and environmental legislation laws towards sustainability.	Applying (K3)
CO5	explain the functions of carbohydrates, lipids, proteins, nucleic acids, Cells and its organelles	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1					3							
CO2	2	1					3							
CO3	3	2	1				3							
CO4	3	2	1				3							
CO5	3	1												

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	NA						
ESE	NA						

* ±3% may be varied (CAT 1, 2 – 50 marks)

22CHL31 -APPLIED ORGANIC CHEMISTRY LABORATORY							
Programme & Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**3**	**ES**	**0**	**0**	**2**	**1**

Preamble	This course enables the students to understand the analysis and preparation of organic compounds.

LIST OF EXPERIMENTS / EXERCISES:

1.	Analysis of organic compounds – Carbohydrates.
2.	Analysis of organic compounds-Esters
3.	Analysis of organic compounds-Thiourea
4.	Analysis of organic compounds-Nitro compounds
5.	Analysis organic compounds-Amides, Acids.
6.	Preparation of m-dinitro benzene from nitro benzene
7.	Preparation of benzoic acid from ethyl benzoate
8.	Preparation of benzoic acid from benzaldehyde
9.	Estimation of phenol/aniline using Winkler's method
10.	Qualitative separation of acid from hydrocarbon mixtures
11.	Estimation of acid value, saponification value and iodine value of the given oil
12.	Determination of the alkali content and fatty acid content in the given soaps

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	analyze the given organic compound for aliphatic or aromatic, saturated or unsaturated, elements and functional groups.	Applying (K3), Manipulation (S2)
CO2	synthesize the required organic compounds and estimate the phenol or aniline content by Winkler's method	Applying (K3), Manipulation (S2)
CO3	analyze the given oil and soap samples, and estimate the separation efficiency of binary mixtures	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1				2	1	1	3	2		1	3	1
CO2	3	2				2	1	1	3	2		1	3	2
CO3	3	1				2	1	1	3	2		1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22CHL32 - FLUID MECHANICS LABORATORY								
Programme & Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**3**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course provides an experiential understandingof flow meters, pumps, valves and fittings to the students.

LIST OF EXPERIMENTS / EXERCISES:

1.	Estimate the discharge coefficient of variable head flow meters
2.	Investigate the flow characteristics of a rotameter
3.	Estimate the discharge coefficient of V- notch
4.	Measure the point velocity of air using a pitot tube
5.	Determine the loss coefficient of valves and pipe fittings
6.	Verify the Moody diagram for flow through straight pipe and helical coils
7.	Study the effect of Reynolds number on friction factor for flow through concentric pipes
8.	Verify Bernoulli's Theorem by Bernoulli's apparatus
9.	Determine the pressure drop for flow through packed bed
10.	Determine the minimum fluidization velocity
11.	Study the characteristics of centrifugal and reciprocating pumps
12.	Study the characteristics of vacuum and gear pumps

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	determine the coefficient of discharge for flow through open and closed channels, and verify Moody chart for closed conduits	Applying (K3), Manipulation (S2)
CO2	estimate pressure drop and minimum fluidization velocity through packed bed and fluidized bed	Applying (K3), Manipulation (S2)
CO3	perform characteristic studies of centrifugal and reciprocating pumps	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1			1	1	1	3	2		2	3	2
CO2	3	2	1			1	1	1	3	2		2	3	2
CO3	3	2	1			1	1	1	3	2		2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22EGL31 - COMMUNICATION SKILLS DEVELOPMENT LABORATORY							
(Common to All Engineering and Technology Branches)							
Programme & Branch	**All B.E./B.Tech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3**	**HS**	**0**	**0**	**2**	**1**

Preamble	This course is designed to impart necessary skills to listen, speak, read and write in order to obtain better professional communication skills.

LIST OF EXPERIMENTS / EXERCISES:	
1.	Self Introduction & Mock Interview
2.	Job Application letter with Resume
3.	Presentation: A Technical topic / Project report &a Case study
4.	Situational Dialogues / Telephonic Conversations
5.	Group Discussion
6.	Reading Aloud
7.	Listening Comprehension
8.	Writing Company Profiles
9.	Preparing reviews of a book/product/movie
10.	Pronunciation Test
	Total:30

REFERENCES/ MANUAL /SOFTWARE:	
1.	Laboratory Manual
2.	Orell Digital Language Lab Software

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	enhance effective listening and reading skills	Understanding (K2), Imitation (S1)
CO2	acquire professional skills required for workplace/higher education	Applying (K3), Naturalization (S5)
CO3	use English language skills effectively in various situations	Applying (K3), Articulation (S4)

Mapping of Cos with POs and PSOs

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1									2	3		3
CO2									2	2		2
CO3									2	2		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

22CHT44 – MATERIALS OF CONSTRUCTION FOR PROCESS INDUSTRIES							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**4**	**ES**	**3**	**0**	**0**	**3**

Preamble	This course gives an overview about different materials used in Industries and their selection criteria	
Unit – I	**Fundamentals of Material Science:**	**9**
Crystallography – Unit Cells, Metallic Crystal Structure, Point, Direction and Plane, Mono crystlline and Polycrystalline materials, Non crystalline solids. Defects in solids – Point defects, Presence of Impurities, interfacial defects, volumetric defects, atomic vibrations. Concept of Grain and grain boundary, Diffusion in solids, Dislocation and its characteristics, Slip systems, Slip in crystals		
Unit – II	**Mechanical Properties of Metals:**	**9**
Concepts of Stress and Strain, Elastic Deformation - Stress-Strain Behavior, Elastic Property of materials, Plastic Deformation – Tensile Properties, True Stress and Strain, Elastic Recovery after plastic deformation, Compressive stress, Shear and Torsional Deformation, Hardness, design and safety factors, Failure of materials – Ductile and brittle fractures, Fatigue – Cyclic stresses, Crack initiation and propagation, Creep – General creep behavior, stress and temperature effects		
Unit – III	**Phase Diagrams:**	**9**
Introduction, Solubility limits, Phases, Microstructure, Phase Equilibria, Unary Phase diagrams, Binary Phase diagrams – Binary Isomorphous systems, Interpretation, Mechanical properties of isomorphous systems, eutectic alloys, Iron – Carbon systems - Iron –Iron Carbide Phase diagram, development of microstructures, influence of alloying materials, Ferrous and Non-ferrous alloys		
Unit – IV	**Stress conditions:**	**9**
High temperature effects – Mechanical failures due to high temperature - creep, stress rupture, Metallurgical effects - sensitization, Spherodization, Graphitization, Chemical effects - Carburization, Fuel Ash Corrosion. Alloys for high temperature operations. Corrosion – Major Corrodents, Stress Corrosion cracking, Wet Sour Services, Corrosion Allowance - Design life, Specific cases – Vessel, Heat exchanger, Pipes		
Unit – V	**Material Selection:**	**9**
Template for material selection, Criteria – Contamination, Reliability, Material selection procedure for Pipes, pumps. Fabricated equipment, Specific material selection procedure and diagram – Low temperature, high temperature, and corrosion conditions, Grouping of process regions, Upset conditions. Case studies – Hydrocarbon process, Petrochemical industries and Chemical processes		
		Total : 45

TEXT BOOK:

1.	Balasubramaniam R. “Callister’s Materials Science and Engineering”. 2nd Edition, Wiley India Pvt. Ltd., 2017 for Unit I, II & III
2.	David A Hansen, Robert B Puyear, “Material Selection for Hydrocarbon and Chemical Plants”, 1st Edition, Taylor and Francis Group, 1996 Unit IV & V

REFERENCES:

1.	James A. Lee, ― Materials of Construction for Chemical Process Industries‖, Mc Graw Hill, 1950
2.	Frank Rumford, ―Chemical Engineering Materials‖, Nabu Press, 2013.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Describe the fundamental concepts of crystalline and non-crystalline materials	Understanding (K2)
CO2	Explain the properties of materials and their failure mechanics	Understanding (K2)
CO3	Discuss the mechanical properties of various metal alloys using Phase Diagrams	Understanding (K2)
CO4	Explain the failures of materials under various loading conditions	Understanding (K2)
CO5	Discuss the criteria for material selection using case studies	Understanding (K2)

Mapping of Cos with POs and PSOs

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2									1	2	2	3
CO2	3	2									1	2	2	3
CO3	3	2									1	2	2	3
CO4	3	2									1	2	2	3
CO5	3	2									1	2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	80					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHC41 - CHEMICAL ENGINEERING THERMODYNAMICS

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PC	3	0	2	4

Preamble	This course introduces the laws and concepts of thermodynamics to analyze and evaluate the performance of various systems and processes in the field of chemical engineering	
Unit – I	**Laws of Thermodynamics**	**9**
Basic concepts: categorization of systems, properties and processes - internal energy – enthalpy. Zeroth law. First law: applications to non-flow and flow processes. Second law: heat engines - Carnot cycle and theorem- Entropy calculations. Third law of thermodynamics.		
Unit – II	**Properties of Real Gases and Thermodynamics Formulations**	**9**
PVT behaviour of fluids: compressibility factor - two-and three-parameter theorems of corresponding states. Equation of states: Virial, Van der Waals, Redlich & Kwong equations. Basic energy relations. Maxwell relations.		
Unit – III	**Properties of Solutions**	**9**
Partial molar properties. Chemical potential. Fugacity and activity coefficients. Gibbs-Duhem equation. Enthalpy, entropy and Gibbs free energy changes in mixing of ideal solution.		
Unit – IV	**Phase Equilibria**	**9**
Phase equilibrium and stability. Criteria for equilibrium between phases in single and multi- component non-reacting systems. Vapour-liquid equilibrium of binary ideal and non-ideal solutions. Azeotropes. Raoult's law and Henry's law. P-x-y and T-x-y diagrams using Antoine equations.		
Unit – V	**Chemical Reaction Equilibria**	**9**
Criteria for chemical equilibrium. Standard free energy change and reaction equilibrium constant. Effect of temperature and pressure on reaction equilibrium constant. Homogeneous chemical reactions. Thermodynamic analysis and prediction of equilibrium compositions.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Determination of specific heat capacity of substances
2.	Determination of entropy change of quenching, heat exchange and mixing processes
3.	Determination of reduced pressure and reduced temperature of fluids
4.	Determination of PVT behavior of pure component
5.	Determination of partial molar properties of liquids
6.	Construction of T-x-y diagram of binary mixture
7.	Estimation of heat of solution
8.	Determination of reaction coordinate of saponification reaction

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Joseph Mauk Smith, Hendrick C. Van Ness, Michael M. Abbott, Mark Thomas Swihart, Introduction to Chemical Engineering Thermodynamics, 8th Edition, McGraw Education, New Delhi, 2017

REFERENCES/ MANUAL / SOFTWARE:

1.	Noel De Nevers, Physical and Chemical Equilibrium for Chemical Engineers, 2nd Edition, John Wiley & Sons, Inc., New Jersey, 2012.
2.	Milo D. Koretsky, Engineering and Chemical Thermodynamics, 2nd Edition, Wiley, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the laws of thermodynamics to practical systems and processes	Applying (K3), Manipulation (S2)
CO2	make use of the equations of state to determine the volumetric properties of pure fluids	Applying (K3)
CO3	apply the summability relation to estimate the molar and partial molar properties of solutions	Applying (K3), Manipulation (S2)
CO4	apply phase equilibrium concepts to systems at VLE	Applying (K3)
CO5	analyze the homogeneous chemical reactions and evaluate the equilibrium composition	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2								1	3	2
CO2	3	3	2	2								1	3	2
CO3	3	3	2	2								1	3	2
CO4	3	3	3	2								1	3	2
CO5	3	3	3	2								1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60		-	-	100
CAT2	10	30	60		-	-	100
CAT3	10	30	60		-	-	100
ESE	10	30	60		-	-	100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHT41 - MASS TRANSFER – I							
Programme& Branch	**B.Tech. & Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Chemical Process Calculations**	**4**	**PC**	**3**	**1**	**0**	**4**

Preamble	This subject focuses on the diffusion, mass transfer co-efficient, theories of mass transfer, the process aspects and principles of mass transfer equipment	
Unit – I	**Diffusive Mass Transfer**	**9+3**
Molecular diffusion in gases and liquids, measurement and calculation of diffusivities, steady state diffusion in multi component mixtures. Diffusion in solids, molecular and Knudsen diffusion in porous solids.		
Unit – II	**Interphase Mass Transfer**	**9+3**
Mass transfer in turbulent flow – mass transfer coefficients – Individual and overall mass transfer coefficients- Theories of mass transfer. Co-current and counter current operations – equilibrium and operating line concept – stages and stage efficiencies- Operating characteristics of stage wise and differential contactors.		
Unit – III	**Humidification**	**9+3**
Humidification; vapour-Gas Mixtures; adiabatic saturation process; wet bulb temperature and measurement of humidity; Humidity chart for humidification calculations; equipments for humidification operations; cooling towers –principle and design.		
Unit – IV	**Absorption**	**9+3**
Gas Absorption; Choice of solvent- absorption factor- calculation of number of theoretical stages- Kremser equation for plate tower- Packed tower absorber – HETP, HTU and NTU calculations; Equipment for gas absorption; Mechanically agitated vessels, packed column and plate columns.		
Unit – V	**Adsorption and Ion Exchange**	**9+3**
Adsorption – Types – nature of adsorbents- adsorption equilibria- adsorption hysteresis- isotherms- break through curves- Adsorption operations – calculations for single and multiple cross current and counter current operations- equipment for adsorption processes- Industrial applications. Ion Exchange – Principles- Techniques and applications- Equilibria-Rate of ion exchange.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Treybal R. E., “Mass-Transfer Operations”, 3rd Edition, McGraw Hill Education, India, 1981.

REFERENCES:

1.	Binay K Dutta, “Principles of Mass Transfer and Separation Process”, 4th Edition, PHI learning private limited, 2007.
2.	Anantharaman N., MeeraSheriffa Begum K.M., “Mass Transfer Theory and Practice”, Prentice Hall of India Pvt. Ltd, New Delhi, 2017.
3.	Geankoplis C.J., “Transport Processes and Separation Process Principles”, 4th Edition, Prentice-Hall of India, New Delhi, 2005.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	calculate diffusion coefficients for gas- liquid systems	Applying (K3)
CO2	apply mass transfer coefficient and stage concept	Applying (K3)
CO3	make use of the concepts of mass transfer for humidification operation and cooling tower applications	Applying (K3)
CO4	determine the number of stages for absorption operations	Applying (K3)
CO5	apply design parameters for adsorption operation and ion exchange	Applying (K3)

Mapping of Cos with POs and PSOs

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1								2	3	1
CO2	3	3	3	1								2	3	2
CO3	3	3	3	2								2	3	2
CO4	3	3	3	2								2	3	2
CO5	3	3	3	2								2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHT42 – PROCESS HEAT TRANSFER

Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**4**	**PC**	**2**	**1**	**0**	**3**

Preamble	This course will help the students to apply the principles of various modes of heat transfer and their application in design and operation of heat transfer equipment	
Unit – I	**Conduction**	**6+3**
Modes of heat transfer. Concept of heat conduction –Fourier's law, thermal conductivity of materials, one dimensional steady state heat conduction equation for composite flat plate, hollow cylinder and hollow sphere, heat conduction through a series of resistances; critical thickness of insulation; fundamental concepts in extended surfaces heat transfer; Transient heat conduction.		
Unit – II	**Convection**	**6+3**
Natural and forced convection –Application of dimensional analysis for convection and dimensionless numbers, Reynolds and Colburn analogy –jH factor, Relationship between Individual and overall heat transfer coefficients; Equations for forced convection under laminar and turbulent flow conditions in pipes, Equations for natural convection in vertical plates, and vertical and horizontal cylinders		
Unit – III	**Radiation**	**6+3**
Introduction to thermal radiations –Concept of Black and grey bodies; Stefan Boltzmann, Kirchhoff's, Planck's and Wien laws; Radiation between surfaces –configuration factor; radiation shield.		
Unit – IV	**Heat Transfer with Phase Change**	**6+3**
Boiling heat transfer-General aspects, boiling regimes, factors affecting boiling, boiling correlations, condensation heat transfer—film and drop wise condensation, Evaporator-Types and method of feed – capacity and steam economy, surface area calculations for single effect evaporator.		
Unit – V	**Heat Exchangers**	**6+3**
Types of heat exchangers; LMTD; use of correction factor charts; Fouling factors; Heat transfer area calculations for double pipe and shell and tube heat exchangers; effectiveness and number of transfer units Heat exchangers for low temperature applications**.**		
		Lecture: 30, Tutorial:15, Total:45

TEXT BOOK:

1.	Binay K. Dutta, "Heat Transfer: Principles and Applications", 7th Edition, PHI Learning Pvt. Ltd., 2000 (Units I,II, & III)
2.	Holman. J.P. and Souvik Battacharyya, "Heat Transfer", 10th Edition, McGraw-Hill Education, Europe, 2011 (Units IV & V)

REFERENCES:

1.	Rajput R.K, "Heat and Mass Transfer", 7th Edition, S.Chand, New Delhi, 2019
2.	Kern D.Q, "Process Heat Transfer", 2nd Edition, Tata McGraw Hill Europe, 1997
3.	Necati Ozisik.M, Helcio R. B. Orlande, "Inverse Heat Transfer", 1st Edition Taylor and Francis, New York, 2000

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply basic laws of heat transfer for steady state and transient heat conduction	Applying (K3)
CO2	make use of the different flow conditions by convective heat transfer	Applying (K3)
CO3	apply the laws of radiation heat transfer for different configurations	Applying (K3)
CO4	solve engineering problems on boiling, condensation and evaporation	Applying (K3)
CO5	analyze the performance of heat exchangers	Analyzing (K4)

apping of Cos with POs and PSOs

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1								2	3	2
CO2	3	3	2	1								2	3	2
CO3	3	3	3	2								2	3	2
CO4	3	3	3	2								2	3	3
CO5	3	3	2	2								2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	30	60				100
CAT3	10	30	40	20			100
ESE	10	30	40	20			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHT43 - MECHANICAL OPERATIONS							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**4**	**PC**	**2**	**1**	**0**	**3**

Preamble	This course enables the students to understand the properties, size reduction, separation, mixing and transportation of solids	
Unit – I	**Properties and Handling of Particulate Solids:**	**6+3**
Introduction to characterization of solid particles, particle shape, particle size, differential and cumulative analysis, Storage of Solids, Bulk storage, flow out of bins, Agglomeration techniques, Transportation of solids.		
Unit – II	**Size Reduction:**	**6+3**
Introduction to comminution, Principles of comminution, Energy and power requirements for comminution, Laws and mechanism of size reduction, Rittinger's and Kick's law; Bond's law and work index, size reduction equipment, coarse, intermediate, fine and ultra fine crushers.		
Unit – III	**Separation and Filtration of Particulate Solids:**	**6+3**
Industrial screens and screen effectiveness, Filtration theory, Classification of filtration process, Selection of filters, Industrial filtration equipment.		
Unit – IV	**Separation of solids in flowing fluid:**	**6+3**
Gravity separation, Classifier, Clarifier, Thickeners, flocculation, Batch and Continuous sedimentation; Centrifugal separation, Cyclone separation, Centrifuge; Flotation, Magnetic and Electrostatic separation.		
Unit – V	**Agitation and Mixing:**	**6+3**
Significance of agitation and mixing, Mixing of solids, Types of Mixers, Mixers for cohesive solids, Change-Can mixers, Kneaders, Dispersers, and Masticators, Mixing index, Equipment for agitation, Types of impellers, Power requirement for mixing of Newtonian liquids.		
		Lecture:30, Tutorial:15, Total:45

TEXT BOOK:

1.	Julian Smith, Warren McCabe, Peter Harriott, emeritus, "Unit Operations of Chemical Engineering", 7th Edition, McGraw-Hill Education, New York, 2017 for Units I, II, III & IV.
2.	Badger Walter L. and Banchero Julius T, "Introduction to Chemical Engineering", 1st Edition, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2008, for Unit V.

REFERENCES:

1.	Coulson, J.M., Richardson, J.F, "Chemical Engineering Volume 2", 5th Edition, Butterworth- Heinemann, United State of America, 2013.
2.	Swain A.K, Patra H. and Roy G.K, "Mechanical Operations", 1st Edition, Tata McGraw Hill Education Pvt. Ltd, New Delhi, 2017.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	identify the characteristics of solids and demonstrate the transportation and storage of solids	Applying (K3)
CO2	utilize energy laws to calculate the power consumption for comminution with classification of size reduction equipment	Applying (K3)
CO3	determine the effectiveness of the screen and pressure drop, washing time and fouling characteristics for filtration	Applying (K3)
CO4	outline the separation of solid-solid, solid-fluid systems	Understanding (K2)
CO5	calculate the characteristics and power consumption for mixing and agitation	Applying (K3)

Mapping of Cos with POs and PSOs

Cos/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1									1	3	1
CO2	3	3	1									1	3	1
CO3	3	2	1									1	3	2
CO4	3	2	1									1	3	2
CO5	3	2	1									1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	40	30				100
CAT2	30	40	30				100
CAT3	30	40	30				100
ESE	30	40	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHL41 - PROCESS HEAT TRANSFER LABORATORY

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PC	0	0	2	1

Preamble	This course enables the students to apply the laws of heat transfer and analyze the performance of heat transfer equipment.

LIST OF EXPERIMENTS / EXERCISES:

1.	Determine the thermal conductivity of the given material
2.	Estimate transient heat conduction at constant flux and constant temperature
3.	Evaluate the overall heat transfer coefficient and heat transfer rate in a packed column
4.	Calculate the heat transfer coefficient and fin efficiency in an extended surface
5.	Determine the heat transfer coefficient under natural convective heat transfer
6.	Estimate the heat transfer coefficient under forced convective heat transfer
7.	Evaluate the Stefan Boltzmann constant
8.	Determine the combined convective and radiative heat transfer coefficient
9.	Investigate the boiling mechanism in heat transfer equipment
10.	Estimate the steam economy and efficiency of a single effect evaporator
11.	Evaluate the heat transfer coefficient in horizontal and vertical condensers
12.	Calculate the heat transfer coefficient in a jacketed vessel
13.	Estimate and compare the heat transfer coefficient in a double pipe heat exchanger for co-current and counter current flow pattern
14.	Determine the overall heat transfer coefficient in a shell and tube heat exchanger for parallel flow pattern

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	determine the rate of heat transfer for steady state and unsteady state conditions	Applying (K3), Manipulation (S2)
CO2	determine the heat transfer coefficients for convective and radiative modes	Applying (K3), Manipulation (S2)
CO3	estimate the heat transfer coefficient for various heat transfer equipment	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3				1	1	1	3	2		2	3	2
CO2	3	3				1	1	1	3	2		2	3	2
CO3	3	3				1	1	1	3	2		2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22CHL42 - MECHANICAL OPERATIONS LABORATORY

Programme & Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**4**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course gives an insight into various mechanical operations carried out in industries

LIST OF EXPERIMENTS / EXERCISES:

1.	Determine the crushing law constants and the power consumption using Jaw crusher
2.	Determine the crushing law constants and the power consumption using Roll crusher
3.	Estimate the critical speed and the power consumption of ball mill
4.	Calculate the average particle size using sieve analysis and find the effectiveness of screen
5.	Estimate the particle size distribution and the average particle size using Beaker decantation
6.	Determine the specific surface area of the given powder using Air permeability
7.	Determine of the specific cake resistance and filter medium resistance using plate and frame filter press
8.	Determine of the specific cake resistance and filter medium resistance using leaf filter
9.	Analyze the performance of screw conveyor
10.	Estimate the separation efficiency of cyclone separator
11.	Conduct the batch sedimentation test to design a thickener
12.	Determine the power consumption in agitated vessel

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	estimate the power requirements and law constants for different size reduction equipment	Applying (K3), Manipulation (S2)
CO2	determine the screen effectiveness, average particle size and particle size distribution for different samples	Applying (K3), Manipulation (S2)
CO3	analyze the performance of separators, conveyor and mixing vessel	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2				1	1	1	3	2		2	3	3
CO2	3	2				1	1	1	3	2		2	3	3
CO3	3	2				1	1	1	3	2		2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

22GEL41 - PROFESSIONAL SKILLS TRAINING - I							
(Common to All BE/ BTech Engineering and Technology branches)							
Programme & Branch	**All BE/ BTech Engineering and Technology branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	EC	-	-	-	2

Preamble	Thissubjectis toenhancetheemployabilityskillsandtodevelopcareercompetency	
Unit – I	**Soft Skills – I :**	**20**
Soft skills and its importance: Pleasure and pains of transition from an academic environment to workenvironment-Need forchange-Fear, stress and competition in the professional world-Importance of positive attitude- Self motivation and continuousknowledgeup gradation-Self-confidence.Professionalgroomingandpractices:Basicsofcorporateculture-Keypillarsofbusiness Etiquette- Basics of etiquette-Introductions and greetings-Rules of the handshake, earning respect, business manners-Telephoneetiquette-Body Language.		
Unit – II	**Quantitative Aptitude and Logical Reasoning – I:**	**30**
Problem solving level I: Number System-LCM &HCF-Divisibility test-Surds and indices-Logarithms- Ratio-proportions and Variation-Partnership-Time speed and distance-Data interpretation-data representation. Logical reasoning: Family tree- Deductions-Logical connectives-Binary logic Linear arrangements- Circular and complex arrangement		
Unit – III	**Grammar, Vocabulary, Listening, Speaking, Reading and Writing:**	**30**
Grammar: Parts of speech - Tenses - Articles and Prepositions - Vocabulary: Synonyms & Antonyms - Analogies - Syllogism - Spelling test - Cloze test - Concord - Spotting Errors - Listening: Listening to TED talks, ESL & ESOL Videos - Podcasts - Speaking : Mock Interviews - Personality traits - Better pronunciation - Extempore talk - Reading: Reading with stress, pauses, slurs and fillers - Soft skills - Writing: Job application letter & resume - Video resume – Different types of writing - Jumbled sentences - Professional e-mail writing - Business letters - One page essay - Report writing - Editing & proofreading – Writing skills for IELTS		
		Total:45

TEXT BOOK:

1. R.S. Aggarwal, "Quantitative Aptitude", 7th Edition, S. Chand Publication, 2022.
2. R.S. Aggarwal, "A Modern Approach to Logical Reasoning", S. Chand Publication, 2022 edition.
3. Edgar Thorpe and Showick Thorpe, "Objective English for Competitive Examination", 6th Edition, Pearson India Education Services Pvt Ltd, 2017.

REFERENCES:

1. Stephen Bailey, "Academic Writing: A practical guide for students", Routledge, New York, 2011.
2. Meenakshi Raman and Sangeeta Sharma. "Technical Communication- Principles and Practice". 4th Edition, Oxford University Press, New Delhi, 2022.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	developthesoftskillsoflearnerstosupportthemworkefficientlyinanorganizationasanindividualandasateam	Applying (K3), Precision (S3)
CO2	solverealtimeproblemsusingnumericalabilityandlogicalreasoning	Applying (K3), Precision (S3)
CO3	apply English language skills for various academic and professional purposes	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				3	3		3		3	2		
CO2	3	2				3	3		3		3	2		
CO3		2					3	3		3	3	3	2	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30				100
CAT2		50	50				100
CAT3		50	50				100
Assessment Test		50	50				100
* ±3% may be varied (CAT 1,2,3 - 50 marks &Assessment Test – 100 marks)							

22CHT51 - MASS TRANSFER- II								
Programme & Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Chemical Process Calculations; Mass Transfer I	**5**	**PC**	**2**	**1**	**0**	**3**

Preamble	This subject focuses on the process aspects and equipment used in the operations like Distillation, Extraction and Leaching, Drying and Crystallization.	
Unit – I	**Distillation**	**6+3**
Vapour liquid 145quilibria – Raoult's law, relative volatility, vapour liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation – flash distillation, differential or simple distillation, steam distillation, multistage continuous rectification, calculation of number of ideal stages by Ponchon – Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio.		
Unit – II	**Stage Calculations**	**6+3**
Number of ideal stages by McCabe – Thiele method, effect of operating conditions on the number of ideal stages, Murphree stage and overall efficiency, calculation of actual number of stages, batch distillation with reflux, packed bed distillation, NTU and HTU calculations.		
Unit – III	**Extraction and Leaching**	**6+3**
Liquid – liquid extraction, ternary liquid- liquid equilibrium, solvent characteristics, equipment for liquid-liquid extraction, stage wise contact – cross current and counter current extraction, continuous contact extraction, packed bed extraction with reflux. Leaching – Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact (shank's system), equipment for leaching operation, multi stage continuous cross current and counter current leaching, stage calculations, stage efficiency.		
Unit – IV	**Drying**	**6+3**
Theory and mechanism of drying-drying characteristics of materials-batch and continuous drying-calculation for continuous drying-various drying equipment and their applications.		
Unit – V	**Crystallization**	**6+3**
Crystallization – principles of crystallization, types of crystals, nucleation theories, crystal growth and law, particle size distribution of crystals, yields, heat and material balances in crystallization, equipment for crystallization.		
		Lecture:30; Tutorial:15;Total:45

TEXT BOOK:

1.	Treybal R.E., "Mass Transfer Operations", 3rd Edition, McGraw Hill Book Co., New York, 2017 (Unit I to IV)
2.	Binay K Dutta, "Principles of Mass Transfer and Separation Process", 1st Edition, PHI learning private limited, 2007 (Unit V)

REFERENCES:

1.	Anantharaman N., Meera Sheriffa Begum K.M., "Mass Transfer Theory and Practice", Prentice Hall of India Pvt. Ltd, New Delhi, 2017.
2.	Geankoplis C.J., "Transport Processes and Separation Process Principles", 4th Edition, Prentice-Hall of India, New Delhi, 2005.
3.	Coulson J.M., Richardson J.F., "Chemical Engineering", 5th Edition, Vol. II, P. Butterworth Heinemann, New Delhi, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the concept of vapour-liquid equilibrium and its application in the distillation	Applying(K3)
CO2	analyze the feed and operating condition and determine the number of stages of distillation column	Analyzing(K4)
CO3	examine extraction and leaching operations by graphical methods	Analyzing(K4)
CO4	determine the drying time and explain the characteristics of industrial driers	Applying(K3)
CO5	estimate crystal yields for batch and continuous equipment	Applying(K3)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	2							2	2	3	3
CO2	3	3	3	2							2	2	3	3
CO3	3	3	3	2							2	2	3	3
CO4	3	3	3	2							2	2	3	3
CO5	3	3	3	2							2	2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	20	60	20	-	-	100
CAT2	-	30	40	30	-	-	100
CAT3	-	40	60	-	-	-	100
ESE	-	20	50	30	-	-	100

* ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)

22CHT52 - CHEMICAL REACTION ENGINEERING- I							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Applied Chemistry & Chemical Process Calculations	**5**	**PC**	**2**	**1**	**0**	**3**

Preamble	This course enables the student to learn the basic concepts of reaction kinetics and design of various ideal reactors.	
Unit - I	**Elements of Reaction Kinetics**	**6+3**
Classification of chemical reactions, rate equation, Reaction Mechanism–elementary and non-elementary reaction. Integral and differential methods for analyzing kinetic data-constant volume and variable volume batch reactor, half life period, irreversible and reversible reaction.		
Unit - II	**Ideal Reactor**	**6+3**
Temperature dependency on rate equation, Performance equations and kinetics studies for Batch, Semi-batch and steady state flow reactors.		
Unit - III	**Design for Single Reactions**	**6+3**
Size comparison of Single reactors: Batch reactor with plug flow reactor, Mixed flow reactor with plug flow reactor. Multiple reactor system: CSTR in series, equal and different size of CSTRs in series, Different types of reactors in series, Plug flow reactors in series and parallel		
Unit - IV	**Design for Multiple Reactions**	**6+3**
Parallel reactions: Product distribution and reactor size Series reactions: Irreversible reactions. Yield: Fractional yield and Selectivity. Recycle reactor, Autocatalytic reactions.		
Unit - V	**Reaction Equilibrium**	**6+3**
Equilibrium in chemically reactive systems, evaluation of reaction equilibrium constant, effect of temperature on equilibrium conversion. Optimum temperature progression, reactor sizing.		
		Lecture:30; Tutorial:15;Total:45

TEXT BOOK:

1.	Levenspiel O, "Chemical Reaction Engineering", 3rd Edition, Wiley India Pvt Ltd, New Delhi, 2009.

REFERENCES:

1.	Fogler H.S., "Elements of Chemical Reaction Engineering", 4th Edition, Prentice Hall of India, New Delhi, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the principles of reaction kinetics and formulate rate equations	Applying (K3)
CO2	analyze the performance equations of ideal reactors	Analyzing (K4)
CO3	examine kinetic data to select a suitable reactor combination for single reactions	Analyzing (K4)
CO4	determine the selectivity and yield for series, parallel and mixed reactions	Applying (K3)
CO5	calculate the equilibrium conversion and optimum size of reactor	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	1	1					2	3	1
CO2	3	3	3	3	1							2	3	3
CO3	3	3	3	3	2							2	3	3
CO4	3	3	3	3	1							2	3	3
CO5	3	3	3	2	1	1						2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	40	40	20			100
CAT2	-	20	40	40			100
CAT3	-	40	60				100
ESE	-	20	50	30			100

* ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)

22CHT53 - PROCESS INSTRUMENTATION DYNAMICS AND CONTROL							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**5**	**PC**	**2**	**1**	**0**	**3**

Preamble	This course enables the students to analyze the response of various control system strategies for process requirements	
Unit - I	**Principles of Measurement**	**6+3**
Introduction to measurement and hardware elements - Transducer function and types – Static and Dynamic characteristics of measuring devices – Types and principle of temperature transmitter – Types and principle of pressure transmitter - Types and principle of level transmitter - Types and principle of flow transmitter		
Unit - II	**Transient response of system**	**6+3**
Introduction to process control – Review of Laplace transforms principles – Transfer function for chemical system- Standard input functions – Transient response and characteristic of first and second order system – Linearization of nonlinear system		
Unit - III	**Development of Feedback control system**	**6+3**
Feedback control system concept, hardware element and development of block diagrams – Controller types and transfer function – Principles of pneumatic and electronic controller – Pneumatic control valve working mechanism and transfer function – Transportation lag		
Unit - IV	**Analysis of closed loop system**	**6+3**
Servo and regulator mechanism problems – reduction of feedback control loop – dynamic response of closed loop system – offset calculations; Stability analysis: Routh test and root locus diagrams		
Unit - V	**Frequency Response Analysis and Advanced Control System**	**6+3**
Introduction to frequency response – frequency response characteristic – Bode diagram – Bode stability criterion – Phase and gain margin – Tuning of controller setting: Ziegler-Nichols and Cohen-Coon method; Advanced control systems: principle and applications of cascade, ratio and feed forward control		
		Lecture:30; Tutorial:15;Total:45

TEXT BOOK:

1.	Alan S Morris, “Measurement and Instrumentation: Theory and Application”, 3rd Edition, Butterworth-Heinemann, New Delhi, 2001 (Unit I)
2.	Donald R. Coughanowr, Steven E. LeBlanc, “Process Systems Analysis and Control”, 3rd Edition, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2013 (Units II, III, IV and V)

REFERENCES:

1.	Stephanopoulos S.G, “Chemical Process Control: An Introduction to Theory and Practice”, 1st Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the principle and working of measuring instruments and transmitters used in process industries	Understanding (K2)
CO2	determine the response of first and second order systems	Applying (K3)
CO3	select the appropriate components and control elements for feedback control system	Applying (K3)
CO4	examine the transient response and stability of closed loop control systems	Analyzing (K4)
CO5	apply the frequency response for closed loop systems and advanced control strategies	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2									2	3	2
CO2	3	1	3									2	3	2
CO3	3	1	3									2	3	2
CO4	3	1	3									2	3	2
CO5	3	1	3									2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	40	60				100
CAT2	-	30	70				100
CAT3	-	20	60	20			100
ESE	-	20	60	20			100

* ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)

22CHC51 - CHEMICAL EQUIPMENT DESIGN AND DRAWING

Programme & Branch	**B.Tech Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Chemical Process Calculation, Heat and Mass Transfer**	**5**	**PC**	**3**	**0**	**2**	**4**

Preamble	To acquire knowledge on design of various equipment used in process industries along with using suitable codes and standards	
Unit – I	**Vessels**	**9**
Introduction to design, Codes and Standards. Design of pressure vessel – under internal pressure, external pressure and combined loading. Design of storage vessel.		
Unit – II	**Heat Transfer Equipment without phase change**	**9**
Design of shell and tube and double pipe heat exchangers – Estimation of individual, overall heat transfer coefficients and pressure drop		
Unit – III	**Heat Transfer Equipment with Phase change**	**9**
Design of condensers, vertical thermosyphon reboiler and single effect evaporator		
Unit – IV	**Mass Transfer Equipment**	**9**
Design of distillation column for binary systems – estimation of height and diameter. Design of plate and packed absorption column.		
Unit – V	**Miscellaneous Equipment**	**9**
Design of rotary and fluid bed dryer, knock out drum, cyclone separator and centrifuge.		

LIST OF EXPERIMENTS / EXERCISES:

1.	Detailed design and drawing of pressure vessel
2.	Detailed design and drawing of storage vessel
3.	Process design and drawing of shell and tube heat exchanger
4.	Process design and drawing of double pipe heat exchanger
5.	Process design and drawing of condenser
6.	Detailed design and drawing of reboiler and evaporator
7.	Process design and drawing of distillation column
8.	Process design and drawing of absorption column
9.	Detailed design and drawing of rotary and fluid bed dryers
10.	Detailed design and drawing of knock out drum, cyclone separator and centrifuge

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Towler C. Gavin and Sinnott Ray, "Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design", 6th Edition, Butterworth-Heinemann , Burlington, USA, 2019 for units I,II,III & IV
2.	Alireza Bahadori, "Natural Gas Processing- Technology and Engineering Design", Elsevier Science, 2014 for unit V

REFERENCES/ MANUAL / SOFTWARE:

1.	Perry's , "Chemical Engineers Handbook", 9th Edition, Tata McGraw Hill Publishing Company Ltd, United State of America, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze the different stresses and estimate the plate thickness required for pressure and storage vessels under different operating conditions	Analyzing (K4) & Manipulating (S2)
CO2	estimate the suitable design parameters of shell and tube and double pipe heat exchangers for the given process conditions	Analyzing (K4) & Manipulating (S2)
CO3	calculate the required design dimensions of a condenser, reboiler and single effect evaporator for the given duty	Analyzing (K4) & Manipulating (S2)
CO4	compute the height and diameter of the distillation and absorption columns for the given systems	Analyzing (K4) & Manipulating (S2)
CO5	perform the mechanical and process design of dryers and separators	Analyzing (K4) & Manipulating (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		1	2	1			3	2		2	3	3
CO2	3	2		1	2	1			3	2		2	3	3
CO3	3	2		1	2	1			3	2		2	3	3
CO4	3	2		1	2	1			3	2		2	3	3
CO5	3	2		1	2	1			3	2		2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	-	33	67			100
CAT2	-	-	33	67			100
CAT3	-	-	33	67			100
ESE	-	-	40	60			100

* ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)

22CHL51 - MASS TRANSFER LABORATORY							
Programme & Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**5**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course emphasizes the practical applications of various mass transfer operations

LIST OF EXPERIMENTS / EXERCISES:

1.	Determine the diffusivity of a fluid – fluid and fluid - solid system
2.	Estimate the mass transfer coefficient of air-water system in a Wetted wall column
3.	Estimate the mass transfer coefficient of air-water system in a cooling tower
4.	Conduct the batch drying experiment to estimate the mass transfer coefficient and psychrometric ratio
5.	Conduct the drying experiment using Vacuum dryer to calculate the drying rate
6.	Determine the activity coefficients and van Laar constants for the given system at VLE
7.	Verify Raleigh’s equation for the separation of the given binary system using simple distillation apparatus
8.	Estimate the height equivalent to a theoretical plate (HETP) and percentage recovery of the overhead and bottom products of the given system in a packed bed distillation column
9.	Determine the vaporization efficiency (Ev) and thermal efficiency (Et) of the given system using steam distillation apparatus
10.	Conduct simple Leaching experiment for the given sample
11.	Conduct the liquid - liquid extraction experiment and plot the binodal curve for the given ternary system
12.	Verify adsorption isotherms for Batch Adsorption of the given system
13.	Determine the exchange rate and saturation point by deionising water using Ion-Exchange columns
	Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	determine the mass transfer coefficient for humidification and drying operations	Applying (K3), Manipulating(S2)
CO2	determine the characteristics of VLE and LLE based mass transfer operations	Applying (K3), Manipulating (S2)
CO3	estimate the separation efficiency of various solid-liquid mass transfer operations	Applying (K3), Manipulating (S2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	2					3	3		2	3	3
CO2	3	3	2	2					3	3		2	3	3
CO3	3	3	2	2					3	3		2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

22CHL52 - PROCESS INSTRUMENTATION DYNAMICS AND CONTROL LABORATORY							
Programme & Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**5**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course enables the students to analyze the response of first order, second order, closed loop system using various controllers and control strategies

LIST OF EXPERIMENTS / EXERCISES:

1.	Estimate the time constant for a first order system
2.	Evaluate the time constant for two-tank non-interacting systems
3.	Evaluate the time constant for two-tank interacting systems
4.	Study the characteristics of pneumatic control valves
5.	Examine the response of servo problem for various controllers (P/PI/PID) in pressure control loop.
6.	Study the response of regulator problem for various controllers (P/PI/PID) in temperature control loop.
7.	Analyze the response of different controller setting for PI & PID controller in level control loop
8.	Compare ON-OFF controller and P controller for different gain values in flow control loop
9.	Estimate the optimum controller settings for temperature control of shell and tube heat exchanger.
10.	Analyze the response of ratio control system for pressure control
11.	Study the response of cascade control system for flow and level control
12.	Perform experiment using feed forward control system for level control

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped** **(Highest Level)**
CO1	estimate the time constant and transient response of various dynamic systems	Applying (K3), Manipulation (S2)
CO2	determine the response of controllers for different applications	Applying (K3), Manipulation (S2)
CO3	estimate optimum controller setting and study the advanced control system responses	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2							3	3		2	3	1
CO2	3	2							3	3		2	3	1
CO3	3	2							3	3		2	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

PST-2

22CHT61 - CHEMICAL REACTION ENGINEERING- II							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Chemical Reaction Engineering I	**6**	**PC**	**2**	**1**	**0**	**3**

Preamble	This course offers an insight into the non-ideal flow, heterogeneous catalytic and non catalytic reactions	
Unit - I	**Non Ideal Flow**	**6+3**
Residence time distribution studies; models for non-ideal flow- segregation, maximum mixedness, dispersion and tanks-in-series; conversion in non-ideal reactors		
Unit - II	**Adsorption and Catalytic Reaction**	**6+3**
Catalysis, Types, Nature of catalysis, catalyst preparation and characterization, catalyst deactivation; surface area and pore-volume distribution , Adsorption isotherm and rates of adsorption, desorption and surface reaction; analysis of rate equation and rate controlling steps		
Unit - III	**Diffusion and Reaction in Porous Catalysts**	**6+3**
Diffusion within catalyst particle, effective thermal conductivity, mass and heat transfer within catalyst pellets; effectiveness factor		
Unit - IV	**Catalytic Reactors**	**6+3**
Types and operation of Fixed bed, Fluidized bed, Slurry, Trickle bed and Airlift Reactors. Industrial application of multiphase reactors		
Unit - V	**Fluid-Solid non-Catalytic Reactions**	**6+3**
Models for explaining the kinetics; shrinking core model; controlling resistances and rate controlling steps; time for complete conversion for single and mixed sizes particle		
		Lecture:30; Tutorial:15;Total:45

TEXT BOOK:

1.	Smith, J. M., "Chemical Engineering Kinetics", 3rd Edition, Tata McGraw Hill Publishing Company Ltd, New York, 1981 (Unit I to IV)
2.	Levenspiel O, "Chemical Reaction Engineering", 3rd Edition, Wiley India Pvt Ltd, New Delhi, 2009 (Unit V)

REFERENCES:

1.	Fogler H.S, "Elements of Chemical Reaction Engineering", 5th Edition, Prentice Hall of India Pvt. Ltd, India, 2015.
2.	Martin Schmal, "Chemical Reaction Engineering: Essentials, Exercises and Examples", 1st Edition, CRC Press, United State of America, 2014.
3.	Viswanathan B, Sivashankar S and Ramasamy A V, “Catalysis- Principles and Applications”, Narosa Publications, 2002

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply the concepts of residence time distribution for the design of non ideal reactors	Applying (K3)
CO2	examine the types of catalysts, their preparation techniques, and the mechanism of adsorption	Applying (K3)
CO3	investigate the catalysis mechanism for porous catalysts for determination of the effectiveness factor	Applying (K3)
CO4	calculate heat and mass transfer coefficients for multiphase reactors used in industries	Applying (K3)
CO5	determine the conversion and time required for complete conversion in non-catalytic fluid-solid reactions	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2							2	3	1
CO2	3	3	2	2	2							2	3	1
CO3	3	3	2	2	2							2	3	1
CO4	3	3	1	2	2							2	3	1
CO5	3	3	1	2	2							2	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	30	60				100
CAT3	10	30	60				100
ESE	10	30	60				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHC61 - PROCESS MODELING AND SIMULATION

Programme & Branch	B.Tech Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**6**	**PC**	**2**	**0**	**2**	**3**

Preamble	This course introduces theoretical and practical aspects of chemical process systems modeling and numerical simulation	
Unit – I	**Fundamentals of process modeling**	**9**
Mathematical modeling, use of modeling, fundamental laws used in modeling, Model building, Constitutive equations, initial conditions and boundary conditions, black box modeling, gray box modeling, Introduction to Process simulation		
Unit – II	**Modeling of Reactors**	**9**
Batch reactor, CSTR, CSTBR (bio reactor), fed batch bio reactor, tubular reactor		
Unit – III	**Modeling of Separation Processes**	**9**
Batch distillation column, batch reactive distillation column, gas absorber column, liquid-liquid extractor		
Unit – IV	**Numerical methods and simulation**	**9**
Over-view on Newton-Raphson method for solving of a set of nonlinear algebraic equations and Runge-Kutta method for IVP ODES. Simulation of model equations developed for CSTBR, fed-batch bio reactor, absorber, tubular reactor		
Unit – V	**Process simulation**	**9**
Basics of sequential modular flow sheeting and equation oriented mode. Over view of process simulation through Aspen plus package using ammonia synthesis process flow sheet, major blocks used and basic steps involved in solving and convergence hints		

LIST OF EXPERIMENTS / EXERCISES:

1.	Analyze the physical properties and construct thermodynamic equilibrium diagram for binary mixtures and azeotropes
2.	Determine the major and minor losses in fluid flow in a pipeline and design a pump
3.	Simulate the separation of a liquid-liquid mixture in a mixer – settler
4.	Simulate the heat exchanger using Aspen Plus and HYSYS
5.	Simulate the distillation column to determine the number of trays, actual and minimum reflux ratio
6.	Perform the sensitivity analysis and influence of flow rate of single component on absorption and its optimization
7.	Simulate and study the performance of extractor for different solvent to feed ratio, number of stages
8.	Simulate the steady state plug flow reactor
9.	Simulate the steady state mixed flow reactorusing Aspen Plus and HYSYS
10.	Generate a simple process flow diagram and perform simulation study using Aspen Plus and HYSYS

Lecture:30, Practical:30, Total:60

TEXT BOOK:

1.	Amiya K. Jana, "Chemical Process Modeling and Computer Simulation", 3rd Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2017 for units I, II, III and IV .
2.	Finlayson, B.A, “Introduction to Chemical Engineering Computing”, 1st Edition, Wiley India, New Delhi , 2006 for unit V.

REFERENCES/ MANUAL / SOFTWARE:

1.	Juma Hayday, “Chemical Process Design and Simulation – Aspen Plus and Aspen Hysys Applications”, AICHE – Wiley, USA, 2019.
2.	Laboratory Manual - Aspen Plus, Aspen HYSYS

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Outline the basic concepts and types of modeling and simulation	Understanding (K2) & Manipulation (S2)
CO2	Develop mathematical models for various reactors including batch and continuous	Applying (K3) & Manipulation (S2)
CO3	Illustrate the procedure of model development for mass transfer operations	Applying (K3) & Manipulation (S2)
CO4	Apply numerical methods for simulation of mathematical models of unit operations and processes	Applying (K3)
CO5	Demonstrate simulation of chemical processes using sequential and modular approaches in Aspen and MATLAB	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3			3				3	3		3	3	2
CO2	3	3	3		3				3	3		3	3	2
CO3	3	3	3		3				3	3		3	3	2
CO4	3	3	3		3				3	3		3	3	2
CO5	3	3	3		3				3	3		3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHL61 - CHEMICAL REACTION ENGINEERING LABORATORY							
Programme & Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**6**	**PC**	**0**	**0**	**2**	**1**

Preamble	This lab course provides a practical exposure to chemical reaction engineering through RTD studies and reaction kinetics

LIST OF EXPERIMENTS / EXERCISES:

1.	Investigate the kinetics of equimolar and non-equimolar reactions in a batch reactor
2.	Determine the effect of flow rate of reactants on conversion in a plug flow reactor
3.	Determine the effect of flow rate of reactants on conversion in a mixed flow reactor
4.	Compare the reaction kinetics in plug flow and mixed flow reactors
5.	Investigate the effect of flow rate of reactants on conversion in a combined reactor
6.	Study the effect of temperature on reaction rate and conversion in a batch reactor
7.	Estimate the effect of temperature on reaction rate and conversion in a plug flow reactor/ mixed flow reactors
8.	Study the residence time distribution in plug flow and mixed flow reactors
9.	Evaluate the non-ideal reactors using dispersion and tank in series models
10.	Study the residence time distribution in fixed bed/ fluidized bed reactors
11.	Compare the catalytic and non catalytic reactions in batch reactor

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped** **(Highest Level)**
CO1	experiment the batch reactor data for kinetics study	Applying(K3)/ Manipulating(S2)
CO2	choose the best reactor combinations	Applying(K3)/ Manipulating(S2)
CO3	determine the parameters for non-ideal reactors	Applying(K3)/ Manipulating(S2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3			1				3	3		2	3	1
CO2	3	3			1				3	3		2	3	1
CO3	3	3			1				3	3		2	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22CHL62- PROCESS COMPUTATION LABORATORY							
Programme & Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**6**	**PC**	**0**	**0**	**2**	**1**

Preamble	This subject focuses on the design and computation aspects of software's like SPREADSHEET, MATLAB, and PYTHON.

LIST OF EXPERIMENTS / EXERCISES:

1.	a) Perform basic Thermodynamic calculations using iterations, v-lookup and dropdown list in spreadsheet b) Plot and fit the curve and determine rate constant and order of given chemical reaction
2.	Perform economic and inventory analysis of a chemical plant using Pivot Table in spreadsheet
3.	Solving Material and Energy Balance for Non-Reactive systems using Macros in spread sheet
4.	Development of a Process Flow Diagram using AutoCAD
5.	Development of Piping and Instrumentation Diagram using AutoCAD and MS Visio
6.	3D drawing of a pressure vessel/ tubular reactor/ flash column using AutoCAD and MS Visio
7.	Basic Commands and Operations in MATLAB: a) Matrix computations b) Solving algebraic, ODE and PDE problems c) 2D and 3D Plots using MATLAB
8.	Design of Heat Exchangers using MATLAB / C Programming
9.	Calculation of Transfer Function of I, II and higher order processes using MATLAB
10.	Design of Single / Multiple effect evaporator using PYTHON Programming
11.	Design of Plug Flow / Mixed Flow Reactor for a given reaction using PYTHON Programming

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Perform Chemical Process Calculations using Spreadsheet	Analyzing(K4), Manipulating(S2)
CO2	Develop Process Flow and Process Instrumentation Diagrams in AUTOCAD	Applying(K3), Manipulating(S2)
CO3	Design Chemical Engineering Equipment/Processes using MATLAB / C Programming / PYTHON Programming	Applying(K3), Manipulating(S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2					2	2		1	3	1
CO2	3	2	3	3					2	2		1	3	1
CO3	3	2	3	3					2	2		1	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

22CHP61 – PROJECT WORK – I

22GEP61 – COMPREHENSIVE TEST AND VIVA

22GCI61 – INDUSTRIAL TRAINING

22CHT71 - PROCESS ENGINEERING ECONOMICS AND MANAGEMENT							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**7**	**HS**	**3**	**1**	**0**	**4**

Preamble	This course enables students to learn the process design, plant layout and financial aspects of process industries	
Unit - I	**Process Design Development**	**9+3**
Design Project Procedure- Types of designs-Feasibility survey-Process development- construction and operation- Design information from the literature- flow diagrams- The preliminary design- Economics- Scale up in design- safety factors- Specifications- Materials of construction		
Unit - II	**Plant Location and Layout**	**9+3**
Selection of the Plant Site – factors- Plant layout- Preparation of the layout- Plant operation and control- Instrumentation- Maintenance- Utilities- Structural design- storage- materials handling- patent considerations		
Unit - III	**Cost accounting and Estimation**	**9+3**
Outline of accounting procedure- basic relationships in accounting- balance sheet- income statements- cost accounting methods. Cost estimation- cash flow for industrial operations- tree diagram- cumulative cash position- factors affecting investment and production costs-sources of equipment- Price Fluctuations- Company Policies- Operating Time and Rate of Production- Governmental Policies		
Unit - IV	**Taxes and Depreciation**	**9+3**
Types of taxes- Property taxes- excise taxes- income taxes- Depreciation- meaning of value- Purpose of Depreciation as a Cost- types of depreciation- service life- salvage value- present value- Methods for determining depreciation- Straight-Line Method- Declining- Balance method- Sinking-Fund Method. Break even analysis		
Unit - V	**Capital Investments**	**9+3**
Fixed-Capital Investment- Working Capital- estimation of capital investment- Types of capital cost estimates- Cost Indexes- cost factors in capital investment- estimating equipment costs by scaling – Methods for estimating capital investment- estimation of total product cost. Selection of alternatives and equipment replacement		
		Lecture:45, Practical:15, Total:60

TEXT BOOK:

1.	Peter and Timmerhaus, “Plant Design and economics for Chemical Engineers”, 5th Edition Reprint, Mc Graw Hill Book Co, New York, 2017.

REFERENCES:

1.	Harry Silla, “ Chemical Process Engineering: Design and Economics”, 1st Edition, CRC press, USA, 2003
2.	Sivasubramanian V, “Process Economics and Industrial Management”,1st Edition, New Delhi, Galcotia Publishers, 2008.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	describe the procedure for process design development in process industries.	Understanding (K2)
CO2	explain the factors affecting the choice of plant location and layout	Understanding (K2)
CO3	apply the aspects of cost accounting for industrial operations	Applying (K3)
CO4	calculate the taxes and depreciation employing diverse methods	Applying (K3)
CO5	estimate the capital cost investment during selection and replacement of equipment	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2								3	2		
CO2	1	1	2								3	2	2	
CO3	3	2	1		2						3	2	2	
CO4	3	2	1		2						3	2	1	
CO5	3	2			2						3	2	2	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	50	30				100
CAT3	10	60	30				100
ESE	10	60	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHP71 – PROJECT WORK II PHASE I

22CHP81 – PROJECT WORK II PHASE II

22CHT72 – TRANSPORT PHENOMENA							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Fluid Mechanics, Mass Transfer I, Process Heat Transfer	**7**	**PC**	**3**	**0**	**0**	**3**

Preamble	To enable students to relate the concepts of heat, mass and momentum transfer.	
Unit - I	**Fundamentals of Transport Phenomena**	**9**
Importance of Transport Phenomena; Analogous nature of transfer processes; Conservation laws; Newtonian and Non-Newtonian fluids- Rheological models; Transport properties of gases and liquids- theories, pressure and temperature effects		
Unit - II	**Shell Momentum Balances and Velocity Distribution in Laminar Flow**	**9**
Shell balance and boundary conditions; Momentum flux and velocity distribution in falling film, circular tube, annulus and two adjacent immiscible fluids; creeping flow around a Sphere. Equations of Continuity and Motion.		
Unit - III	**Shell Energy Balances and Temperature Distribution in Laminar Flow**	**9**
Heat Conduction with Electrical, Nuclear and Viscous Heat Sources; Heat Conduction - Composite Walls and Cooling Fin; Use of equations of change to solve tangential flow in an annulus with viscous Heat Generation and Transpiration cooling.		
Unit - IV	**Shell Mass Balance and Concentration Distributions in Solids and Laminar Flow**	**9**
Diffusion - Stagnant Gas Film, Heterogeneous and Homogeneous Chemical Reactions, Falling Liquid Film (Gas Absorption); Diffusion and Chemical Reaction inside a Porous Catalyst.		
Unit - V	**Analogies of Transport Process**	**9**
Development and applications of analogies between momentum, heat and mass transfer- Reynolds, Prandtl, Von Karman and Chilton-Colburn analogies.		
		Total:45

TEXT BOOK:

1.	Bird R.B., Stewart W.E. and Lightfoot E.N, "Transport Phenomena", 2nd Edition, John Wiley & Sons, USA, 2007.

REFERENCES:

1.	Brodkey Robert S. and Hershey Harry C., "Transport Phenomena - A united approach", 1st Edition, Brodkey Publications, United State of America, 2003.
2.	Welty J.R., Wicks C. E. and Wilson R. E., "Fundamentals of Momentum, Heat and Mass Transfer", 5th Edition, John Wiley & Sons Inc, United State of America, 2007.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply the analogous nature of transport processes; discern rheological models and fluid transport properties	Applying (K3)
CO2	apply the shell momentum balance approach to determine momentum flux and velocity distribution; understand equations of continuity and motion	Applying (K3)
CO3	make use of equations of change to solve heat transfer problems and shell balance approach for conduction and convection	Applying (K3)
CO4	develop solutions for homogeneous and heterogeneous chemical reactions by applying shell mass balance	Applying (K3)
CO5	interpret the analogy between the transport processes	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1								1	3	1
CO2	3	3	2	1								1	3	1
CO3	3	3	2	1								1	3	1
CO4	3	3	2	1								1	3	1
CO5	3	3	2	1								1	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	20	30	50				100
CAT3	20	40	40				100
ESE	20	20	60				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE01 - ORGANIC SYNTHESIS

Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course highlights the synthesis of industrially important organic compounds	
Unit - I	**Nitration and Amination**	**9**
Principle of Nitration, N-Nitro compounds and Nitration esters- Typical industrial equipment and processes- Nitration of Benzene, Naphthalene, and Propane; Principle of Amination, methods – reduction and its methods, Manufacture of Aniline and Nitro-Aniline by different methods.		
Unit - II	**Halogenation and Sulfonation Processes**	**9**
Halogenation reactions, Chlorination mechanism, Manufacture of Vinyl Chloride, Allyl chloride, Chloral and DDT. Sulfonation and sulfation agents, Industrial process- sulfonation of benzene, potassium anthraqunioline sulfonate and production of ethanol; Desulfonation reactions.		
Unit - III	**Ammonolysis and Oxidation**	**9**
Principles of Ammonolysis. Aminating agents and survey of amination reactions, Manufacture of Aniline, p-Pheneyldiamine and Methylamines; Principles of Oxidation, Oxidizing agents, Types of Oxidative reaction, Synthesis of Acetic acid, Formaldehyde and Styrene.		
Unit - IV	**Hydrogenation and Hydroformylation**	**9**
Production and Properties of Hydrogen, Catalytic hydrogenation and Hydrogenolysis-Hydrogenation of Cottenseed oil and Heavy oil and Synthesis of Methanol; Methanation and Fisher-Tropsch reactions- Oxo, Synol and Isosynthesis processes.		
Unit - V	**Esterification, Hydrolysis and Alkylation**	**9**
Esterification of organic and inorganic acids, applications in chemical industries- Manufacture of ethyl acetate and vinyl acetate monomer; Hydrolyzing agents, processes and equipment-manufacture of Glycerol, Furfural and Ethanol. Types and Factors affecting alkylation, Industrial alkylation process-Alkyl aryl detergent.		
		Total:45

TEXT BOOK:

1.	Groggins, P.H., "Unit Processes in organic synthesis", 5th Edition, McGraw Hill Book Co, New York, 2007.

REFERENCES:

1.	Austin, G.T, "Shreve's chemical process industries", 5th Edition, McGraw Hill International Edition, New York, 2005.
2.	Tiwari, K.S., Vishnoi, N.K., "A Textbook of Organic Chemistry", 4th Edition, Vikas Publications, India, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the nitration and amination processes in industries	Applying (K3)
CO2	choose the halogenation and sulfonation processes in industries	Applying (K3)
CO3	select the process flow diagrams for ammonolysis and oxidation processes	Applying (K3)
CO4	identify various methods for production of hydrogen and hydrocarbon	Applying (K3)
CO5	choose the unit processes involved in hydrolysis, esterification reaction and alkylation reaction	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3				2					2		2	3
CO2	3	3				2					2		2	3
CO3	3	3				2					2		2	3
CO4	3	3				2					2		2	3
CO5	3	3				2					2		2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	60	40				100
CAT2	-	60	40				100
CAT3	-	60	40				100
ESE	-	60	40				100

* ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)

22CHE02 – FERTILIZER TECHNOLOGY

Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course offers an insight into the sources and production of different fertilizers	
Unit - I	**Overview of Fertilizer**	**9**
Synthetic fertilizers, Classification of fertilizers, Role of essential Elements in plant Growth, Macro elements and Micro elements, Application of fertilizers considering Nutrient Balance and types of crop. Development of fertilizer industry; Fertilizer production and consumption in India; Nutrient contents of fertilizers; Secondary nutrients; Synthetic fertilizers, Classification of fertilizers, Feedstock and raw materials for nitrogenous, phosphatic and potassic fertilizers.		
Unit - II	**Nitrogen based Fertilizers**	**9**
Introduction to Nitric acid: Chemical, physical properties and applications, Manufacturing of Nitric Acid by Pressure ammonia oxidation process and Intermediate pressure ammonia oxidation process, Concentration of Nitric acid by $Mg(NO_3)_2$. Manufacturing of Ammonium nitrate by Prilling process, Ammonium sulphate from Ammonium carbonate and gypsum, Ammonium chloride from Ammonium sulphate and sodium chloride		
Unit - III	**Ammonia & Urea**	**9**
Introduction to Ammonia: Physical & chemical properties, applications, Synthesis gas by Catalytic partial oxidation Steam Hydrocarbon reforming, Ammonia converters: Design aspect of Single bed and multi-bed converter, Kellogg process and Haldor Topsoe process, Storage and Transportation of Ammonia. Urea: Physical, chemical properties, Manufacturing of Urea by Stamicarbon's CO_2 stripping process, Toyo-Koatsu total recycle process		
Unit - IV	**Potassium Fertilizers**	**9**
Physical, chemical properties and uses of Potassium Chloride, Potassium nitrate, Potassium sulphate, Manufacturing of potassium chloride from sylvinite, Preparation of Potassium nitrate, Potassium sulphate		
Unit - V	**Miscellaneous Fertilizer and Bio Fertilizers**	**9**
Manufacturing of NPK, Ammonium Sulphate Phosphate (ASP), Calcium Ammonium Nitrate(CAN), Biofertilizers, Types and preparation of biofertilizers, Nitrogen fixing biofertilizers, Phosphate-solubilizing biofertilizers; liquid fertilizers.		
		Total:45

TEXT BOOK:

1.	Collings G.H., “Commercial Fertilizers”, 5th Edition, Mc Graw Hill, New York, 1995.

REFERENCES:

1.	Editorial Board, The Fertilizer Association of India, “Handbook of Fertilizer Technology”, 1977.
2.	Slacks A V., “Chemistry and Technology of Fertilizers”, Interscience, New York, 1966.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	outline the essential plant growth nutrients, components, significance of fertilizers and the industrial manufacturing practices	Understanding (K2)
CO2	identify the manufacturing processes and applications of nitrogen based fertilizers	Applying (K3)
CO3	explain the physical, chemical properties, manufacturing and applications of ammonia and urea	Understanding (K2)
CO4	select the manufacturing processes and applications of potassium based fertilizers	Applying (K3)
CO5	summarize the miscellaneous types of fertilizers and production of bio fertilizers.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2											3	2
CO2	3	2											3	2
CO3	3	2											3	2
CO4	3	2											3	2
CO5	3	2											3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	70	30	-	-	-	100
CAT2	-	70	30	-	-	-	100
CAT3	-	70	30	-	-	-	100
ESE	-	70	30	-	-	-	100

* ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)

22CHE03 – POLYMER TECHNOLOGY							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course highlights the importance, properties and production of various polymers	
Unit - I	**Introduction**	**9**
Monomer-functionality and degree of polymerizations- polymers and their classification- Types of polymerization and mechanisms- addition, condensation and copolymerization- bulk, solution, emulsion and suspension polymerizations.		
Unit - II	**Structure and Classification**	**9**
Structure of polymers- linear, branched and cross linked-Characterization of polymers- molecular weight- crystallinity- glass transition and mechanical properties- Ultrasonic waves- Photo degradation- High energy radiation- Oxidative and hydrolytic.		
Unit - III	**Polymers and Applications**	**9**
Polyethylene- poly propylene- polystyrene-polymethyl methacrylate - polyvinyl chloride; polytetrafluoroethylene- polyacrylate- nylon 6- nylon 6,6 and polyesters- Phenol formaldehyde- urea formaldehyde and melamine formaldehyde- epoxy-urethanes and silicones-ion exchange polymers.		
Unit - IV	**Chemical Analysis of Polymer**	**9**
X-ray diffraction- Microscopic technique-Light scattering- SEM- Spectroscopic methods- IR,NMR- Thermal analysis-DSC, DTA and TGA.		
Unit - V	**Introduction to Plastics**	**9**
Anti-oxidants and stabilizers- polymer additives- fillers- plasticizers-colorants- Molding methods-Injection-compression- transfer and blow molding- Processing techniques- Calendaring- casting- extrusion-thermoforming- foaming.		
		Total:45

TEXT BOOK:

1.	Rodriguez. F., Cohen, C., Ober, C, Archer, L.A., "Principles of Polymer Systems", 5th Edition, Taylor and Francis, Great Britain, London, 2014 for units I, II, III & IV.
2.	Manas Chanda, Salil K. Roy, “Plastics Technology Handbook”, 5th Edition, CRC Press, United States of America, 2017 for unit V.

REFERENCES:

1.	Bahadur P., Sastry N.V., "Principles of Polymer Science", 2nd Edition, Narosa, India, 2002.
2.	Stevens M.P., "Polymer Chemistry: An Introduction", 3rd Edition, Oxford University Press, New York, 1999.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the principles, types and mechanism of polymerization processes	Understanding (K2)
CO2	identify the structure and properties of polymers	Applying (K3)
CO3	infer the properties and manufacturing processes of polymers	Understanding (K2)
CO4	choose the characterization techniques for polymers	Applying (K3)
CO5	outline the principles and methods of molding plastics	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3				2	2					2	3	2
CO2	3	3				2	2					2	2	3
CO3	3	3				2	2					2	2	3
CO4	3	3				2	2					2	3	3
CO5	3	3				2	2					2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	70	30	-	-	-	100
CAT2	-	70	30	-	-	-	100
CAT3	-	70	30	-	-	-	100
ESE	-	70	30	-	-	-	100

* ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)

22CHE04 – AIR POLLUTION CONTROL

Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course delivers the framework of different air pollutants and the controlling equipment

Unit - I | Introduction to Air Pollution | 9

Air pollutants – History, air quality standards, monitoring and measurement, sampling and analysis- classifications of pollutants – sources and effects. Regulatory system: Framework in India- clean air act – provisions for recent development

Unit - II | Gaseous pollutants and Particulates | 9

Chemical and physical properties of gaseous pollutants- Stack Plumes- models, general characteristics and types. Particulates: Collection mechanism- particle size distribution- collection efficiency.

Unit - III | Air Pollution Controlling Equipment | 9

Incinerators, Absorbers, Thermal oxidizers, Gravity settling chambers – classifications, operation, typical applications and suggestions for improvement.

Unit - IV | Design of Equipment | 9

Cyclone separators, Electrostatic precipitators, Bag house filters-– design, operations and maintenance, typical applications.

Unit - V | Hybrid systems and Air Pollution Survey | 9

Hybrid systems – Wet electrostatic precipitators, Dry scrubbers, Electrostatically augmented fabric filters. Air pollution surveying guidelines

Total:45

TEXT BOOK:

1. Louis Theodore, Anthony J. Buonicore, "Air Pollution Control Equipment Calculations",1st Edition, Wiley, USA, 2008 for units I,II,III & IV.
2. Rao M.N. and Rao H.V.N, "Air Pollution", 1st Edition, McGraw Hill International edition, India, 2001 for units IV & V.

REFERENCES:

1. Cooper C.D. and Alley F.C, "Air Pollution Control-A Design Approach", 4th Edition, Waveland Pr Inc, United State of America, 2010.
2. C. S. Rao, “Environmental Pollution Control Engineering”, Revised second Edition, New Age International, 2007

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the evolution procedure in analysing the air pollutants based on air quality standards	Understanding (K2)
CO2	identifythe characteristics of gaseous pollutants and particulates	Applying (K3)
CO3	outline the operations and applications of air pollution control equipment	Understanding (K2)
CO4	apply design principles to develop and size cyclone separators, electrostatic precipitators, and bag house filtersfor air pollution control	Applying (K3)
CO5	explain the concepts involved in hybrid systems and air pollution survey	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2			3	3				1		3	2
CO2	3	2	2			3	3				1		3	2
CO3	3	2	2	1	2	3	3				1		3	2
CO4	3	2	2	1	2	3	3				1		3	2
CO5	3	2	2	1	2	3	3				1		3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	70	30	-	-	-	100
CAT2	-	60	40	-	-	-	100
CAT3	-	70	30	-	-	-	100
ESE	-	70	30	-	-	-	100

* ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)

22CHE05 – ORES AND MINERALS PROCESSING

Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Mechanical Operations**	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	The student will gain knowledge on the principles of ores and mineral processing.

Unit - I **Mineralogy:** **9**

Studies of important metallic and non-metallic minerals, their characteristics, origin etc. application of non-metallic minerals. Sea as a source of minerals. Status of mineral beneficiation industry in India. Study of some representative beneficiation practices with flow sheets. Sampling methodology and equipment

Unit - II **Comminution and Screening:** **9**

Classification of size reduction equipment. Cylindrical and cylindro conical ball mills, Rod mills, Tube / Pot mills, and their performances, capacities, reduction ratios etc. Dry and Wet Grinding. Open and closed circuit grinding. Work Index calculations. Interlocking and liberation of minerals. Particle size distribution, Sorting, Sizing and Pneumatic classifiers and their performances. Thickeners, Hydro cyclones.

Unit - III **Gravity Concentration Techniques:** **9**

Theory and practice of sedimentation and filtration. Working of Rotary vacuum filters. Principles of Jigging, Tabling and Heavy Media Separation. Processes with equipment used, important controlling factors in operation and application. Beneficiation practice for arsenopyrite containing scheelite.

Unit – IV **Froth Flotation:** **9**

Natural and Artificial Floatability of minerals. Frothers, Collectors, Depressants, Activators / Deactivators, pH Modifiers, etc. Flotation machines. Study of representative sulfide and non-sulfide minerals and non-metallic ores. Multistage flotation and Column Flotation

Unit – V **Electrostatic and Magnetic Separation:** **9**

Principles of Electrostatic and Magnetic Separation (Dry and Wet type). Separation units used in practices and examples in the industries. Calculation of Recovery and ratio of concentration and Mass balance calculations in ore dressing. Industrial set up of Ore Dressing plant

Total:45

TEXT BOOK:

1. Barry A Wills and Tim Napier Munn., " Will's Mineral Processing Technology – An introduction to the practical aspects of ore treatment and mineral recovery", 7th Edition, Butterworth Heinemann - Elsevier Imprint, Amsterdam, 2006.

REFERENCES:

1. Rutley F., "Elements of Mineralogy", 27th Edition, CBS Publishers and Distributors, New Delhi, 2005.
2. Gaudin A.M., "Principles of Mineral Dressing", 1st Edition, Tata McGraw Hill Publishing Company Ltd, New York, 2005.
3. Pryor E.J, "Mineral Processing", 3rd Edition, Kluwer Academic Publishers, New York, 1965.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the sources, beneficiation, sampling methodologies in mineral processing	Understanding (K2)
CO2	determine power consumption for the various comminution and solid screening techniques	Applying (K3)
CO3	explain the aspects of gravity concentration techniques	Understanding (K2)
CO4	illustrate the importance of froth flotation in ore processing	Understanding (K2)
CO5	calculate recovery and ratio of concentration and mass balance calculations in ore dressing	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2										1	3	2
CO2	3	2										1	3	2
CO3	3	2										1	3	2
CO4	3	2										1	3	2
CO5	3	2										1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	70	30				100
CAT2	-	70	30				100
CAT3	-	70	30				100
ESE	-	70	30				100

* ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)

22CHE06 – BIO CHEMICAL ENGINEERING							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	To gain knowledge in Microbes, Enzymes and Bioreactors for various Industrial applications.	
Unit - I	**Microbes and Microbial Kinetics**	**9**
Classification of Microbes, Typical growth characteristics of microbial cells- Factors affecting growth, Monod model, Microbial Taxonomy. Growth of Filamentous organisms, substrate and product inhibition on cell growth		
Unit - II	**Enzyme Kinetics**	**9**
Classification of Enzymes- Mechanism of enzymatic reactions, Michaelis-Menten Kinetics. Enzyme Inhibition. Industrial Applications of Enzymes, Immobilization of Enzymes.		
Unit - III	**Sterilization and Fermentation**	**9**
Batch and Continuous Sterilization, Sterilization of Air, Effect of Sterilization on Quality of Nutrients Requirements of fermentation process, Aerobic and Anaerobic fermentation Processes, Solid state and Submerged fermentation.		
Unit - IV	**Transport in Microbial Systems**	**9**
Theories of Diffusional Mass Transfer, Mass Transfer by Convection, Measurement of mass transfer coefficient K_La, Oxygen Transfer Methodology, Factors affecting Oxygen Transfer Rate.		
Unit - V	**Bioreactors and Downstream Processes**	**9**
Classification based on feeding Mechanism-batch, continuous, fed batch reactors, Fluidized bed reactor, Immobilized cell reactor, Air-Lift reactor. Suspended solids removal, Filtration, Sedimentation, Centrifugation, Cell disruption, Extraction, Membrane Separation, Chromatography, Crystallization and Drying.		
		Total:45

TEXT BOOK:

1.	Bailey, J. E. and Ollis, D. F, "Biochemical Engineering Fundamentals", 2nd Edition, Tata McGraw-Hill, New Delhi, 2010.

REFERENCES:

1.	Rao,D.G., "Introduction to Biochemical Engineering", 2nd Edition, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2009.
2.	T Palmer and P L Bonner, "Enzymes Biochemistry, Biotechnology, Clinical Chemistry", 2nd Edition, Woodhead Publishing, Europe, 2007.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped** **(Highest Level)**
CO1	describe the microbial classification and microbial growth kinetics	Understanding (K2)
CO2	explain Michaelis Menten Kinetics and immobilization techniques	Understanding (K2)
CO3	illustrate the sterilization and fermentation process	Understanding (K2)
CO4	outline theories of mass transfer to microbial systems	Understanding (K2)
CO5	explain bioreactors classification and the downstream processing techniques	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1					2					1	2	2
CO2	3	1					2					1	2	2
CO3	3	1					2					1	2	2
CO4	3	2					2					1	2	2
CO5	3	1					2					1	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	40	60					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE07 – MACHINE LEARNING FOR PROCESS ENGINEERS							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course presents the fundamental aspects of chemical engineering and their applications through machine learning	
Unit – I	**What is machine learning (ML)?:**	**6**
Understanding how machine works, using data to make decisions, Following the ML workflow – from data to deployment, boosting model performance with the advanced techniques		
Unit – II	**Real world data:**	**6**
Getting started data collection, Preprocessing the data for modeling – dealing with missing data, Using data visualization – Mosaic plots, Box plots, Density plots, Scatter plots.		
Unit – III	**Modeling and prediction:**	**6**
Basic machine learning modeling- supervised and unsupervised learning. Classification – building a classification and making predictions, regression-predicting numerical values. Algorithm highlights- logistic regression, Support vector machine (SVM) ,k-nearest neighbors, linear regression, random forest		
Unit – IV	**Model evaluation and optimization:**	**6**
Model generalization, Evaluation of classification models, Evaluation of regression models, Model optimization through parameter tuning, Case studies of ML application		
Unit – V	**Neural Networks:**	**6**
Neural network, training single layer NN –delta rule, generalize delta rule, Training multi-layer neural network-back propagation algorithm, cost function and learning rule, comparison of cost functions. Neural network and classification Deep Learning – concept of deep learning and its relation to machine learning, Rectified linear unit (ReLU) as the activation function		
		Total : 45

TEXT BOOK:

1.	Brink H, Richards J W and Fetherolf M., Real world Machine learning, Dreamtech Press, New Delhi, 2017, for Units I, II, III & IV.
2.	Kim P, MATLAB Deep learning, Apress, New York, 2017, for Unit V.

REFERENCES:

1.	G.James, D.Witten, T.Hastie and R.Tibshirani, An Introduction to Statistical Learning, 6^{th}Ed. (corrected reprint) Springer, New York, 2015
2.	Chemie Ingenier Technik, Special Issue: AI in Chemical Engineering, V93, N 12 , Dec 2021

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain the working of machine and machine learning	Understanding (K2)
CO2	demonstrate the concepts of data collection and visualization	Applying (K3)
CO3	perform modeling and prediction based on data	Applying (K3)
CO4	describe the techniques in model evaluation and perform optimization	Applying (K3)
CO5	elaborate neural networks and concepts of deep learning	Understanding (K2)

Mapping of Cos with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30				100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	20	50	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE08 – PULP AND PAPER TECHNOLOGY							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course will able to help the students to understand the production of paper in industries	
Unit - I	**Wood Preparation and Pulping**	**9**
Basics of pulp and paper technology- Wood as raw material- Pulpwood harvesting, debarking, chipping, screening and storage- Mechanical pulping, Chemical pulping and Semi chemical pulping- Chemical recovery.		
Unit - II	**Processing and Bleaching of Pulp**	**9**
Processing of pulp- Cooking, Defibering, Deknotting ,Washing, Screening and Thickening- Bleaching- Oxygen bleaching, Chlorine-dioxide bleaching, Hydrosulfite bleaching, Peroxide bleaching, Ozone bleaching - Stock preparation.		
Unit - III	**Paper Manufacture Operations**	**9**
Secondary Fiber Processing- Paper making process- Wet end operations- Fourdrinier paper machine- Forming and Pressing- Dry end operations- Drying, Calendering, Reeling, winding and Roll finishing -Surface treatments- Sizing, Coating and Super calendering.		
Unit - IV	**Specific grades and Testing of Pulp and Paper**	**9**
Manufacturing techniques of Specific paper and Board grades – Properties and testing of pulp - Properties and testing of paper - Paper end uses- Sheet finishing, Converting and Printing - Process control- Quality assurance.		
Unit - V	**Sources and control of Pollution**	**9**
Sources of Pollutants from pulp and paper industry – Characteristics of pollutants-Solid, liquid & gaseous wastes- Water pollution control- Color removal-Air pollution control- Solids handling and Land disposal.		
		Total:45

TEXT BOOK:

1.	Smook G.A., "Handbook for Pulp & Paper Technologists", 3rd Edition, Angus Wilde Publications, Incorporation, USA, 2003.

REFERENCES:

1.	Kenneth W. Brittt, "Handbook of Pulp and Paper Technology", 2nd Edition, John Wiley & Sons Inc, United State of America, 1971.
2.	Kent J.A., "Riggel's Hand Book of Industrial Chemistry", 1st Edition, Van Nostrant Reinhold, United State of America, 1974.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	discuss the various methods for wood preparation and pulping	Understanding (K2)
CO2	explain the processing and bleaching of pulp	Understanding (K2)
CO3	deduce the finishing and surface treatment of various grades of paper	Understanding (K2)
CO4	demonstrate various methods for testing of pulp and paper	Understanding (K2)
CO5	demonstrate control measures relevant to solid , liquid and gaseous pollution from pulp and paper industry	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2				2					3	2	1
CO2	3	2	2				2					3	3	1
CO3	3	2	2				2					3	3	1
CO4	2	2	3				2	3				3	3	1
CO5	3	2	3				2	3				3	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	20	80					100
CAT3	20	80					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE09 – INDUSTRIAL WASTE WATER TREATMENT							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	To promote understanding of basic and advanced concepts in Industrial wastewater treatment technologies	
Unit – I	**Sources types and characteristics of Industrial Wastewater**	**9**
Sources and types of industrial wastewater – Characteristics: Physical, Inorganic non metallic constituents, metallic constituents, Organic constituents, Biological Characteristic, Toxicity tests		
Unit – II	**Introduction to process selection**	**9**
Physical unit operation: Screening, Coarse solid reduction, Equalization, Mixing and flocculation, Gravity separation, Grit removal, Sedimentation, Neutralization, Clarification, Flotation. Role of Chemical unit operations in wastewater treatment, Chemical unit Process: Chemical Coagulation, Chemical Precipitation- , Phosphorus removal, Heavy metal Removal, Chemical oxidation, Chemical Neutralization and stabilization		
Unit – III	**Biological Treatment**	**9**
Composition and Classification of Microorganisms, Bacterial growth, Microbial growth, Aerobic biological oxidation, biological Nitrification, denitrification, nitrogen cycle, Anaerobic fermentation and oxidation, Biological removal of heavy metals, Activated sludge process, Trickling Filters, Rotating Biological Contactors, Combined aerobic treatment processes, Anaerobic treatment process, Anaerobic sludge blanket process, Attached growth anaerobic process		
Unit – IV	**Advanced wastewater treatment**	**9**
Depth filtration, surface filtration Membrane filtration, Adsorption, Ion exchange, advanced oxidation process, Photo catalysis, Wet Air Oxidation, Evaporation. Disinfection Processes: Disinfection with chlorine, Disinfection with chlorine dioxide, Dechlorination, Disinfection with ozone, Ultraviolet radiation Disinfection. Other chemical Disinfection methods		
Unit – V	**Industrial Effluent Treatment Plants**	**9**
Individual and Common Effluent Treatment Plants – Zero liquid discharge systems –Wastewater reclamation and reuse – Disposal of effluent on land – Quantification, characteristics and disposal of Sludge. Industrial process description, ground water and wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing - Pharmaceuticals – Sugar and Distilleries – Food Processing –Fertilizers – Industrial Estates, Indian regulations.		
		Total:45

TEXT BOOK:

1.	Metcalf Eddy by George Tchobanoglous, Franklin L. Burton, "Wastewater Engineering: Treatment and Reuse", 4th Edition, McGraw Hill Book Company, USA, 2011.

REFERENCES:

1.	Eckenfelder, W.W., "Industrial Water Pollution Control", 1st Edition, McGraw Hill International edition, United State of America, 1999.
2.	Frank Woodard, "Industrial waste treatment Handbook", 1st Edition, Butterworth Heinemann, New Delhi, 2001.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	describe the sources, types and characteristics of Industrial Wastewater	Understanding (K2)
CO2	outline the principles of physical and chemical unit operations in wastewater treatment	Understanding (K2)
CO3	explain the industrial biological wastewater treatment techniques	Understanding (K2)
CO4	describe the advanced wastewater treatment techniques used in industries	Understanding (K2)
CO5	demonstrate the operations of various industrial effluent treatment plants	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2			2	3						3	2
CO2	3		1			2	3						3	2
CO3	3	1	2			2	3						3	2
CO4	3	2	2			2	3					1	3	2
CO5	3	2	2				3					1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	20	50	30				100
ESE	20	50	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE10 – MODERN SEPARATION PROCESSES							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**6**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course highlights the modern separation techniques adopted in process industries.	
Unit - I	**Fundamentals and Filtration**	**9**
Basic Concepts – Characteristics and Mechanism of Separation, Feasibility of Separation Processes. Theory and Selection of Equipment for Filtration Process		
Unit - II	**Membrane Process**	**9**
Theory of Membranes Process, Types and Choice of Membranes, Types and Relative Merits of Membrane Modules		
Unit - III	**Applications of Membrane Process**	**9**
Principle and Applications of Dialysis and Electro Dialysis; Nano Filtration and Reverse Osmosis, Pervaporation, Ultra filtration, Micro filtration.		
Unit - IV	**Other Separation Process I**	**9**
Principle and Applications of Ion Exchange, Electrophoresis, Dielectrophoresis, Lyophilisation, Chromatography-Gas Chromatography, Column, Paper, HPLC.		
Unit - V	**Other Separation Process II**	**9**
Principles and Applications of Supercritical Fluid Extraction, Zone melting, Adductive crystallization, Reversible Chemical Complexation, Foam Separation, Thermal Diffusion, Cryoseparations		
		Total:45

TEXT BOOK:

1. Seader, J.D., Ernest J., Henley, Keith Roper D., "Separation Process Principles", 3rd Edition, John Wiley & Sons, USA, 2010.

REFERENCES:

1. Coulson, J.M., Richardson, J.F, "Chemical Engineering", 4th Edition, Butterworth- Heinemann, United State of America, 1996.
2. Scott K., Hughes R, "Industrial Membrane Separation Technology", 1st Edition, Blackie Academic and Professional Publications, United State of America, 1996.
3. Ronald W Rousseau, “ Handbook of Separation Process Technology”, 1st Edition, Wiley India Pvt Ltd, 2008.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	describe the filtration process and selection of filters	Understanding (K2)
CO2	explain the membrane process and its application	Understanding (K2)
CO3	apply membrane separation processes in process industries	Applying (K3)
CO4	comprehend the principles and applications of ion exchange, phoresis and chromatography	Understanding (K2)
CO5	apply advanced separation processes in process industries	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1				1	2					2	3	2
CO2	3	2				1	2					2	3	2
CO3	3	2				1	2					2	2	2
CO4	3	2				1	2					2	3	2
CO5	3	2				1	2					2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	80					100
CAT2	10	60	30				100
CAT3	10	60	30				100
ESE	10	60	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE11 – INSTRUMENTAL METHODS OF ANALYSIS

Programme& Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	PE	3	0	0	3

Preamble	This course helps the student to understand the basic principle, instrumentation and applications of various chemical analysis techniques.	
Unit – I	**Introduction to Instrumental Methods and UV-Visible and IR Spectroscopy**	**9**
Classification of instrumental methods based on physical properties of molecules – The electromagnetic spectrum – Interaction of photons with matter – Absorbance and transmittance – Beer and Lambert's laws. Ultra violet and Visible spectrometry: Theory – Types of Transitions – Red and blue shifts – Instrumentation – Single beam and double beam spectrophotometers and applications. Infrared spectrometry: Requirements for IR absorption – Modes of vibrations – Instrumentation- Applications – Finger print region.		
Unit – II	**Flame emission Photometer, Thermal Methods and Morphology Analysis**	**9**
Flame emission photometer, Polarimetry and Refractometry – Principle, instrumentation and applications – Thermogravimetry: Principle, instrumentation and applications, factors affecting shapes of thermograms. Differential Thermal Analysis: Principle, instrumentation and applications. Differences between DSC and DTA. Application of DSC (Inorganic & Polymer samples). Morphology Analysis **–** Scanning Electron Microscopy – Transmission Electron Microscopy – Principle and Applications.		
Unit – III	**Atomic Absorption Spectrophotometer, NMR and Mass spectroscopy**	**9**
Advantages of ASS over FES – Principle, Instrumentation – Interference and applications. Nuclear Magnetic Resonance: Introduction to NMR – Energy levels of nucleus – Equivalent and non-equivalent protons – Chemical shift – Shielding – TMS – Factors affecting chemical shift and instrumentation (proton NMR) – Applications. Theory – components of mass spectrometer – General rules for Interpretation of mass spectra – Applications of mass spectra.		
Unit – IV	**Conductance, EMF measurement and Electrophoresis**	**9**
Definitions, conductance measurements, applications, Types, advantages and disadvantages of Conductometric titrations. Potential measurements, pH determination, Potentiometric Titrations. Basic principles of electrophoresis, theory and application of paper, starch gel, agarose, PAGE, SDS-PAGE electrophoresis.		
Unit – V	**Chromatographic Methods**	**9**
Introduction – Classification of chromatographic methods: Column chromatography, Thin Layer chromatography, Paper chromatography, Gas chromatography and High Performance Liquid Chromatography (HPLC) – Principle, important components and their functions mode of separation, Instrumentation and applications		
		Total:45

TEXT BOOK:

1.	Gurdeep R. Chatwal Shan K Anand, "Instrumental methods of Chemical Analysis", 5th Edition, Himalaya Publishing House, New Delhi, 2018.

REFERENCES:

1.	Willard H.H., Merritt L.L., Dean J.A., and Settle F.A., "Instrumental Methods of Analysis", 7th Edition, C B S Publishers & Distributors, Delhi, 2004.
2.	Daniel C. Harris, "Qualitative chemical analysis", 9th Edition, W. H. Freeman and Company, New York, 2015.
3.	Banwell. G. C, "Fundamentals of Molecular Spectroscopy", 5th Edition, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret UV-Visible, IR instrument for chemical analysis	Understanding (K2)
CO2	infer the principle of thermal and Morphology techniques for chemical Analysis.	Understanding (K2)
CO3	explain the principle, instrumentation and applications of ASS, NMR and Mass spectroscopy	Understanding (K2)
CO4	demonstrate the usage of conductance and potential measurements for chemical components and separation by electrophoresis.	Understanding (K2)
CO5	identify suitable chromatographic methods to separate and quantify the chemical components.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		2								2	2	3
CO2	3	3		2								2	2	3
CO3	3	3		2								2	2	3
CO4	3	3		2								2	2	3
CO5	3	3		2								2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	40	60					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE12 – SURFACE COATING TECHNOLOGY

Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	To gain knowledge on surface engineering, chemical conversion, surface coating, electro-deposition coating methods and design guidelines for surface coating	
Unit - I	**Surface Engineering**	**9**
Introduction to surface engineering, scope of surface engineering, surface engineering to combat corrosion and wear, Surface preparation– selective surface hardening, laser melting, shot peening, shot blasting, sand blasting, vapor phase degreasing and hydro-blasting.		
Unit - II	**Chemical Conversion Coating**	**9**
Phosphate and chromate chemical conversion coating – types and applications. Aluminium, chromic, sulfuric and hard coat anodizing. Oxidation treatments, Diffusion heat treatment coatings and pack-cementation diffusion coatings.		
Unit - III	**Surface coating methods**	**9**
Organic coating - paints, Ceramic coating and Linings – Glass lining, porcelain enamels, concrete and cementations coating and lining, high performance ceramic coating and lining, Hot dipping – Batch and continuous process, coating microstructure, galvanized aluminium and terne coatings.		
Unit - IV	**Electro-deposition coating methods**	**9**
Electrochemical deposition – aqueous solution electroplating, continuous electro deposition, fused-salt electroplating, precious metal plating, electroless plating, and composite coatings. Weld-overlay coatings, Thermal spray coatings, Chemical and physical vapor deposition coatings.		
Unit - V	**Design guidelines for surface coating**	**9**
Pre-processing and Post processing Heat Treatment, Coating Thickness, Case Depth, and Component Distortion Considerations, Surface Roughness and Finishing, Design guidelines for surface preparation, organic and inorganic coating and other important considerations.		
		Total:45

TEXT BOOK:

1.	J.R. Davis and Associates, “Surface Engineering for corrosion and wear resistance”, ASM internationals and IOM communications, 2001.

REFERENCES:

1.	Rudolf Strauss, “Surface Mount Technology”, Butterworth-Heinemann Publisher, 1994
2.	Brian Griffiths, “Manufacturing Surface Technology: Surface Integrity and Functional Performance (Manufacturing Processes Modular S.) (Manufacturing Processes Modular)”, 2001.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain the basics of surface engineering and surface preparation methods.	Understanding (K2)
CO2	infer the principles and applications of different chemical conversion coating methods.	Understanding (K2)
CO3	illustrate the principles and applications of different surface coating methods.	Understanding (K2)
CO4	explain the principles and applications of various surface laying methods.	Understanding (K2)
CO5	demonstrate the design guidelines and surface preparation methodologies for various surfaces.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2				2						2	2
CO2	3	2	2				2						2	2
CO3	3	2	2				2						2	2
CO4	3	2	2				2						2	2
CO5	3	2	3				2						2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	50	50					100
CAT2	50	50					100
CAT3	30	70					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE13 – ENERGY TECHNOLOGY							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	The course outlines the world energy scenario, available energy resources and production technologies	
Unit - I	**Overview of Energy Scenario**	**9**
Introduction to Global and domestic energy supply and consumption and Energy statistics, Sector wise energy consumption, Energy Crisis, Energy alternatives, Units of energy and conversion factors, Classification of Energy Sources.		
Unit - II	**Non – Renewable Sources**	**9**
Fossil Fuels: Coal - Classification and Conversion technologies, Petroleum - Products and Properties, Shale oil and gas, Natural gas - CNG and LNG. Nuclear energy sources - Fission and fusion processes, Types of nuclear reactors, Nuclear Power plants.		
Unit - III	**Renewable Energy Sources-I**	**9**
Biomass Energy - Resources and conversion processes, Fundamentals of power generation systems and applications - Hydro power plants, Wind mills and Solar energy systems.		
Unit – IV	**Renewable Energy Sources-II**	**9**
Fundamentals of Power generation systems and applications – Geothermal and ocean energy, fuel cells, Hydrogen Technologies-storage, transportation and applications.		
Unit – V	**Energy Conservation and Management**	**9**
Energy forecasting and planning, Energy conservation – Act, Waste heat recovery and heat pipes, Energy Audits, Cogeneration practices in industries, Energy Storage – Batteries and Fuel Cells, and Energy efficiency in emerging economies.		
		Total:45

TEXT BOOK:

1.	Rao S. and Dr. B.B. Parulekar, “Energy Technology”, 4th Edition, Khanna Publishers, 2005 for units I, II, III & IV.
2.	Twidell John and Weir Tony, — “Renewable Energy Sources”, 2nd Edition, Taylor and Francis, New York, 2006 for unit V.

REFERENCES:

1.	Beggs Clive, “Energy: Management Supply and Conservation”, Butterworth-Heinemann, Oxford, 2002.
2.	Fay James A. and Golomb Dan S., “Energy and the Environment”, Oxford University Press Inc., New York, 2002

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	summarize the global energy scenario and available sources for energy production	Understanding (K2)
CO2	explain the energy production and associated technologies from fossil fuels and nuclear sources	Understanding (K2)
CO3	illustrate the energy production from biomass, hydro, wind and solar systems	Understanding (K2)
CO4	explain the contributions of geothermal, ocean energy, fuel cells and hydrogen technologies in energy production	Understanding (K2)
CO5	describe the energy conservation measures and efficient energy management practices.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2	2		3	3					2	2	2
CO2	2	2	2			3	3					2	2	2
CO3	2	2	2			3	3					2	2	2
CO4	2	2	2			3	3					2	2	2
CO5	2	2	2	2		3	3					2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	70					100
CAT2	30	70					100
CAT3	30	70					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE14 – FLUID MOVERS							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course helps the student to understand the basic principle, working, construction and applications of various pumps, compressor, fan and blowers in industries.	
Unit – I	**Kinetic Pump**	**9**
Classification and selection of pumps. Centrifugal pump-Theory, analysis, performance and construction. Multistage pumping. Selection of pump materials. Industrial application		
Unit – II	**Pump Parts**	**9**
Pump drives and power transmission-pump drives and speed varying devices. Pump sealing-Centrifugal pump packing, mechanical seal and injection type shaft seals. Pump noise measurement-noise measurement techniques, estimating pump noise level and noise control techniques. Pump testing- classification of testing, test procedure and measurement		
Unit – III	**Reciprocating Pump**	**9**
Displacement pump-Theory, design and construction of Diaphragm, Screw, Jet, Rotary, Lobe, Solid handling and Gear Pump. Multistage pump. Industrial application		
Unit – IV	**Compressor**	**9**
Compressor Theory- Compressed air and air usage. Compressor-Types and selection. Effect of operating conditions .Thermodynamic compression. Real gas effects. Description and control of surge in centrifugal and axial compressor. Multistage and inter-cooling system. Performance analysis of compressor		
Unit – V	**Fan and Blower**	**9**
Theory and types of Fan and Blowers. Working Principle of blowers. Cross flow and vortex blowers –Flow pattern and performance. Velocity Triangle and Parametric Calculations: Work, Efficiency and Number of Blades and Impeller sizes. Types, Selection, Law, Performance and efficiency of Fan. Fan less air movers. Vacuum cleaners		
		Total:45

TEXT BOOK:

1.	Igor J. Karassik, Joseph P. Messina, Paul Cooper, Charles C. Heald, "Pump Handbook", 4th Edition, McGraw Hill Book Co, New Delhi, 2008 for units I, II & III.
2.	Jonathan Moore, "Hand book of Fluid Movers: Pumps, Compressors, Fans, and Blowers", 1st Edition, Delve Publishing, USA, 2015 for units IV & V.

REFERENCES:

1.	Giampaolo Tony, "Compressor Handbook -Principles and Practices", 1st Edition, Fairmount Press Incorporation, United State of America, 2010.
2.	Christie J. Geankoplis, "Transport Processes and Separation Process Principles", 4th Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 1993.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	elaborate the types, characteristics, construction and performance of centrifugal pump	Understanding (K2)
CO2	familiarize the drives, parts and power transmission of pumps; testing of pump	Understanding (K2)
CO3	illustrate the types, characteristics, construction and performance of positive displacement pumps	Understanding (K2)
CO4	explain the types, characteristics and performance of compressors	Understanding (K2)
CO5	exhibit familiarity with the types, theory, performance and application of fans and blowers	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1			1	2					1	3	2
CO2	3	2	1			1	2					1	3	2
CO3	3	2	1			1	2					1	3	2
CO4	3	2	1			1	2					1	3	2
CO5	3	2	1			1	2					1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	60					100
CAT2	30	70					100
CAT3	30	70					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE15 –PROCESS PLANT SAFETY

Programme & Branch	**B.Tech& Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	The course outlines the workplace safety and associated terms applicable to the Process Industries	
Unit - I	**Safety Principles**	**9**
Need for safety, Safety programs, Training & Education; Personal protective Equipment, Safety codes: NFPA, IS, API, and OSHA standards; Colour codes for pipe lines. Materials Safety Data sheets;		
Unit - II	**Hazards and Occupational Health**	**9**
Hazards- fire, explosion and radiation; Designs to prevent fire and explosion hazards; Relief Valves; Occupational diseases – Types, Causes and effects, Safety in storage and handling of chemicals		
Unit - III	**Safety in Operations and Processes**	**9**
Safety in operations and processes. Runaway reactions, unstable products; Safety Studies – HAZOPS, HAZAN, Fault tree, Event tree and risk analysis, Working at Height, Lock out-Tag out, Hot Work Permit, Emergency Planning and Response		
Unit - IV	**Industrial Accidents**	**9**
Industrial accidents –types, causes, effects, costs, prevention, investigation and analysis, accident proneness, case studies: The Flixborough UK - Cyclohexane Disaster, Seveso Accident, The Chernobyl Nuclear Disaster, Bhopal Gas Tragedy; Field visits		
Unit - V	**Legal Aspects of Industrial Safety**	**9**
Safety Laws - Factories act, ESI act and Workmen's compensation act; Promotion of safety - Role of Government, Management, Safety organizations, and Trade unions; Rules and requirements governing Chemical industries in India.		
		Total:45

TEXT BOOK:

1.	Daniel A. Crowl, Joseph F. Louvar, "Chemical Process Safety: Fundamentals with Applications", 3rd Edition, Prentice Hall, India, 2011.

REFERENCES:

1.	Roy E. Sanders, "Chemical Process Safety: Learning from case histories", 4th Edition, Butterworth Heinemann, United State of America, 2015.
2.	Raju K.S.N, "Chemical Process Industry Safety", 1st Edition, McGraw Hill International Edition, New Delhi, 2017.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	recall the industrial safety programs and the safety standards	Understanding (K2)
CO2	recognize the industrial hazards and apply the safety procedure to prevent fire and explosion hazards	Applying (K3)
CO3	describe safety in operation and processes through HAZOP and HAZAN studies	Applying (K3)
CO4	examine major industrial accidents, their consequences and describe the preventive methods	Applying (K3)
CO5	summarize use of the legal aspects of industrial safety	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1				3	3	2	1	2		2	1	1
CO2	2	1				3	3	2	1	2		2	1	1
CO3	2	2	1			3	3	2	1	2		2	1	1
CO4	2	2		1		3	3	2	1	2		2	1	1
CO5	1					3	3	2	1	2		2	1	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	20	40	40				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1 & 2 – 60 marks & ESE – 100 marks)

22GEE02 –TQM

22CHE16 –MOMENTUM, HEAT AND MASS TRANSPORT							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	To enable students to relate the concepts of heat, mass and momentum transfer.	
Unit - I	**Fundamentals of Transport Phenomena**	**9**
Importance of Transport Phenomena; Analogous nature of transfer processes; Conservation laws; Newtonian and Non-Newtonian fluids- Rheological models; Transport properties of gases and liquids- theories, pressure and temperature effects		
Unit - II	**Shell Momentum Balances and Velocity Distribution in Laminar Flow**	**9**
Shell balance and boundary conditions; Momentum flux and velocity distribution in falling film, circular tube, annulus and two adjacent immiscible fluids; creeping flow around a Sphere. Equations of Continuity and Motion.		
Unit - III	**Shell Energy Balances and Temperature Distribution in Laminar Flow**	**9**
Heat Conduction with Electrical, Nuclear and Viscous Heat Sources; Heat Conduction - Composite Walls and Cooling Fin; Use of equations of change to solve tangential flow in an annulus with viscous Heat Generation and Transpiration cooling.		
Unit - IV	**Shell Mass Balance and Concentration Distributions in Solids and Laminar Flow**	**9**
Diffusion - Stagnant Gas Film, Heterogeneous and Homogeneous Chemical Reactions, Falling Liquid Film (Gas Absorption); Diffusion and Chemical Reaction inside a Porous Catalyst.		
Unit - V	**Analogies of Transport Process**	**9**
Development and applications of analogies between momentum, heat and mass transfer- Reynolds, Prandtl, Von Karman and Chilton-Colburn analogies.		
		Total:45

TEXT BOOK:

1.	Bird R.B., Stewart W.E. and Lightfoot E.N, "Transport Phenomena", 2nd Edition, John Wiley & Sons, USA, 2007.

REFERENCES:

1.	Brodkey Robert S. and Hershey Harry C., "Transport Phenomena - A united approach", 1st Edition, Brodkey Publications, United State of America, 2003.
2.	Welty J.R., Wicks C. E. and Wilson R. E., "Fundamentals of Momentum, Heat and Mass Transfer", 5th Edition, John Wiley & Sons Inc, United State of America, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the analogous nature of transport processes; discern rheological models and fluid transport properties	Applying (K3)
CO2	apply the shell momentum balance approach to determine momentum flux and velocity distribution; understand equations of continuity and motion	Applying (K3)
CO3	make use of equations of change to solve heat transfer problems and shell balance approach for conduction and convection	Applying (K3)
CO4	develop solutions for homogeneous and heterogeneous chemical reactions by applying shell mass balance	Applying (K3)
CO5	interpret the analogy between the transport processes	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1								1	3	1
CO2	3	3	2	1								1	3	1
CO3	3	3	2	1								1	3	1
CO4	3	3	2	1								1	3	1
CO5	3	3	2	1								1	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	20	30	50				100
CAT3	20	40	40				100
ESE	20	20	60				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE17 – CORROSION SCIENCE AND ENGINEERING

Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	The student will gain knowledge on the principles of corrosion, its testing methods, control measures in specific environments and its impact on country's economy	
Unit - I	**Types of Corrosion and Testing**	**9**
Basic principles of corrosion and its control – Forms of corrosion, Uniform, Galvanic, Crevice, Pitting, Inter-granular, Selective leaching, Erosion, Stress corrosion; Hydrogen Blistering and Embrittlement, Cracking, Cavitation and their Fracture Mechanics. Corrosion testing– Classification, Purpose, Material and Specimen, Surface preparation, Measuring and Weighing, Exposure Techniques, Duration – Planned interval test; NACE test methods, Slow-Strain-Rate test, Linear Polarization, AC Impedance method.		
Unit - II	**Corrosion Prevention Methods**	**9**
Corrosion inhibitors, electroplated coatings, conversion coatings, anodizing, hot dipping, spray metal coatings, zinc coating by alloying, electrophoretic coatings and electro painting, powder coating, corrosion minimization by material selection– Cathodic and Anodic protections.		
Unit - III	**Corrosion in Specific Environments**	**9**
Corrosion by organic acids and alkalies; Seawater and Fresh water corrosion on concrete structures, Corrosion in automobiles, Biological corrosion, Halogen corrosion of metals, Corrosion in Petroleum industry, Corrosion in aerospace.		
Unit - IV	**Corrosion in Specific Cases and Control**	**9**
Corrosion and selection of materials of pulp and paper plants – Corrosion of wet scrubbers in pollution control – Nuclear waste isolation and corrosion by liquid metal and fused salts – corrosion of surgical implants and prosthetic devices –corrosion in electronic equipment.		
Unit – V	**Corrosion Inspection and Management**	**9**
Corrosion inspection methods–visual, liquid penetration, magnetic particle, radiographic, eddy current, ultrasonic, thermography testing; Corrosion management systems – process maintenance procedures.		
		Total:45

TEXT BOOK:

1.	Fontana M.G., "Corrosion Engineering", Tata McGraw Hill, 2005.

REFERENCES:

1.	Jones D.A., "Principal and Protection of Corrosion", Prentice-Hall, 1996.
2.	Sastri V.S., Ghali E. And Elboujdaini M., "Corrosion Prevention and Protection: Practical Solutions", John Wiley and Sons, 2007.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	classify the different types of corrosion and their testing methods	Understanding(K2)
CO2	explain corrosion protection methods for applications in chemical process industries	Understanding(K2)
CO3	illustrate the corrosion in specific environments and its control	Understanding(K2)
CO4	explain corrosion control methods in industrial applications and case studies	Understanding(K2)
CO5	outline corrosion inspection and management practices and impact of corrosion in nations economy	Understanding(K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1								2	2	1
CO2	2	2	2	1		1	3					2	2	1
CO3	2	2	2	1		1	3				1	2	2	1
CO4	2	2	2	1		1	2					2	2	1
CO5	1	2	2			2	3				1	2	2	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	80					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE18 – ADVANCED PROCESS CONTROL							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides basic knowledge about the advanced process control techniques in chemical industries	
Unit - I	**Introduction to process control**	**9**
Principles of measurement and classification of process control instruments; temperature, pressure, fluid flow, liquid level, velocity, fluid density, viscosity. Instrument scaling; sensors; transmitters and control valves		
Unit - II	**Process Automation**	**9**
Basic concepts - terminology and techniques for process control - control modes - controller design - Tuning process controllers		
Unit - III	**Advanced Control Systems**	**9**
feed forward, ratio control, Cascade control, split rage control, adaptive control system; MIMO: Degrees of freedom, Alternative loop configurations, interaction of control loops, relative gain array, selection of loops; ; statistical process control; expert system; multivariable control techniques; supervisory control.		
Unit - IV	**Digital Control**	**9**
Digital Computer, Computer- process interface for data acquisition and control, computer control loops, continuous- time to discrete –time systems, sampling continuous, reconstruction of continuous signal, conversion of continuous to discrete time model		
Unit – V	**Discrete Time Response**	**9**
z transforms - function ad Applications; discrete time response of dynamic systems, design of digital feedback controllers - Introduction to SCADA		
		Total:45

TEXT BOOK:

1. Stephanopoulos G., “Chemical Process Control”, Tata McGraw-Hill, New Delhi, 1993.

REFERENCES:

1. Chidambaram M., “Computer Control of Processes”, Alpha Science International Ltd, India, 2002.
2. Nakara B.C. and Choudary K.K., “Instrumentation and Analysis”, Tata McGraw-Hill, New Delhi, 1993.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	describe the principles of measurement techniques in process industries	Understanding(K2)
CO2	explain the concepts of process control strategies	Understanding(K2)
CO3	elaborate the advanced control techniques used in process control	Understanding(K2)
CO4	explain the digital controllers and discrete time model approaches	Understanding(K2)
CO5	illustrate the discrete time response of dynamic system	Understanding(K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1							3	3	2
CO2	3	2	2	1	1							3	3	2
CO3	3	2	2	1	1							3	3	2
CO4	3	2	2	1	1							3	3	2
CO5	3	2	2	1	1							3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	80					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE19 – NATURAL GAS ENGINEERING

Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course offers an insight into the properties, production, application and safety features of Oil and Natural Gas Industry	
Unit - I	**Natural gas fundamentals and exploration**	**9**
Natural gas origin, classification of sources – conventional and non-conventional / shale gas, composition and classification of natural gas; Properties of natural gas – chemical, physical properties, thermodynamic, Natural gas reservoirs, Natural gas exploration – conventional, non-conventional / shale gas, well deliverability		
Unit - II	**Natural gas transportation and storage**	**9**
Transportation methods – Pipelines, LNG, CNG, Gas-to-liquids, Gas-to-soild, Gas-to-wire, Underground gas storage – Depleted reservoirs, aquifers, salt caverns		
Unit - III	**Multiphase gas transmission and operation**	**9**
Multiphase flow terminologies– superficial velocity, mixture velocity, holdup, phase velocity, slip, Mixture-density, viscosity, pressure drop, enthalpy. Multiphase flow regimes- two, three phase and condensate phase. Multiphase pipeline operations – leak detection, pipeline depressurization, pigging. Gas hydrates and prevention techniques.		
Unit - IV	**Natural Gas treatment**	**9**
Chemical absorption processes– alkanolamine solvents, potassium carbonate solution, Physical Solvent processes – propylene carbonate, dimethyl ether of polyethylene glycol, methanol, Solid bed absorption process- Iron sponge, Zinc oxide, Solid bed adsorption process.		
Unit - V	**Dehydration and Sulfur recovery**	**9**
Water content determination, Natural Gas Dehydration – Glycol dehydration – TEG, Enhanced TEG, glycol injection, Sufur recovery – Modified Claus process, Direct oxidation process, Tail gas cleanup processes – reduction, sulfur dioxide scrubbing, catalytic oxidation		
		Total:45

TEXT BOOK:

1.	Saeid Mokhatab, William Poe and John Mak, “Handbook of Natural Gas Transmission and Processing”, 4th Edition, Gulf Professional Publishing, USA, 2019.

REFERENCES:

1.	Charles Sheppard, “World Seas: An Environmental Evaluation: Volume III: Ecological Issues and Environmental Impacts”, 2nd Edition, Academic Press, UK, 2019.
2.	Primož Potocnik, “Natural Gas”, 1stEdition(reprint) Intech Open, Croatia, 2010.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain the basic properties of natural gas and classify traps based on formation	Understanding (K2)
CO2	demonstrate the techniques involved in transportation and storage of natural gas	Understanding (K2)
CO3	illustrate the deliverability and flow behaviour in a reservoir	Understanding (K2)
CO4	summarize the purification and natural gas treatment processes	Understanding (K2)
CO5	explain the dehydration and sulfur recovering techniques	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2				2	2					2	2	2
CO2	3	2				2	2					2	2	2
CO3	3	2				2	2					2	2	2
CO4	3	2				2	2					2	2	2
CO5	3	2				2	2					2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	40	60					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE20 – BATTERY AND FUEL CELL TECHNOLOGY							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course deals with the fundamentals of electrochemical engineering and its applications.	
Unit - I	**Basics of Electrochemistry**	**9**
Importance of electrochemical systems: Faraday's law - Current density - Potential and Ohm's law. Cell potential. Electrochemical kinetics: Double layer - Butler–Volmer Kinetic Expression - Influence of Mass Transfer on the Reaction Rate - Current efficiency.		
Unit – II	**Transport phenomena and Electrodes**	**9**
Mobility of electrons in cells, Concentration over potential, Current distribution and membrane transport. Electrode configuration – Porous electrodes, characterization, current distribution, Three phase electrodes, Electrodes with flow		
Unit - III	**Batteries and Fuel cells**	**9**
Components of a cell - Classification of batteries and cell - Theoretical capacity and state of charge - Cell characteristics and electrochemical performance - Heat efficiency of secondary cells- Charge retention and self-discharge - capacity fade in secondary cells. Fuel cell fundamentals: Types of fuel cells- Current–voltage characteristics and polarizations - Electrode structure - Proton-Exchange Membrane (PEM) fuel cells - Solid Oxide Fuel cells.		
Unit – IV	**Electrochemistry for e-vehicles**	**9**
Introduction to fuel cell stack and super capacitors. Electric and Hybrid vehicles - Objectives, power demand determination, regenerative braking, Battery electric vehicle, Hybrid electric vehicle, Start-Stop hybrid, Fuel Cell Hybrid systems		
Unit – V	**Electro-deposition and Corrosion**	**9**
Electro-deposition: Fundamentals – Nucleation - Deposit morphology – Additives - Impact of side reactions and resistive substrates. Corrosion: Fundamentals - Thermodynamics of corrosion systems - Localized corrosion - Corrosion protection.		
		Total:45

TEXT BOOK:

1.	Thomas F.Fuller and John N.Harb, "Electrochemical Engineering", 1st Edition, John Wiley & Sons, USA, 2018.

REFERENCES:

1.	Allen J.Bard and Larry R. Faulkner, "Electrochemical Methods, Fundamentals and Applications", 2nd Edition, John Wiley & Sons Inc, United State of America, 2000.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the basics of electrochemical systems and electrochemical kinetics.	Understanding (K2)
CO2	illustrate the transport properties of electrochemical systems and electro analytical techniques.	Understanding (K2)
CO3	explain the fundamental properties and classification of batteries and fuel cells.	Understanding (K2)
CO4	outline the technology of electrochemical systems for electric vehicles	Understanding (K2)
CO5	illustrate the concepts of electro-deposition and corrosion prevention.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2											2	1
CO2	3	2											2	1
CO3	3	2											2	1
CO4	3	2											2	1
CO5	3	2											2	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	30	70					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEE01 – FUNDAMENTALS OF RESEARCH

22CHE21 – PIPING ENGINEERING

Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course offers an insight into the design, operation and maintenance of pipes and piping networks	
Unit - I	**Piping Fundamentals**	**9**
Introduction to Piping – Pipe and tube, Classification of Pipes, Piping Materials and Selection criteria, Piping components – Valves, Joints and Fittings. Fluid Flow Problems – Estimation of Major and Minor Losses, Pumping requirements		
Unit - II	**Piping in practice**	**9**
Piping Network – Series and Parallel pipes, Pipe Network analysis using spreadsheets. piping for pumps and compressor		
Unit - III	**Generic Piping design**	**9**
Usage of Standard and codes. Piping Design – material compatibility, estimation of optimum diameter, selection of valves and fittings, complexity factor, stress analysis, selection of pipe supports.		
Unit - IV	**Piping Systems**	**9**
Design considerations for piping systems – water and waste water, steam, compressed air, industrial gases, oil, refrigeration, solid and slurry systems		
Unit - V	**Operation and Maintenance**	**9**
Inspection of Pipelines – Testing techniques and leak detection. Maintenance – Cleaning, coating, freeze prevention, drag reduction, insulation, Common failures and repair techniques, Piping Plan development.		
		Total:45

TEXT BOOK:

1.	Henry Liu, "Pipeline Engineering", 2nd Edition, Lewis Publishers, USA, 2003 for units I & II.
2.	Mohinder L. Nayyar, "Piping Handbook", 7th Edition, Tata McGraw Hill Publishing Company Ltd, USA, 2000 for units III, IV & V.

REFERENCES:

1.	John J Mcketta, "Piping Handbook", 3rd Edition, Marcel Dekker Inc, United State of America, 1992.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply the fundamental principles of fluid mechanics to solve fluid flow problems	Applying (K3)
CO2	interpret the piping symbols, codes and sketch a piping layout for a given problem	Applying (K3)
CO3	apply the concepts of generic piping design for optimal design of piping systems	Applying (K3)
CO4	perform the process design of various pipeline systems	Applying (K3)
CO5	demonstrate the techniques involved in inspection and maintenance of pipelines	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	2	1	1					1	3	2
CO2	3	2	2	1	2	1	1					1	3	2
CO3	3	3	2	1	2	1	1				1	1	3	2
CO4	3	3	2	1	2	1	1				1	1	3	2
CO5	3	3	2	1	2	1	1					1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	60	30				100
CAT2	10	60	30				100
CAT3	10	60	30				100
ESE	10	60	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEE02 - TOTAL QUALITY MANAGEMENT							
(Common to All BE/BTech branches)							
Programme & Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course deals with quality concepts and Total Quality Management (TQM) principles focusing on process quality for customer perspective. It also deals with the basic and modern quality management tools including ISOstandards	
Unit – I	**QualityConceptsandPrinciples**	**9**
DefinitionofQuality – DimensionsofQuality – QualityPlanning – QualityAssuranceandControl –QualityCostswithCaseStudies - Elements / PrinciplesofTQM-HistoricalReview – Leadership – Qualities / Habits –QualityCouncil – QualityStatements,StrategicPlanning –Importance –CaseStudies –DemingPhilosophy –BarrierstoTQM Implementation – Cases with TQM Success and Failures.		
Unit – II	**TQM-PrinciplesandStrategies**	**9**
Customer Satisfaction - Customer Perception of Quality - Customer Complaints - Customer Retention, Employee Involvement –Motivation - Empowerment - Teams - Recognition and Reward - Performance Appraisal, Continuous Process Improvement - Juran'sTrilogy-PDSACycle-5S -Kaizen,SupplierPartnership -Partnering-Sourcing-SupplierSelection-SupplierRating - Relationship Development, PerformanceMeasures – Purpose –Methods - Cases.		
Unit – III	**ControlChartsfor ProcessControl**	**9**
BasicSevenToolsofQualityanditsRoleinQualityControl,StatisticalFundamentals–MeasuresofCentralTendencyandDispersion,Populationand Sample - Normal Curve -Control Chartsfor Variables and Attributes-ProcessCapability - Case Study – Introductionto Six Sigma.		
Unit – IV	**TQM-ModernTools**	**9**
New Seven Tools of Quality, Benchmarking - Need - Types and Process, Quality Function Deployment - House of Quality (HOQ)Construction - Case Studies, Introduction to Taguchi's Robust Design - Quality Loss Function -Design of Experiments (DOE), TotalProductiveMaintenance(TPM) – UptimeEnhancement,FailureModeandEffectAnalysis (FMEA) – RiskPriorityNumber(RPN)–Process - CaseStudies.		
Unit – V	**QualitySystems**	**9**
NeedforISO9000andOther QualitySystems-ISO9000:2015QualitySystem– Elements-ImplementationofQualitySystem-Documentation-QualityAuditing,IntroductiontoISO14000 -IATF16949-TL9000-IEC17025-ISO18000-ISO20000-ISO22000 - ISO21001. Process ofImplementingISO – BarriersinISO Implementation.		
		Total:45

TEXT BOOK:

1.	BesterfieldDale H.,Besterfield Carol, Besterfield GlenH.,BesterfieldMary,UrdhwaresheHemant,UrdhwaresheRashmi. "TotalQualityManagement",5th Edition,PearsonEducation,Noida,2018.

REFERENCES:

1.	Subburaj Ramasamy, "TotalQualityManagement",McGrawHillEducation,NewDelhi,2017.
2.	JamesR.EvansandWilliamM.Lindsay, "TheManagementandControlof Quality",8th Edition, CengageLearning,2012.
3.	DavidGoetsch& Stanley Davis,"Quality Management for OrganizationalExcellence:IntroductiontoTotalQuality", 8th Edition,Pearson,2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the evolutionofTQMprinciples	Understanding (K2)
CO2	illustratetheprinciplesandstrategiesofTQM	Understanding (K2)
CO3	use control charts and identify process capability of a process	Applying(K3)
CO4	applyvariousqualitytoolsandtechniques inbothmanufacturing andserviceindustry	Applying(K3)
CO5	choose appropriate quality standards and implement them in the respective industry	Applying(K3)

Mapping ofCOswithPOsand PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2				1						1		3
CO2	2	2				1						1		3
CO3	2	2				1						1		3
CO4	2	2				1						1		3
CO5	1	1				1						1		3

1 –Slight, 2–Moderate, 3–Substantial,BT-Bloom'sTaxonomy

ASSESSMENTPATTERN-
THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	45	30				100
CAT2	20	40	40				100
CAT3	25	45	30				100
ESE	20	40	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CHE22 – NANO MATERIALS AND COMPOSITE MATERIALS FOR CHEMICAL ENGINEERS							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course will able to help students to gain knowledge in preparation and application of nanomaterials	
Unit – I	**Overview of Nanomaterials**	**9**
Introduction and Classification, Nanostructure induced effects on properties. Introduction to Fabrication and preparation techniques		
Unit - II	**Characterization of Nanomaterials**	**9**
General classification of characterization techniques, Usage of Microscopy – SEM, TEM, STM & AFM, Usage of Crystallography – XRD & XRF. Spectroscopy – IR, NMR and Raman Spectroscopy.		
Unit - III	**Key nanostructures and applications**	**9**
Nano – Semiconductors, Nanomagnetic Materials, Carbon based Nanomaterials – Bucky ball, CNT, Graphite and Graphene. Templated Nanostructures, Nano catalysts, Biological Nanomaterials – Polypeptides, DNA		
Unit – IV	**Introduction to Composite materials**	**9**
Definition of composite materials, Fibers and Matrices, Key properties of composites. Manufacturing processes – Molding, Forming, 3D assembly and Tape laying, Sandwich composites		
Unit - V	**Applied composites**	**9**
Application of Composite materials – Aerospace construction, Automotives, Wind turbines, Ship building, Ski, Bicycles, Other applications – Pressure gas bottle, Bogie Frame, Offshore installations, Biomechanical applications, Cable car, Applications of Nanocomposites		
		Total:45

TEXT BOOK:

1.	Robert Kelsall, Ian W Hamley and Mark Geoghegan, “ Nanoscale Science and Technology”, 1st Edition, Wiley, UK, 2005 for units I, II & III.
2.	Daniel Gay, “Composite Materials – Design and applications”, CRC Press, Boca Raton, USA, 2014 for units IV & V.

REFERENCES:

1.	William A. Goddard, "Hand book of Nanoscience, Engineering and Technology ", 1st Edition, CRC Press, United State of America, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	describe the phenomena of nanosize and the general synthesis techniques	Understanding (K2)
CO2	explain the techniques available for characterization of nanomaterials	Understanding (K2)
CO3	discuss the synthesis characterization and applications of various nanomaterials	Understanding (K2)
CO4	explain the key features of composites and their manufacturing techniques	Understanding (K2)
CO5	illustrate the important applications of composite and nano composite materials in various sectors	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1				1	1	1				1	3	2
CO2	3	1	1	1	2	1	1	1				1	3	2
CO3	3	1	1	1	2	1	1	1				1	3	2
CO4	3	2	1	1	2	1	1	1				1	3	2
CO5	3	2	1	1	2	1	1	1				1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	20	80					100
ESE	20	80					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE23 – PETROLEUM REFINERY ENGINEERING

Programme& Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course covers classification of petroleum products, purification and upgradation techniques and basic safety measure to be followed in the refinery.	
Unit - I	**Petroleum Formation and Evaluation**	**9**
Origin and formation, Composition of petroleum, Evaluation of petroleum – UOP Characterization factor, Correlation Index, Distillation Characteristics – Crude Assay analysis, TBP apparatus, Average boiling point.		
Unit - II	**Petroleum product fractions, properties and Test methods**	**9**
Thermal properties of petroleum fractions – Specific heat, Heat of Combustion, Latent heat of vaporization, thermal expansion, spontaneous ignition temperature, Viscosity, Thermal conductivity, Test methods for petroleum products – ASTM distillation, Reid vapor pressure, Octane number, Oxidation stability, Sulfur, Carbon content, Pour point, Smoke point, Fire point, Flash point, Aniline point, Burning Quality Test		
Unit - III	**Fractionation and Treatment techniques**	**9**
Dehydration and desalting of crudes, Distillation (ADU, VDU), Production and treatment of LPG, Gasoline – Copper chloride process, Inhibitor sweetening, caustic and methanol, lead doctoring, Merox treatment, sulfuric acid treatment , catalytic desulfurization		
Unit - IV	**Upgradation Processes**	**9**
Thermal cracking- vis breaking, Dubbs two coil process, Catalytic cracking – fixed, moving bed, fluidized bed (FCC), Catalytic reforming, Naphtha cracking, Coking (Delayed, Fluidized), Hydrocracking (single, two stage), Hydrodesulphurization, Alkylation (Sulfuric and Fluoric acid methods), Isomerization (Aluminum chloride method)		
Unit - V	**Asphalt technology, Biodiesel and Oil spill management**	**9**
Asphalt – source, chemical structure, types, Air blowing of Bitumen, Biodiesel production, Oil spill management – Cleaning equipment – Skimmers.		
		Total:45

TEXT BOOK:

1.	Bhaskara Rao.B.K, "Modern Petroleum Refining Processes", 6th Edition, Oxford and IBH Publishing Company, New Delhi, 2017.

REFERENCES:

1.	Nelson.W.L, "Petroleum Refinery Engineering", 4th Edition, McGraw Hill International Edition, New York, 1958.
2.	Mark J. Kaiser, Arno deKlerk, James H. Gary and Glenn E.Handwerk, "Petroleum Refining: Technology, Economics, and Markets", 6th Edition, CRC Press, United Kingdom, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	discuss the formation, classification and properties of petroleum	Understanding (K2)
CO2	explain the crude properties and test methods for petroleum	Understanding (K2)
CO3	classify the purification methods for petroleum products	Understanding (K2)
CO4	outline the production of LPG, LNG and hydro treatment processes	Understanding (K2)
CO5	summarize the process of isomerization, polymerization and processing of heavy crude	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1								1	2	1
CO2	2	2	1	1								1	2	1
CO3	2	2	2									1	2	1
CO4	2	2	1									1	2	1
CO5	2	2	1									1	2	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	30	70					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEE01 - FUNDAMENTALS OF RESEARCH							
(Common to All BE/BTech branches)							
Programme & Branch	**All BE/BTech branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**GE**	**3**	**0**	**0**	**3**

Preamble	This course familiarizes the fundamental concepts/techniques adopted in research, problem formulation and also disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools.	
Unit – I	**Introduction to Research**	**9**
Introduction to Research: Types and Process of Research - Outcomes of Research - Sources of Research Problem - Characteristics of a Good Research Problem - Errors in Selecting a Research Problem - Importance of Keywords.		
Unit – II	**Literature Review**	**9**
Literature Review: Literature Collection - Methods - Analysis - Citation Study - Gap Analysis - Problem Formulation Techniques.		
Unit – III	**Research Methodology**	**9**
Research Methodology: Appropriate Choice of Algorithms/Methodologies/Methods – Data Collection – Primary Data Analysis – Experimental Methods and Result Analysis - Investigation of Solutions for Research Problem - Interpretation - Research Limitations.		
Unit – IV	**Journals and Papers**	**9**
Journals and Papers: Journals in Science/Engineering - Indexing and Impact factor of Journals. Plagiarism and Research Ethics. Types of Research Papers - Original Article/Review Paper/Short Communication/Case Study.		
Unit – V	**Reports and Presentations**	**9**
How to Write a Report - Language and Style - Format of Project Report - Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures - Appendix - Bibliography etc - Different Reference Formats. Presentation using PPTs. Research Tools.		
		Total:45

TEXT BOOK:

1.	Walliman, Nicholas. "Research Methods: The basics". 2nd edition, Routledge, 2017., for Units I, II, III, IV & V

REFERENCES:

1.	Mishra, S.B. and Alok, S. "Handbook of research methodology" Educreation Publishing, 2017
2.	Kumar, Ranjit. "Research Methodology: A step-by-step guide for beginners". SAGE Publications Limited, 2019.
3.	Nayak, J.K. and Singh, P. "Fundamentals of Research Methodology Problems and Prospects". SSDN Publishers & Distributors, 2021.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	list the various stages in research and categorize the quality of journals	Applying (K3)
CO2	formulate a research problem from published literature/journal papers	Evaluating (K5)
CO3	write, present a journal paper/ project report in proper format	Creating (K6)
CO4	select suitable journal and submit a research paper	Applying (K3)
CO5	compile a research report and the presentation	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	1	1	3	3	1	1	3	3	3
CO2	3	3	3	3	2	1	1	3	3	3	3	3	3	3
CO3	3	3	3	3	3	1	1	3	3	3	1	3	3	3
CO4	3	2	1	1	2	1	1	3	2	1	1	3	3	3
CO5	3	3	2	2	3	1	1	3	3	3	1	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		40	50	10			100
CAT2		30	50	10	10		100
CAT3		20	30	30	10	10	100
ESE		40	40	10	10		100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE24 – FUNDAMENTALS OF COMPUTATIONAL FLUID DYNAMICS

Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	With the advent of high speed computing, CFD has become an integral part of engineering design, simulation and performance analysis. This course deals with the fundamentals of CFD, grid generation, meshing and solution techniques using finite volume method.

Unit - I	**Conservation Laws of Fluid Motion and Boundary Conditions**	**9**
Governing equations of fluid flow and heat transfer: Equations of state -Navier-Stokes equations for Newtonian fluid - conservative form of governing equations of flow - differential and integral forms of general transport equations - classification of physical behavior.		
Unit – II	**Turbulence and its Modeling**	**9**
Transition from laminar to turbulent flow - effect of turbulence on properties of the mean flow - Reynolds-averaged Navier-Stokes equations and classical turbulence models - mixing length model – k-ϵ model; Turbulent models - Reynolds Stress model and large eddy simulation.		
Unit – III	**Finite Volume Method for Diffusion and Convective-Diffusion Problems**	**9**
Finite volume method for one-dimensional, two-dimensional and three-dimensional steady state diffusion - steady one-dimensional convection and diffusion- Discretization schemes: the central differencing scheme - Properties of discretization schemes - Assessment of the central differencing scheme for convection-diffusion problems - upwind differencing scheme - Hybrid differencing scheme - power-law scheme.		
Unit – IV	**Solution Algorithms for Pressure-Velocity Coupling in Steady Flows**	**9**
Staggered grid - momentum equations - SIMPLE algorithm - Assembly of a complete method - SIMPLER, SIMPLEC, and PISO algorithms. Solution of discretized equations: Tri-diagonal matrix algorithm - application of TDMA to two-dimensional and three-dimensional problems.		
Unit – V	**Finite Volume Method for Unsteady Flows**	**9**
One-dimensional unsteady state heat conduction - implicit method for two-and three-dimensional problems - discretization of transient convection-diffusion equation - solution procedures for unsteady flow calculations - steady state calculations using pseudo-transient approach.		
		Total:45

TEXT BOOK:

1. Versteeg H.K. and Malalasekara W, "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", 2nd edition, Pearson Education, India, 2007.

REFERENCES:

1. Anderson John D., "Computational Fluid Dynamics-The Basics with Applications", 1st edition, Tata McGraw Hill Publishing Company Ltd, United State of America, 2012.
2. https://www.ansys.com/en-in/products/fluids/ansys-fluent
https://www.solidworks.com/

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the governing equations for fluid flow and heat transfer.	Applying (K3)
CO2	explain the different types of models for turbulence.	Understanding (K2)
CO3	apply finite volume method for developing solution of steady state diffusion and convection diffusion problems.	Applying (K3)
CO4	formulate algorithms for pressure–velocity coupling in steady flows.	Applying (K3)
CO5	apply the knowledge of algorithms in solving unsteady flow heat conduction and convection diffusion processes.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2							2	2	2
CO2	3	3	2	2	2							2	2	2
CO3	3	3	2	3	2							2	2	2
CO4	2	3	2	3	2							2	2	2
CO5	2	3	2	3	2							2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	60	30				100
CAT2	10	30	50				100
CAT3	10	30	50				100
ESE	10	30	50				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE25 – RECENT TRENDS IN CHEMICAL ENGINEERING

Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course highlights different advanced fields in which the chemical engineering field is growing	
Unit - I	**Sustainable development**	**9**
Renewable energies, Process Intensification for energy conservation, Bio-based platforms and bio-molecule production, soil and water remediation techniques, solar CSPs, Combined production of hydrogen and electricity		
Unit – II	**Process Intensification**	**9**
Approaches to process intensification, PI utilization in chemical industries, role of membrane systems, membrane reactors, applications		
Unit – III	**Bio and Nano-technology**	**9**
Production of bio-ethanol and biodiesel, usage of biomass. Bio-plastics - concept, production, strength and weakness. Bio-surfactants – Production and recovery technologies, applications. Introduction, Silica nanoparticles and its applications, Magnetic nano-particles and its applications, titania nano particles and its applications		
Unit – IV	**Industry 4.0 – I**	**9**
Introduction – Sensing, actuation and communication, Networking, Smart Factories, Cyber Physical systems, Collaborative Platforms and Product Life cycle assessment, AR and VR, AI, Big data analytics		
Unit – V	**Industry 4.0 – II**	**9**
Industrial IOT, Layers, Applications of Big Data Analytics and SDN, Applications of IOT in Oil, Petrochemical, Pharmaceutical, Milk industries		
		Total:45

TEXT BOOK:

1.	Vincenzo Piemonte, Marcello De Falco, Angelo Basile, “ Sustainable Development in Chemical Engineering”, Wiley Publishing, UK, 2013 (Unit I, II & III)
2.	Sudeep Misra, Chandana Roy, Anand Mukherjee, “Introduction to Industrial Internet of Things and Industry 4.0”, CRC Press, London, 2021 (Unit IV & V)

REFERENCES:

1.	https://nptel.ac.in/courses/106105195

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Discuss the importance of chemical engineering in renewable energy	Understanding (K2)
CO2	Explain various developments in process intensification	Understanding (K2)
CO3	Describe the growth of chemical engineering in bio and nanotechnology	Understanding (K2)
CO4	Explain the foundation concepts of industry 4.0	Understanding (K2)
CO5	Discuss the IOT applications in process industries with case studies	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3					1					2	2	2
CO2	3	3					1					2	2	2
CO3	3	3					1					2	2	2
CO4	2	3			1							2	2	2
CO5	2	3			1							2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	80					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE26 – PROCESS OPTIMIZATION							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Engineering Mathematics	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides knowledge about the fundamentals of optimization and its applications in process industries.	
Unit - I	**Developing Models for Optimization**	**9**
Scope and hierarchy of optimization, Essential features of Optimization problems, Classification of Models, Building a model, Factorial experimental designs, Degree of freedom.		
Unit – II	**Basic Concepts of optimization**	**9**
Formation of objective function, continuity of functions, NLP problem statement, convexity and applications, Interpretation of objective function based on its Quadratic approximation, Necessary and sufficient conditions for an extremum.		
Unit - III	**Optimization of Unconstrained Functions**	**9**
Methods for one dimensional search, Newton‘s method and Quasi – Newton methods for uni-dimensional search. Polynomial approximation methods.		
Unit - IV	**Unconstrained Multivariable Optimization**	**9**
Methods using function value only, methods using first derivative, Newton‘s method, Quasi – Newton methods.		
Unit - V	**Linear Programming and applications of optimization**	**9**
Simplex method, Barrier method, sensitivity analysis, Linear mixed integer programs. Applications of optimization in chemical processes.		
		Total:45

TEXT BOOK:

1.	Edgar T.F., Himmelblau D.M. and Ladson L.S., “Optimization of Chemical Processes”, 2nd Edition, McGraw Hill, New York, 2003.

REFERENCES:

1.	Urmila M. Diwekar, “Introduction to Applied Optimization”, 2nd Edition, Springer, 2008.
2.	Rao S.S., “Engineering Optimization: Theory and Practice”, 4th Edition, New Age Publishers, 2011.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain different optimization models in a system.	Understanding (K2)
CO2	interpret the objective functions of optimization.	Understanding (K2)
CO3	apply unidirectional search methods in solving unconstrained functions.	Applying (K3)
CO4	solve optimization problems using unconstrained multivariable optimization.	Applying (K3)
CO5	apply optimization techniques to solve chemical engineering problems.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	1							2	2	
CO2	3	3	3	3	1							2	2	
CO3	3	3	3	2	1							2	2	
CO4	3	3	3	3	1							2	2	
CO5	3	3	3	3	1							2	2	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	10	30	60				100
CAT3	10	30	60				100
ESE	10	30	60				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE27 – NUCLEAR ENGINEERING FOR CHEMICAL ENGINEERS							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course offers an insight into the fundamentals and applications of Nuclear engineering	
Unit - I	**Foundations of Nuclear Sciences**	**9**
Introduction to Nuclear Energy – Binding and Separation Energy, Nuclear Reactions – Classification, Conservation of charge, Q – value for reactions, Radioactivity – Types of radioactive decay, Characteristics, Half life and Decay Chain, Radio – Isotopes		
Unit - II	**Nuclear energetics – I**	**9**
Characteristics of Nuclear Fission – Fission Products, Neutron Emission, Energy Released; Characteristics of Nuclear Fusion – Energy generation, Nucleogenesis, Conservation of mass, energy and linear momentum, Reaction Threshold Energy		
Unit - III	**Nuclear energetics – II**	**9**
Nuclear Chain reaction – Controllable and Uncontrollable reaction, Nuclear fuel cycle, Fuel bundle preparation, Moderation of neutrons, selection of moderators, Homogenous and Heterogeneous cores, Neutron Reflectors		
Unit - IV	**Nuclear Reactor Technology**	**9**
Generation of Nuclear reactor technology, Nuclear Thermal Reactors – Components and steam cycles of BWR, PWR, PHWR, LWR, AGR. Fast Breeder Technology – Fissile material for fast reactors, Breeder Reactor Technologies, Problems with Fusion Reaction, Economics of Nuclear Power		
Unit - V	**Instrumentation and Safety**	**9**
Detection and Measurement of Radiation – Gas filled detectors, Scintillation detectors, Semi-conductor Ionizing Detectors, Personal Dosimeters. Hazard Assessment – Containment Technology, natural exposure for humans, Health and hereditary effects, Cancer Risks, Personal Protective equipment, Radiation Protection Standards		
		Total:45

TEXT BOOK:

1.	J. Kenneth Shultis, Richard E Faw, "Fundamentals of Nuclear Science and Engineering", 3rd Edition, CRC press, USA, 2016.

REFERENCES:

1.	Rüdiger Meiswinkel, Julian Meyer, Jürgen Schnell, "Design and Construction of Nuclear Power Plants", 1st Edition, Ernst & Sohn, Germany, 2013.
2.	James H. Rust, "Nuclear Power Safety", 1st Edition, Pergamon Publishers, Paris, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the fundamental concepts of nuclear reactions and radio-activity	Understanding (K2)
CO2	describe the characteristics of nuclear fission and fusion for energy generation	Understanding (K2)
CO3	explain the nuclear fuel cycle and the preparatory aspects of nuclear reactor	Understanding (K2)
CO4	describe the working and economics of various fission reactors	Understanding (K2)
CO5	illustrate the working of radiation instruments and discuss about the nuclear safety	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2					1						1	3
CO2	3	2					1						1	3
CO3	3	2					1						1	3
CO4	3	2					1						1	3
CO5	3	2					1						1	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	30	70					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHE28 – PHARMACEUTICAL PROCESS TECHNOLOGY								
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**8**	**PE**	**3**	**0**	**0**	**3**

Preamble	To gain knowledge in formulation and manufacturing of drugs and its quality analysis.	
Unit - I	**Principles and Kinetics**	**9**
Introduction to drugs and pharmaceutical, application of organic therapeutic agents, pharmaco kinetics-Absorption, Distribution, metabolism and Excretion-mechanism and physico chemical principles.		
Unit - II	**Process Synthesis**	**9**
Chemical Conversion process- alkylation, carboxylation, condensation and cyclisation, dehydration, esterification, halogenation, oxidation and sulfonation reactions.		
Unit - III	**Drug Delivery Systems**	**9**
Tablets and capsules -Types of Tablets and capsules -Formulation and Manufacturing; parential solutions, oral liquids, injections and ointments-methods of preparation.		
Unit - IV	**Pharmaceutical Products**	**9**
Vitamins-Functions, laxatives-classification and uses, analgesics-Types and Mechanisms, antacids and antiseptics-classification, mechanism and applications.		
Unit – V	**Quality Control**	**9**
Concept of quality control-IPQC tests for tablets, Quality analysis – raw materials, process and finished products. Good Manufacturing Practices-cGMP, FDA regulations.		
		Total:45

TEXT BOOK:

1.	Brahmankar D.M. and Sunil B. Jaiswal, “Bio pharmaceutics and Pharmacokinetics: A Treatise”, 1st Edition, Vallabah Prakashan India, 2017 for units I, II & III.
2.	Arthur Owen Bentley, "Text book of Pharmaceutics", 8th Edition, All India Traveller Book Seller, India, 2002 for units IV & V.

REFERENCES:

1.	Banker G.S. and Rhodes C.T., "Modern Pharmaceutics", 4th Edition, Marcel Dekker Inc, United State of America, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the drug metabolism and pharmaco–kinetic principles	Understanding (K2)
CO2	illustrate the different chemical conversion processes in pharmaceutical industries	Understanding (K2)
CO3	outline the formulation and manufacturing of drug delivery systems	Understanding (K2)
CO4	explain the manufacturing processes of different types of pharmaceutical products	Understanding (K2)
CO5	summarize the importance of good manufacturing practices and quality control procedures	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1				1						1	2	2
CO2	3	1				1						1	2	2
CO3	3	1				1						1	2	2
CO4	3	1				1						1	2	2
CO5	3	1				1						1	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
CAT3	40	60					100
ESE	40	60					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	22CHO01	Industrial Enzymology	3	1	0	4	V
2.	22CHO02	Waste to Energy Conversion	3	1	0	4	V
3.	22CHO03	Applied Nanotechnology	3	1	0	4	V
4.	22CHO04	Air Pollution Monitoring and Control	3	1	0	4	VI
5.	22CHO05	Paints and Coatings	3	1	0	4	VI
6.	22CHO06	Powder Technology	3	1	0	4	VI
7.	22CHO07	Hydrogen Energy	3	0	0	3	VII
8.	22CHO08	Rubber Technology	3	0	0	3	VII
9.	22CHO09	Industrial Accident Prevention and Management	3	0	0	3	VIII
10.	22CHO10	Electrochemical Engineering	3	0	0	3	VIII
11.	22CHO11	Smart and Functional Materials	3	0	0	3	VIII

22CHO01 - INDUSTRIAL ENZYMOLOGY							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	The course helps the students to understand the basic principles of enzyme and its structure, function and kinetics, mechanism of enzyme action and inhibitors and application of enzymes for various industrial processes

Unit – I	**INTRODUCTION TO ENZYMOLOGY**	**9 + 3**
Classification of enzymes. Mechanisms of enzyme action; History of Industrial enzyme development; concept of active site and energetics of enzyme substrate complex formation; specificity of enzyme action; principles of catalysis – collision theory, transition state theory.		
Unit – II	**KINETICS OF ENZYME ACTION**	**9 + 3**
Kinetics of single substrate reactions; estimation of Michaelis – Menten parameters, enzyme inhibition multisubstrate reactions - mechanisms and kinetics for steady state; Allosteric regulation of enzymes, Monod Changeux Wyman model, pH and temperature effect on enzymes & deactivation kinetics.		
Unit – III	**PURIFICATION AND PRODUCTION OF INDUSTRIAL ENZYMES**	**9 + 3**
Production and purification of crude enzyme extracts from plant, animal and microbial sources; methods of characterization of enzymes - microbial fermentation and downstream processing.		
Unit – IV	**INDUSTRIAL APPLICATION OF ENZYME**	**9 + 3**
Enzymes involved in production process of Brewing and Baking industry, dairy industry, meat processing, Fruit and Vegetable processing, pharmaceutical industries		
Unit – V	**ALTERING ENZYME PERFORMANCE AND STABILITY**	**9 + 3**
Modification of industrial enzyme function and stability by enzyme engineering approaches; immobilization of enzymes. Safety and regulatory aspects: ethics in the use of enzymes in food products, medical and dietary considerations, evaluation of enzyme safety, toxicity consideration in the use of enzymes		

Lecture:45, Tutorial:15, Total:60

TEXTBOOK:

1.	Trevor Palmer,“Enzymes”,2nd Edition,Horwood Publishing Ltd, 2007.
2.	Robert J. Whitehurst & Maarten van Oort, "Enzymes in Food Technology", 2nd Edition, John Wiley & Sons, UK, 2009.

REFERENCES:

1.	Ed Godfrey and West, Industrial Enzymology- Macmillan Press Ltd 2nd edition, 1996.
2.	MuthusamyChandrasekaran, "Enzymes in Food and Beverage Processing", 1st Edition, CRC Press, USA, 2016.
3.	N Gray, M Calvin, Enzymes Biotechnology SC Bhatia CBS Publishers and Distributors Pvt Limited Edition, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer the classification, mechanisms, history, active site concept, specificity, and catalysis in enzymology	Understanding (K2)
CO2	apply kinetic principles for single-substrate and multisubstrate enzyme reactions	Applying (K3)
CO3	make use of the techniques in production and purification of industrial enzymes from diverse sources	Applying (K3)
CO4	identify the utilization of enzymes in industrial applications	Applying (K3)
CO5	outline the industrial modification of enzyme function and its stability through enzyme engineering and immobilization	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2							1	1	2		
CO2	2	2	2							2	2	2		
CO3	2	2	2							1	1	2		
CO4	2	2	1							2	2	2		
CO5	2	2	1							2	2	2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	70	30				100
CAT2	-	70	30				100
CAT3	-	70	30				100
ESE	-	70	30				100

* ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)

22CHO02 - WASTE TO ENERGY CONVERSION

Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course focuses on waste to energy conversion, covering the principles, technologies, and applications of various conversion processes. Students will learn how to design, optimize, and evaluate the environmental and economic impacts of waste-to-energy systems.	
Unit - I	**Introduction to Waste Management and Energy Conversion**	**9 + 3**
Waste management and the importance of waste-to-energy conversion; Types of wastes; Pre-treatment for wastes – drying, milling, and grinding, need for pre-treatment; Waste storage, handling techniques and hazards associated.		
Unit - II	**Waste Characterization and Analysis**	**9 + 3**
Properties and methods for waste characterization; Techniques for determining waste composition and energy content; 3R Principles of waste utilization; Densification of solids – Piston, Screw and Roll presses; Collection and transport systems wastes.		
Unit - III	**Waste Conversion Technologies**	**9 + 3**
Incineration, Pyrolysis, Gasification; Anaerobic digestion and biogas production; Fermentation; Composting and vermiculture – fundamentals, Types, Operation, and maintenance.		
Unit - IV	**Pollution control in WTE facilities**	**9 + 3**
Overview of pollution from WTE conversion facility, Particulates; Facilities to control pollution - Cyclone separator, Electrostatic precipitator, Bag house filters, Scrubbers – Working, cleaning and optimization.		
Unit - V	**Environmental impact, case studies and applications**	**9 + 3**
Environmental impact of waste-to-energy conversion; Life cycle assessment and sustainability analysis; Economic and policy considerations for waste-to-energy systems; Case studies of successful waste-to-energy projects; Applications of waste-to-energy technologies in various industries.		
		Lecture:45, Tutorial:15, Total:60

TEXTBOOK:

1.	Marc J. Rogoff, Francois Screve, “Waste-to-Energy: Technologies and Project Implementation” 2nd Edition, Elsevier Science, UK, 2011.

REFERENCES:

1.	George Tchobanoglous, Frank Kreith, “Handbook of Solid Waste Management” 2nd Edition, McGraw Hill Professional, 2002.
2.	Naomi B Klinghoffer, Marco J Castaldi, “Waste to Energy Conversion Technology” Woodhead Publishing Limited, UK, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the importance of waste-to-energy conversion and its role in sustainable development	Understanding (K2)
CO2	determine composition and energy content of waste materials	Applying (K3)
CO3	compare the different conversion technologies and suggest suitable conversion technology based on the nature of wastes	Understanding (K2)
CO4	identify the pollution sources and select suitable control devices in waste to energy conversion facilities	Applying (K3)
CO5	outlinethe basic concepts of life cycle assessment and sustainability analysis for evaluating the environmental impact of waste-to-energy conversion technologies	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2		3	3					2	2	2
CO2	2	2	2			3	3					2	2	2
CO3	2	2	2			3	3					2	2	2
CO4	2	2	2			3	3					2	2	2
CO5	2	2	2	2		3	3					2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	70	30				100
CAT2	-	70	30				100
CAT3	-	70	30				100
ESE	-	70	30				100

* ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)

22CHO03 - APPLIED NANOTECHNOLOGY								
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course will able to help students to gain knowledge in preparation and application of nanomaterials	
Unit - I	**Overview of Nanomaterials**	**9 + 3**
Introduction and Classification, Nanostructure induced effects on properties. Introduction to Fabrication and preparation techniques		
Unit - II	**Characterization of Nanomaterials**	**9 + 3**
General classification of characterization techniques, Usage of Microscopy – SEM, TEM, STM & AFM, Usage of Crystallography – XRD & XRF. Spectroscopy – IR, NMR and Raman Spectroscopy.		
Unit - III	**Key nanostructures and applications**	**9 + 3**
Nano – Semiconductors, Nanomagnetic Materials, Carbon based Nanomaterials – Bucky ball, CNT, Graphite and Graphene. Templated Nanostructures, Nano catalysts, Biological Nanomaterials – Polypeptides, DNA		
Unit - IV	**Introduction to Composite materials**	**9 + 3**
Definition of composite materials, Fibers and Matrices, Key properties of composites. Manufacturing processes – Molding, Forming, 3D assembly and Tape laying, Sandwich composites		
Unit - V	**Applied composites**	**9 + 3**
Application of Composite materials – Aerospace construction, Automotives, Wind turbines, Ship building, Ski, Bicycles, Other applications – Pressure gas bottle, Bogie Frame, Offshore installations, Biomechanical applications, Cable car		
		Lecture:45, Tutorial:15, Total:60

TEXTBOOK:

1.	Robert Kelsall, Ian W Hamley and Mark Geoghegan, “Nanoscale Science and Technology”, 1st Edition, Wiley, UK, 2005.(Units I, II & III)
2.	Daniel Gay, “Composite Materials – Design and applications”, CRC Press, Boca Raton, USA, 2014. (Units IV & V)

REFERENCES:

1.	William A. Goddard, "Hand book of Nanoscience, Engineering and Technology ", 1st Edition, CRC Press, United State of America, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the phenomena of nanosize and the general synthesis techniques	Understanding (K2)
CO2	apply diverse characterization techniques in studying the characteristics of nanomaterials	Applying (K3)
CO3	choose the synthesis, characterization methods of key nanostructures	Applying (K3)
CO4	explain the key features of composites and their manufacturing techniques	Understanding (K2)
CO5	apply composite materials in commercial applications	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1				1	1	1				1		
CO2	3	1	1	1	2	1	1	1				1		
CO3	3	1	1	1	2	1	1	1				1		
CO4	3	2	1	1	2	1	1	1				1		
CO5	3	2	1	1	2	1	1	1				1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	60	40				100
CAT2	-	60	40				100
CAT3	-	60	40				100
ESE	-	60	40				100

* ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)

22CHO04 - AIR POLLUTION MONITORING AND CONTROL							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course will enable the students to have a comprehensive understanding of powder technology and its fundamentals	
Unit - I	**Introduction to Air Pollution**	**9+3**
Air pollutants – History, air quality standards, monitoring and measurement, sampling and analysis- classifications of pollutants– sources andeffects. Regulatory system: Framework in India- clean air act – provisions for recent development		
Unit - II	**Gaseous pollutants and Particulates**	**9+3**
Chemical and physical properties of gaseous pollutants- Stack Plumes- models, general characteristics and types. Particulates: Collection mechanism- particle size distribution- collection efficiency		
Unit - III	**Ambient Air Quality Monitoring**	**9+3**
Air-Quality Sampling Program, Reference Methods and Continuous Monitoring, Environmental Surveillance and Control System, Typical Air Sampling Train, Integrated Sampling Devices for Suspended Particulate Matter		
Unit - IV	**Air Pollution Controlling Equipment**	**9+3**
Incinerators, Absorbers, Thermal oxidizers, Gravity settling chambers –classifications, operation, typical applications and suggestions for improvement		
Unit - V	**Hybrid systems and Air Pollution Survey**	**9+3**
Hybrid systems –Wet electrostatic precipitators, Dry scrubbers, Electrostatically augmented fabric filters. Air pollution surveying guidelines		
		Lecture:45, Tutorial:15, Total:60

TEXTBOOK:

1.	Louis Theodore, Anthony J. Buonicore, "Air Pollution Control Equipment Calculations",1stEdition, Wiley, USA, 2008
2.	Karl B. Schnelle, Jr., Russell F. Dunn, Mary Ellen Ternes "Air Pollution Control Technology Handbook" 2ndEdition, CRC Press, 2017

REFERENCES:

1.	Rao M.N. and Rao H.V.N, "Air Pollution", 1stEdition, McGraw Hill International edition, India, 2001
2.	C. S. Rao, "Environmental Pollution Control Engineering", Revised second Edition, New Age International, 2007

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	describe the evolution procedure in analyzing the air pollutants based on air quality standards	Understanding (K2)
CO2	explain the characteristics of gaseous pollutants and particulates	Understanding (K2)
CO3	demonstrate the air quality monitoring techniques	Understanding (K2)
CO4	execute the operations, applications of air pollution control equipment	Applying (K3)
CO5	explain the concepts involved in hybrid systems and air pollution survey	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2			3	2							
CO2	3	2	2			3	2							
CO3	3	2	2			3	2							
CO4	3	2	2			3	2							
CO5	3	2	2			3	2							

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	20	60	20				100
ESE	20	60	20				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHO05 - PAINTS AND COATINGS							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	To gain knowledge on surface engineering, chemical conversion, surface coating, electro-deposition coating methods and design guidelines for surface coating	
Unit - I	**Surface Engineering**:	**9+3**
Introduction to surface engineering, scope of surface engineering, surface engineering to combat corrosion and wear, Surface preparation– selective surface hardening, laser melting, shot peening, shot blasting, sand blasting, vapor phase degreasing and hydro-blasting.		
Unit - II	**Chemical Conversion Coating:**	**9+3**
Phosphate and chromate chemical conversion coating – types and applications. Aluminium, chromic, sulfuric and hard coat anodizing. Oxidation treatments, Diffusion heat treatment coatings and pack-cementation diffusion coatings.		
Unit - III	**Surface coating methods**:	**9+3**
Organic coating - paints, Ceramic coating and Linings – Glass lining, porcelain enamels, concrete and cementations coating and lining, high performance ceramic coating and lining, Hot dipping – Batch and continuous process, coating microstructure, galvanized aluminium and terne coatings.		
Unit - IV	**Electro-deposition coating methods**	**9+3**
Electrochemical deposition – aqueous solution electroplating, continuous electro deposition, fused-salt electroplating, precious metal plating, electroless plating, and composite coatings. Weld-overlay coatings, Thermal spray coatings, Chemical and physical vapor deposition coatings.		
Unit - V	**Design guidelines for surface coating:**	**9+3**
Pre-processing and Post processing Heat Treatment, Coating Thickness, Case Depth, and Component Distortion Considerations, Surface Roughness and Finishing, Design guidelines for surface preparation, organic and inorganic coating and other important considerations.		
		Lecture:45, Tutorial:15, Total:60

TEXTBOOK:

1.	J.R. Davis and Associates, “Surface Engineering for corrosion and wear resistance”, ASM internationals and IOM communications, 2001.

REFERENCES:

1.	Rudolf Strauss, “Surface Mount Technology”, Butterworth-Heinemann Publisher, 1994
2.	Brian Griffiths, “Manufacturing Surface Technology: Surface Integrity and Functional Performance (Manufacturing Processes Modular S.) (Manufacturing Processes Modular)”, 2001.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the basics of surface engineering and surface preparation methods.	Understanding (K2)
CO2	infer the principles and applications of different chemical conversion coating methods.	Understanding (K2)
CO3	illustrate the principles and applications of different surface coating methods.	Understanding (K2)
CO4	explain the principles and applications of various surface laying methods.	Understanding (K2)
CO5	demonstrate the design guidelines and considerations for surface coating.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2				2							
CO2	3	2	2				2							
CO3	3	2	2				2							
CO4	3	2	2				2							
CO5	3	2	3				2							

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	50	50					100
CAT2	50	50					100
CAT3	30	70					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHO06 - POWDER TECHNOLOGY

Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course will enable the students to have a comprehensive understanding of powder technology and its fundamentals

Unit - I | Particle size Characterization and Measurement | 9 + 3

Particle Size , Particle Size Distribution, Average Particle Size, Size Measurement, Particle Size Analysis Methods and Instrumentation: Visual methods, Separation methods, Stream scanning methods, Field scanning methods, Sedimentation, Surface methods.

Unit - II | Particle shape Characterization and Measurement | 9 + 3

Particle Shape Characterization. Introduction, Representative Size, Geometrical Shape Descriptors, Dynamic Equivalent Shape, Particle Density, Measurement Method for Particle Density, Hardness, Stiffness and Toughness of Particles- Indentation Hardness, Measurement of Hardness, Measurement of Stiffness, Measurement of Toughness.

Unit - III | Fundamental Properties of Particles | 9 + 3

Diffusion of Particles, Optical Properties: Light Scattering, Light Extinction, Dynamic Light Scattering, Photophoresis, Particle Sedimentation, Settling of Two Spherical Particles, Rate of Sedimentation in Concentrated Suspension, Particle Electrification and Electrophoresis, Particle Deposition and Reentrainment, Agglomeration, Particle Impact Breakage, Sintering, Ignition and Combustion Reaction, Solubility and Dissolution Rate

Unit - IV | Particle Generation and Fundamentals | 9 + 3

Aerosol Particle Generation, Generation of Particles by Reaction, Crystallization, Design and Formation of Composite Particles, Surface Modification, methods, Microencapsulation and Nanocoating, Polymerization and Precipitation In Situ, Mechanical Routes, Characterization of Coated Particles, Recent developments

Unit - V | Particle Hazards and protective devices | 9 + 3

Health Effects Due to Particle Matter, Respiratory System, Penetration and Deposition of Particles in the Respiratory Tract, Fate of Deposited Particles, Health Effects of Inhaled Particles, Threshold Limit Value, Respiratory Protective Devices for Particulate Matter, Types of Respirators, Air-Purifying Respirators, Atmosphere-Supplying Respirators, Protection Factor, Spontaneous Ignition and Dust Explosion Mechanism and Prevention, Applications to industrial processes and equipment.

Lecture:45, Tutorial:15, Total:60

TEXTBOOK:

1.	Hiroaki Masuda, KoHigashitani, Hideto Yoshida, Powder Technology Hand book, 3rd edition, CRC Press, Taylor Francis Group, 2006.

REFERENCES:

1.	Agba D. Salman, Michael Hounslow, Jonathan P.K. Seville, Hand book of powder technology, Vol 11, Granulation, Elsevier, 2006.
2.	Muhammad E. Fayed, Lambert Otten, Hand book of powder science & Technology, 2nd edition, International Thomson Publishing, Chapman & Hall , 1997

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	summarize particle size characterizations and its measurement techniques	Understanding (K2)
CO2	explain different particle shape characteristics and its measurement methods	Understanding (K2)
CO3	interpret fundamental properties of particles	Understanding (K2)
CO4	outline the fundamentals of techniques available for particle generation	Understanding (K2)
CO5	illustrate health hazards of powders, its health effects and protective techniques	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3													
CO3	3													
CO4	3	2				2						1		
CO5	3	1	3			3	3					2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	30	70					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHO07– HYDROGEN ENERGY								
Programme& Branch	**B.TECH. – Chemical Engineering**		**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil		**7**	**OE**	**3**	**0**	**0**	**3**
Preamble	To gain knowledge on fundamentals of hydrogen energy as energy systems, production processes, storage, utilization, and safety.							
Unit - I	**Introduction of Hydrogen Energy Systems**							**9**
Hydrogen pathway's introduction – current uses, General introduction to infrastructure requirement for hydrogen production, storage, dispensing and utilization, and Hydrogen production power plants								
Unit - II	**Hydrogen Production Processes**							**9**
Thermal-Steam Reformation, Thermo chemical Water Splitting, Gasification, Pyrolysis, Nuclear thermo catalytic and partial oxidation methods; Electrochemical, Electrolysis, Photo electro chemical; Biological, Photo Biological; Anaerobic Digestion, Fermentative Microorganisms								
Unit - III	**Hydrogen Storage**							**9**
Physical and chemical properties, General storage methods, compressed storage, Composite cylinders, Glass micro sphere storage, Zeolites, Metal hydride storage, chemical hydride storage and cryogenic storage.								
Unit - IV	**Hydrogen Utilization**							**9**
Overview of Hydrogen utilization: I.C. Engines, gas turbines, hydrogen burners, power plant, refineries, domestic and marine applications. Hydrogen fuel quality, performance, COV, emission and combustion characteristics of Spark Ignition engines for hydrogen, back firing, knocking, volumetric efficiency, hydrogen manifold and direct injection, fumigation,								
Unit - V	**Hydrogen Safety**							**9**
Safety barrier diagram, risk analysis, safety in handling and refueling station, safety in vehicular and stationary applications, fire detecting system, safety management, and simulation of crash tests.								
								Total:45

TEXT BOOK:

1.	Michael Ball and Martin Wietschel, "The Hydrogen Economy Opportunities and Challenges", Cambridge University Press, 2009

REFERENCES:

1.	Bent Sorensen, Giuseppe Spazzafumo; "Hydrogen and Fuel Cells", 3rd Edition, Elsevier, 2018
2.	Bockris. J.O.M, "Energy options: real economics and the solar hydrogen system", Halsted Press and London publisher, 1980

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	explain the basics of hydrogen pathways	Understanding (K2)
CO2	outline the fundamentals in hydrogen production processes	Understanding (K2)
CO3	illustrate the chemical and physical properties required for storage of Hydrogen	Understanding (K2)
CO4	identify utilization of hydrogen energy in industrial sectors	Understanding (K2)
CO5	explain various risk analysis and safety protocols during hydrogen handling	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2										1		
CO2	3	3										1		
CO3	3	2										1		
CO4	3	2										1		
CO5	3	2										1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	30	70					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHO08– RUBBER TECHNOLOGY							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course aims to introduce elementary concepts on basics, compounding, vulcanization, components of rubber manufacturing, testing methods involved and manufacturing process in specific rubber and their applications.	
Unit – I	**Rubber – Basics**	**9**
Polymers and Monomers, Synthesis of Macromolecules – addition polymerization and condensation polymerization, Physical behavior of polymers - Interatomic and Intermolecular Forces, Structure and Behavior of Macromolecular Chains, Classification of Rubber – Natural and Synthetic, Elastomers and their characteristics		
Unit - II	**Compounding and Vulcanization**	**9**
Compounding Recipes – Components, Processing Methods, Finishing Steps; Equipment for Compounding – Types of Mills and Banbury Mixers for rubber processing, Mixing Cycles and Mixing Steps, Vulcanization – Sulfur and Sufurless, Vulcanization Conditions, Vulcanization Techniques, Special Types – Continuous, Cold, High Energy Radiation and Microwave		
Unit - III	**Fillers for Rubber & Their Roles**	**9**
Manufacture and Grades, Processing, Vulcanization and Compounding with four Fillers - Carbon Black, Calcium Carbonate, Clays, Silicas and their applications		
Unit - IV	**Processing, Vulcanization, Properties Tests**	**9**
Processability Tests – Plasticity, Compression, Rotary Shear, Mixing, Extrusion, Relaxation, Scorch; Vulcanization Tests – Cruing, Effect of Temperature; Stress-Strain Tests – Tensile, Hardness, Crystallization, Low temperature stiffness, Low temperature Brittleness; Dynamic Mechanical Tests – Rebound, Free vibration, Flex resistance, Crack initiation and growth; Aging Tests – Oxygen aging, Heat aging, Water Resistance, Tear Test		
Unit - V	**Manufacturing Process of Specialty Rubbers**	**9**
Styrene-Butadiene rubber, Polybutadiene and polyisoprene rubber, Ethylene-propylene rubber, Butyl and Halobutyl rubber, Nitrile rubber, Polyacrilic rubber, Neoprene, Silicone rubber, Fluorocarbon elastomer, Polyurethane elastomer		
		Total:45

TEXT BOOK:

1.	Maurice Morton, “Rubber Technology”, 3rd Edition, Springer Science+ Business Media Dordrecht, 1999.

REFERENCES:

1.	Martin.J.M and Smith.W.K, Handbook of Rubber Technology, Vol.2, CBS Publishers & Distributors, New Delhi, 2004.
2.	White.J.L., Rubber Processing Technology Materials, Principles, Hanser Publication,New York, 1995
3.	Blow.C.M. and Hepburn.C. Rubber Technology and Manufacture, Butterworths, 1982.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the polymer science behind rubber technology	Understanding (K2)
CO2	infer the processes of compounding and vulcanization	Understanding (K2)
CO3	describe the properties of fillers and additives	Understanding (K2)
CO4	outline major testing methods and processes involved in rubber manufacture	Understanding (K2)
CO5	explain the manufacturing process of specialty rubbers	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2				2	2					2		
CO2	3	3				2	2					2		
CO3	3	2				2	2					2		
CO4	3	2				2	2					2		
CO5	3	2				2	2					2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	30	70					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHO09 - INDUSTRIAL ACCIDENT PREVENTION AND MANAGEMENT

Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course deals with the fundamentals of electrochemical engineering and its applications.

Unit – I | **Introduction** | **9**

Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages.

Unit – II | **Personal protection in work environment** | **9**

Personal protection in the work environment, Types of PPEs, Personal protective equipment-respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring Safety Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s ofhousekeeping. Work permit system- objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces.

Unit - III | **Safety issues in construction** | **9**

Introduction to construction industry and safety issues in construction Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning &Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space –Temporary Structures. Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety. Relevance of ergonomics in construction safety. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders

Unit – IV | **Safety hazards in machines** | **9**

Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas5welding and Arc Welding. Material Handling-Classification-safety consideration-manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance. Maintenance of common elements-wire rope, chains slings, hooks, clamps. Hearing Conservation Program in Production industries

Unit - V | **Hazard identification and analysis** | **9**

Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers, fire explosion and toxic gas release, Structure of hazard identification and risk assessment. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants- The Dow Fire and Explosion Hazard Index, Preliminary hazard analysis, Hazard and Operability study (HAZOP)) – methodology, criticality analysis, corrective action and follow-up. Control of Chemical Hazards, Hazardous properties of chemicals, Material Safety Data Sheets

Total:45

TEXTBOOK:

1. Paul S V, Safety management System and Documentation training Programme Handbook, CBS Publication, 2000.

REFERENCES:

1. AIChE/CCPS, Guidelines for Hazard Evaluation Procedures. (Second edition).Centre for Chemical Process Safety, American Institute of Chemical Engineers, NewYork, 1992.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	describe the theories of accident causation and preventive measures of industrial accidents.	Understanding (K2)
CO2	explain about personal protective equipment, its selection, safety performance & indicators and importance of housekeeping.	Understanding (K2)
CO3	explain safety issues in construction industries	Understanding (K2)
CO4	describe hazards associated with different machines and material handling.	Understanding (K2)
CO5	illustrate hazard identification tools in different industries with the knowledge of types of chemical hazards	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3	3	3	2	1	1	3		
CO2	2					3	3	3	2	1	1	3		
CO3	2					3	3	3	2	1	1	3		
CO4	2					3	3	3	2	1	1	3		
CO5	3		2	2		3	3	3	2	1	1	3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	80					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHO010 - ELECTROCHEMICAL ENGINEERING							
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course deals with the fundamentals of electrochemical engineering and its applications.	
Unit - I	**Basics of Electrochemistry:**	**9**
Importance of electrochemical systems: Faraday's law - Current density - Potential and Ohm's law. Cell potential. Electrochemical kinetics: Double layer - Butler–Volmer Kinetic Expression - Influence of Mass Transfer on the Reaction Rate - Current efficiency.		
Unit - II	**Transport phenomena and Electrodes**	**9**
Mobility of electrons in cells, Concentration over potential, Current distribution and membrane transport. Electrode configuration – Porous electrodes, characterization, current distribution, Three phase electrodes, Electrodes with flow		
Unit - III	**Batteries and Fuel cells**	**9**
Components of a cell - Classification of batteries and cell - Theoretical capacity and state of charge - Cell characteristics and electrochemical performance - Heat efficiency of secondary cells- Charge retention and self-discharge - capacity fade in secondary cells. Fuel cell fundamentals: Types of fuel cells- Current–voltage characteristics and polarizations - Electrode structure - Proton-Exchange Membrane (PEM) fuel cells - Solid Oxide Fuel cells.		
Unit – IV	**Electrochemistry for e-vehicles**	**9**
Introduction to fuel cell stack and super capacitors. Electric and Hybrid vehicles - Objectives, power demand determination, regenerative braking, Battery electric vehicle, Hybrid electric vehicle, Start-Stop hybrid, Fuel Cell Hybrid systems		
Unit - V	**Electro-deposition and Corrosion**	**9**
Electro-deposition: Fundamentals – Nucleation - Deposit morphology – Additives - Impact of side reactions and resistive substrates. Corrosion: Fundamentals - Thermodynamics of corrosion systems - Localized corrosion - Corrosion protection.		
		Total:45

TEXTBOOK:

1.	Thomas F.Fuller and John N.Harb, "Electrochemical Engineering", 1st Edition, John Wiley & Sons, USA, 2018.

REFERENCES:

1.	Allen J.Bard and Larry R. Faulkner, "Electrochemical Methods, Fundamentals and Applications", 2nd Edition, John Wiley & Sons Inc, United State of America, 2000.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the basics of electrochemical systems and electrochemical kinetics.	Understanding (K2)
CO2	demonstrate the transport properties of electrochemical systems and electro analytical techniques.	Understanding (K2)
CO3	summarize the fundamental properties and classification of batteries and fuel cells.	Understanding (K2)
CO4	expalin the technology of electrochemical systems for electric vehicles	Understanding (K2)
CO5	illustrate the concepts of electro-deposition and corrosion prevention.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	2	1											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	80					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHO11 -SMART AND FUNCTIONAL MATERIALS								
Programme& Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	To acquire knowledge on smart and intelligent materials, their synthesis method and their applications in various fields	
Unit – I	**Smart Materials and Structures**	**9**
Introduction, System intelligence- components and classification of smart structures, common smart materials and associated stimulus-response, Application areas of smart systems		
Unit - II	**Ferroelectric Materials**	**9**
Introduction, Piezoelectric materials- piezoelectric effect, Direct and converse, parameter definitions, Piezoceramics, Piezopolymers, Piezoelectric materials as sensors, Actuators and bimorphs.		
Unit - III	**Shape Memory Materials**	**9**
Introduction, Shape memory effect, Martensitic transformation, One way and two-way SME, training of SMAs, binary and ternary alloy systems, Functional properties of SMAs		
Unit – IV	**Smart Hydrogels**	**9**
Introduction, Synthesis, Fast responsive hydrogels, Molecular recognition, Smart hydrogels as actuators, Controlled drug release, Artificial muscles, Hydrogels in microfluidics		
Unit – V	**Smart systems for space applications**	**9**
Introduction, Elastic memory composites, Smart corrosion protection coatings, Self-healing materials, Sensors, Actuators, Transducers, MEMS, Deployment devices, Molecular machines		
		Total:45

TEXT BOOK:

1.	Schwartz. M, “New Materials, Processes, and Methods Technology”, CRC Press, 2006.
2.	D.J. Leo. D.J, “Engineering Analysis of Smart Material Systems”, Wiley 2007.

REFERENCES:

1.	Yui. N, Mrsny. R.J, “Reflexive Polymers and Hydrogels: Understanding and Designing Fast Responsive Polymeric Systems”, CRC Press, 2004.
2.	Ball. P, ”Made to Measure: Materials for the 21stCentury”, Princeton University Press, 1997.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the classification and applications of smart materials	Understanding (K2)
CO2	describe the various ferroelectric materials and its applications	Understanding (K2)
CO3	explain the significance of shape memory materials and its functional properties	Understanding (K2)
CO4	elaborate the synthesis of smart hydrogels and their applications in various fields	Understanding (K2)
CO5	enumerate the role of smart systems in space applications	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1					1	1	2			1		
CO2	3	1					1	1	2			1		
CO3	3	1					1	1	2			1		
CO4	3	1					1	1	2			1		
CO5	3	1					1	1	2			1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70					100
CAT2	30	70					100
CAT3	30	70					100
ESE	30	70					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

OPEN ELECTIVE COURSES OFFERED BY OTHER DEPARTMENTS (OE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**OFFERED BY**
		SEMESTER V					
1.	22MAO01	Mathematical Foundations for Machine Learning	3	1	0	4	MATHS
2.	22MAO02	Numerical Computing	3	1	0	4	MATHS
3.	22MAO03	Stochastic Processes and Queuing Theory	3	1	0	4	MATHS
4.	22MAO04	Statistics for Engineers	3	1	0	4	MATHS
5.	22PHO01	Thin Film Technology	3	1	0	4	PHYSICS
6.	22PHO02	High Energy Storage Devices	3	1	0	4	PHYSICS
7.	22PHO03	Structural and Optical Characterization of Materials	3	1	0	4	PHYSICS
8.	22CYO01	Instrumental Methods of Analysis	3	1	0	4	CHEMISTRY
9.	22CYO02	Chemistry Concepts for Competitive Examinations	3	1	0	4	CHEMISTRY
10.	22CYO03	Organic Chemistry for Industry	3	1	0	4	CHEMISTRY
		SEMESTER VI					
11.	22MAO05	Graph Theory and its Applications	3	1	0	4	MATHS
12.	22MAX01	Data Analytics using R Programming	3	0	2	4	MATHS
13.	22MAO06	Operations Research	3	1	0	4	MATHS
14.	22MAO07	Number Theory and Cryptography	3	1	0	4	MATHS
15.	22PHO04	Synthesis, Characterization and Biological Applications of Nanomaterials	3	1	0	4	PHYSICS
16.	22PHO05	Techniques of Crystal Growth	3	1	0	4	PHYSICS
17.	22CYO04	Corrosion Science and Engineering	3	1	0	4	CHEMISTRY
18.	22CYO05	Chemistry of Cosmetics in Daily Life	3	1	0	4	CHEMISTRY
19.	22CYO06	Nanocomposite Materials	3	1	0	4	CHEMISTRY
20.		**SEMESTER VII**					
21.	22MAO08	Non-Linear Optimization	3	0	0	3	MATHS
22.	22MAO09	Optimization for Engineers	3	0	0	3	MATHS
23.	22CYO07	Waste and Hazardous Waste Management	3	0	0	3	CHEMISTRY
24.	22CYO08	Chemistry in Every day Life	3	0	0	3	CHEMISTRY
		SEMESTER VIII					
25.	22CYO09	Chemistry of Nutrition for Women Health	3	0	0	3	CHEMISTRY

22MAO01 - MATHEMATICAL FOUNDATIONS FOR MACHINE LEARNING							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	To impart the basic knowledge in linear algebra, decomposition of matrices, continuous optimization, linear regression and support vector machines which provide the foundations for machine learning and deep learning.	
Unit – I	**Vector Spaces:**	**9+3**
Real Vector spaces (Definition & Problems) – Subspaces – Linear Combinations – Linear dependence and independence – Basis and dimension – Row space, Column space and Null Space.		
Unit – II	**Linear Transformations:**	**9+3**
Introduction – Rank and nullity. – Dimension theorem – Kernel and range – Change of basis – Composition and inverse transformations – Matrices of linear transformations.		
Unit – III	**Inner Product Spaces:**	**9+3**
Norms – Inner products – Length and Distance – Angle and Orthogonality – Orthonormal Basis – Gram-Schmidt Process – QR-Decomposition.		
Unit – IV	**Matrix Decomposition and Vector Calculus:**	**9+3**
Matrix Decomposition: Cholesky decomposition – Singular Value Decomposition. Vector Calculus: Differentiation of Univariate Functions – Partial Differentiation and Gradients – Gradients of Vector valued functions – Gradients of matrices – Useful Identities for Computing Gradients – Higher Order Derivatives – Linearization and Multivariate Taylor Series.		
Unit – V	**Optimization:**	**9+3**
Introduction –Classification of Optimization Problems – Constrained multivariable optimization with inequality constraints – Kuhn Tucker conditions – Lagrange's multiplier method –- Unconstrained optimization: Steepest descent method – Newton's method.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Howard Anton and Chris Rorres, "Elementary Linear Algebra", 11th Edition, John Wiley & Sons, New Delhi, 2014 for Units I,II,III.
2.	M. P. Deisenroth, A. A. Faisal, and C. S. Ong, "Mathematics for Machine Learning", 1st Edition Cambridge University Press, 2019 for Units – IV, V.

REFERENCES:

1.	David C. Lay, Steven R. Lay, Judith McDonald, "Linear Algebra and its Applications", 5th Edition, Pearson Education, New Delhi, 2016.
2.	Ethem Alpaydin, "Introduction to Machine Learning(Adaptive Computation and Machine Learning series)", 4th Edition, MIT Press,USA,2020.
3.	R. O. Duda, E. Hart, and D.G. Stork, "Pattern classification", 2nd Edition, John Wiley & Sons, 2012.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the concepts of vector spaces.	Understanding (K2)
CO2	interpret the concepts of linear transformations.	Understanding (K2)
CO3	apply the concept of inner product space and decompose the given matrix by means of orthonormal vectors.	Applying (K3)
CO4	demonstrate the knowledge of factorisation of matrices and vectors in Machine learning.	Understanding (K2)
CO5	identify suitable optimization algorithms for machine learning applications.	Applying (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	3	1												
CO3	3	2												
CO4	3	3	3	1										
CO5	3	2	3	3										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	15	65	20				100
CAT2	15	65	20				100
CAT3	15	50	60				100
ESE	10	40	50				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MAO02 - NUMERICAL COMPUTING							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	To impart knowledge in interpolation, numerical differentiation and integration. Also develop skills to apply numerical algorithms to identify roots of algebraic and transcendental equations, finding eigen values and solve linear system of equations, ordinary differential equations.	
Unit – I	**Solution to Algebraic and Transcendental Equations and Eigen value problems:**	**9+3**
Solution to Algebraic and Transcendental Equations**:** Bisection method **-** Iteration method – Method of false position – Newton-Raphson method Iterative method for Eigen values: Power method – Jacobi's method.		
Unit – II	**Solution of Simultaneous Linear Algebraic equations:**	**9+3**
Introduction - Direct methods: Gauss elimination method – Gauss - Jordan method – LU decomposition method – Crout's method –Iterative methods: Gauss Jacobi and Gauss – Seidel methods.		
Unit – III	**Interpolation:**	**9+3**
Interpolation with equal intervals: Newton's forward and backward difference formulae – Central difference interpolation formulae: Gauss forward and backward interpolation formulae – Interpolation with unequal intervals: Lagrange's interpolation formula – Newton's divided difference formula.		
Unit – IV	**Numerical Differentiation and Integration:**	**9+3**
Differentiation using Newton's forward, backward and divided difference formulae – Numerical integration: Trapezoidal rule – Simpsons 1/3rd rule – Simpsons 3/8th rule – Double integrals using Trapezoidal and Simpson's rules.		
Unit – V	**Numerical Solution of First order Ordinary Differential Equations:**	**9+3**
Single step methods**:** Taylor series method – Euler method – Modified Euler method – Fourth order Runge-Kutta method – Multi step methods: Milne's predictor corrector method – Adam's Bashforth method.		
Lecture:45, Tutorial:15, Total:60		

TEXT BOOK:

1.	Veerarajan T, Ramachandran T., "Numerical Methods", 1st Edition, Tata McGraw Hill Publishing Company, New Delhi, 2018.

REFERENCES:

1.	Kandasamy, P., Thilakavathy, K. and Gunavathy, K., "Numerical Methods", Reprint Edition, S.Chand & Co, New Delhi, 2016.
2.	Sankara Rao. K., "Numerical Methods for Scientists and Engineers", 3rd Edition, Prentice Hall of India Pvt. Ltd, , New Delhi, 2007.
3.	Steven C. Chapra, Raymond P. Canale., "Numerical Methods for Engineers", 7th Edition, McGraw-Hill Education, 2014.
4.	Sastry, S.S, "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning Pvt. Ltd, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply various numerical techniques to solve algebraic and transcendental equations.	Applying (K3)
CO2	solve simultaneous linear equations by numerical methods.	Applying (K3)
CO3	compute intermediate values of given evenly (or) unevenly spaced data.	Applying (K3)
CO4	apply the concepts of numerical differentiation and integration in real time applications.	Applying (K3)
CO5	identify the solution of first ordinary differential equations by numerical methods.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1											
CO2	3	2	2											
CO3	3	3	2											
CO4	3	2	1											
CO5	3	3	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	15	75				100
CAT2	10	15	75				100
CAT3	10	15	75				100
ESE	10	15	75				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MAO03 - STOCHASTIC PROCESSES AND QUEUING THEORY							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	To provide an in-depth knowledge in random variables, random process, correlation and promote the ability to apply suitable queuing models to real time applications.	
Unit – I	**Random Variables:**	**9+3**
Discrete and Continuous random variables – Probability Mass and Probability density functions – Mathematical expectation and Variance – Moments – Moment generating functions.		
Unit – II	**Random processes:**	**9+3**
General concepts and definitions – Classification – Stationary process – Markov chains – Transition probabilities – Poisson process.		
Unit – III	**Correlation and Spectral densities:**	**9+3**
Auto Correlation – Cross Correlation – Properties (Without Proof) – Power spectral density – Cross spectral density – Properties (Without Proof) – Wiener- Khintchine relation – Relationship between cross power spectrum and cross correlation function.		
Unit – IV	**Queuing Theory:**	**9+3**
Characteristics of a queueing system – Kendall‘s notation – Queuing model I (Infinite capacity single server Poisson queue model) (M/M/1) : (∞/FIFO) – Little‘s formulae – Queuing model II (Infinite capacity multiple server Poisson queue model (M/M/C): (∞/FIFO) – Queuing model III (Finite capacity single server Poisson queue model) (M/M/1): (N/FIFO) – Queueing model IV (Finite capacity multiple server Poisson model) (M/M/C) : (N/ FIFO).		
Unit – V	**Non-Markovian Queues and Queue Networks:**	**9+3**
Introduction to Non-Markovian queues – M/G/1 queue – Pollaczek-Khintchine formula – Series queues – Open and Closed queuing networks		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Veerarajan, T, “Probability and Statistics, Random Processes and Queuing Theory”, 1st edition, McGraw-Hill Education, Chennai, 2019.

REFERENCES:

1. Athanasios Papoulis, S. Unnikrishna Pillai., “Probability, Random Variables and Stochastic Processes”, 4th edition, McGraw Hill, New Delhi, 2017.
2. Allen A.O., “Probability, Statistics and Queuing Theory”, 2nd Edition, Academic Press, New Delhi, 1990.
3. Roy D. Yates and David J. Goodman, “Probability and Stochastic Processes - A friendly Introduction for Electrical and Computer Engineers”, 3rd edition, John Wiley & Sons, 2014.
4. John F. Shortle, James M. Thompson, Donald Gross and Carl M. Harris, “Fundamentals of Queuing Theory”, 5th edition, John Wiley and Sons, New York, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply random variables suitably in practical problems.	Applying (K3)
CO2	apply the concept of random process in communication problems.	Applying (K3)
CO3	understand the concepts and properties of Spectral Density Function and Cross Correlation function.	Understanding (K2)
CO4	use the appropriate queuing model for a given practical application.	Applying (K3)
CO5	identify the real time queue in computer networks and take decision accordingly.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	3	2												
CO3	3	2												
CO4	3	3	3										2	
CO5	3	3	3										3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	70				100
CAT2	10	30	60				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MAO04 - STATISTICS FOR ENGINEERS							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	To impart the basic knowledge in presentation of data, descriptive statistical measures and provide skills to apply correlation, suitable non- parametric tests and control charts to control the variations in real time applications.	
Unit – I	**Organization and Presentation of Data:**	**9+3**
Introduction to Statistics – Collection of data – Classification and tabulation of data – Types of data: primary, secondary, quantitative and qualitative data – Types of Measurements: nominal, ordinal, discrete and continuous data – Presentation of data – Diagrammatic and Graphical Representation: Histogram - Frequency curve - Frequency polygon - Cumulative frequency distributions – Ogive curves – Stem and leaf chart.		
Unit – II	**Descriptive Statistics:**	**9+3**
Measures of location or central tendency: Arithmetic mean – Median – Mode – Geometric mean – Harmonic mean – Partition values: Quartiles – Deciles and percentiles – Measures of dispersion: Mean deviation – Quartile deviation – Standard deviation – Coefficient of variation – Measures of skewness – Kurtosis.		
Unit – III	**Correlation and Regression:**	**9+3**
Correlation and Regression: Scatter Diagram – Karl Pearson's Correlation Coefficient – Rank Correlation - Regression Coefficients – Fitting of Regression Lines. Multiple Correlation and Regression: Multiple and partial correlation – Method of least squares – Plane of regression – Properties of residuals – Coefficient of multiple correlation – Coefficient of partial correlation – Multiple correlation with total and partial correlations – Regression and partial correlations in terms of lower order coefficient..		
Unit – IV	**Non-parametric tests:**	**9+3**
Introduction – Sign test: One sample sign test – Sign test for paired samples – Signed rank test – Rank Sum test: Mann Whitney U test – Kruskal-Wallis test – One sample run test – Tests of randomness.		
Unit – V	**Statistical Quality Control:**	**9+3**
Introduction to Statistical quality control – Control charts – Control chart for variables: $\bar{X}$-chart – R-chart – s-chart – Charts for attributes: np-chart – p-chart – c-chart.		
Lecture:45, Tutorial:15, Total:60		

TEXT BOOK:

1.	S.P.Gupta, "Statistical Methods", 44th Revised Edition, Sultan Chand & Sons, New Delhi, 2011 for Units I,II, V
2.	S.C.Gupta, V.K.Kapoor, "Fundamentals of Mathematical Statistics", 12th Edition, Sultan Chand & Sons, New Delhi, 2022. for Units III, IV.

REFERENCES:

1.	Jay L. Devore., "Probability and Statistics for Engineering and the Sciences", 9th Edition, Cengage Learning, USA, 2016.
2.	G.C.Beri, "Business Statistics", 3rd Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.
3.	Johnson. R.A., Miller. I and Freund. J., "Probability and Statistics for Engineers", 9th Edition, Pearson Education, India, 2018.
4.	Anthony Hayter, "Probability and Statistics for Engineers and Scientists", 4th Edition, Cengage Learning, USA, 2012.
5.	J. K. Sharma, "Business Statistics", 5th Edition, Vikas Publishing House Pvt Ltd, Noida, 2020.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	demonstrate the classification of data and present the data in various forms.	Understanding (K2)
CO2	compute and interpret descriptive statistical measures using numerical and graphical techniques.	Applying (K3)
CO3	apply statistical methods like correlation, regression analysis in analysing and interpreting experimental data.	Applying (K3)
CO4	use appropriate non-parametric test to analyze experimental data.	Applying (K3)
CO5	identify suitable control charts for monitoring processes..	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	3	2												
CO3	3	3	2											
CO4	3	3	1											
CO5	3	3	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	40	50				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22PHO01 - THIN FILM TECHNOLOGY
(Offered by Department of Physics)

Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course aims to impart the essential knowledge on deposition, characterization and application of thin films in various engineering fields, and also provides motivation towards innovations.	
Unit – I	**Theories and models of thin film growth:**	**9+3**
Introduction – Theories of thin film nucleation: Impingement, Adsorption and Thermal accommodation – The capillarity model – The atomistic models – Structural consequences of thin film nucleation – The four stages of film Growth –The incorporation of defects during growth.		
Unit – II	**Vacuum technology:**	**9+3**
Principle and working of vacuum pumps: Roots vacuum pump, Rotary pump, Diffusion pump, Turbo molecular pump, Cryogenic pump, Ion pump, Ti-sublimation pump –Measurement of Pressure: Bayet-Albert gauge, Pirani and Penning gauge – Cold cathode and hot cathode ionization gauges – Pressure controlling system (qualitative).		
Unit – III	**Deposition of thin films - Physical methods:**	**9+3**
Thermal evaporation – Electron beam evaporation – Pulsed laser deposition – Ion plating – DC sputtering – RF sputtering – Magnetron sputtering – Reactive sputtering – Molecular beam epitaxy - Demonstration of deposition of thin films by RF sputtering.		
Unit – IV	**Deposition of thin films – Chemical methods:**	**9+3**
Chemical vapor deposition – Sol-gel method – Chemical bath deposition – Hydro thermal methods – Electroplating deposition – Electroless deposition – Spray Pyrolysis - Spin coating.		
Unit – V	**Characterization and Applications of thin films:**	**9+3**
Characterization: X-ray diffraction, Energy dispersive X-ray analysis, Atomic probe microscopy, Scanning Tunneling Microscope, X-ray Photoemission Spectroscopy, UV-vis spectroscopy and Four probe resistivity – Applications (qualitative): Thin film solar cells, Thin film gas sensors, Thin films for information storage and Optical coatings.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Maissel L.I. and Glang R, Hand book of Thin Film Technology, Reprint, McGraw Hill Inc., New York, 1970, (Unit I – IV)
2.	Sam Zhang, Lin Li and Ashok Kumar, Materials Characterization Techniques, 1stedition, CRC Press, Boca Raton, 2008 (Unit V)

REFERENCES:

1.	Ohring M, Material Science of Thin Films, 2nd Edition, Academic Press, New Jersey, 2001
2.	Goswami A, Thin Film Fundamentals, Reprint, New Age International (P) Ltd, New Delhi, 2003
3.	Chopra K. L, Thin Film Phenomena, Illustrated, McGraw Hill Inc., New York, 1969

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	utilize the appropriate theory and models to comprehend the thin film growth process.	Applying (K3)
CO2	apply the principle of vacuum pump to explain select methods to create vacuum and to make use of the principle of vacuum gauge to explain the measurement of vacuum by select methods.	Applying (K3)
CO3	describe the deposition of thin films by select physical methods using the principle of working of respective methods.	Applying (K3)
CO4	explain the deposition of thin films by select chemical methods using the principle of working of respective methods.	Applying (K3)
CO5	make use of select characterization techniques to comprehend the properties of thin films and also to illustrate the various device applications of thin films.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2						2	2		2		
CO2	3	2	2						2	2		2		
CO3	3	2	2						2	2		2		
CO4	3	2	2						2	2		2		
CO5	3	2	2						2	2		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22PHO02 - HIGH ENERGY STORAGE DEVICES
(Offered by Department of Physics)

Programme& Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	This course aims to impart the essential knowledge on the fundamental principles and application areas of proven technologies and materials for energy storage solutions, together with an overview of development trends in this engineering field.	
Unit – I	**Introduction to Energy Storage:**	**9+3**
An overview of energy storage systems (qualitative): Thermal energy storage, mechanical energy storage, chemical energy storage, electrical energy storage, electrochemical energy storage, electrostatic energy storage, magnetic energy storage and optical energy storage – General criteria of energy storage systems – Conventional batteries: fundamentals and applications –Grid connected and off grid energy storage systems and requirements.		
Unit – II	**Thermal storage and Mechanical Storage:**	**9+3**
Thermal storage: Thermal properties of materials, principle of operations, efficiency factors, large scale and medium scale operations – Merits and demerits of thermal storage system – Recent development in thermal storage systems. Mechanical Storage: Types of mechanical storage systems, principle of operations, emerging advances and technologies in mechanical storage systems –Flywheel.		
Unit – III	**Magnetic storage, Electro-optic, Optical and Chemical Storage:**	**9+3**
Magnetic storage: Principle of operation, emerging challenges and a review on devices and technology. Electro-optic and optical storage: Emerging devices and upcoming technologies (qualitative). Chemical storage: Power to gas – Hydrogen and Methane. Power to liquid–Bio fuels – Aluminum-Boron, silicon, and zinc.		
Unit – IV	**Electrochemical Storage:**	**9+3**
Materials, Principle of operation, positive electrode materials, negative electrode materials, electrolytes. Li-ion batteries: Principle of operation, battery components, design of electrodes, cell and battery fabrications – Building block cells – Battery modules and packs –Li-polymer batteries – Applications – Future developments: Sodium-battery, magnesium battery, aluminum battery and silicon battery.		
Unit – V	**Fuel Cells, Hydrogen storage and Super capacitors:**	**9+3**
Fuel Cells: Introduction to fuel cells, PEM (polymer electrolyte membrane), Hydrogen PEM fuel cell, direct methanol fuel cell, alkaline fuel cells and solid oxide fuel cells. Hydrogen storage systems: Solid state hydrogen storage tanks, gas phase hydrogen storage tanks, cryogenic hydrogen storage tanks and liquid phase hydrogen storage tanks. Super capacitors: Features of super capacitors, basic principle of operation, performance and technologies of super capacitors.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Robert A. Huggins, Energy Storage, Springer, 2010, (Unit I – V)
2.	Ehsani, Y. Gao, S. Gay, A. Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles, CRC Press, New York, 2005 (Unit I - V)

REFERENCES:

1.	Yuping Wu, Lithium-Ion Batteries: Fundamentals and Applications(Electrochemical Energy Storage and Conversion), CRC Press, United Kingdom, 2015
2.	Trevor M. Letcher, Storing Energy: with Special Reference to Renewable Energy Sources, 2nd edition, Elsevier, 2022
3.	D. Linden and T. S. Reddy, Handbook of Batteries, 4th edition, McGraw Hill, Newyork, 2011

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	utilize the appropriate concepts and models to comprehend the basics of energy storage systems.	Applying (K3)
CO2	apply the principle of thermal and mechanical storage systems to explain the working and the recent advancements in thermal and mechanical storagesystems.	Applying (K3)
CO3	ultilize the principle of operation of magnetic storage systems, electro-optic, optical and chemical storage systems to illustrate the respective process under gone in these techniques.	Applying (K3)
CO4	explain the principle of operation of electrochemical storage device and materials used and to elucidate the construction and working of various types of high energy storage batteries.	Applying (K3)
CO5	make use of various techniques to construct different types of fuel cells and to explain the advanced techniques involved in hydrogen storage systems and also to explain the principle and working of super capacitors.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2						2	2		2		
CO2	3	2	2						2	2		2		
CO3	3	2	2						2	2		2		
CO4	3	2	2						2	2		2		
CO5	3	2	2						2	2		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22PHO03 - STRUCTURAL AND OPTICAL CHARACTERIZATION OF MATERIALS
(Offered by Department of Physics)

Programme& Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course aims to impart the essential knowledge on the characterization of materials using X-ray diffraction, Raman spectroscopy, UV-visible spectroscopy, Electron microscopy and Scanning tunneling microscopy and their application in various engineering fields, and also provides motivation towards innovations.	
Unit – I	**Introduction to Characterization Techniques and X-Ray Diffraction:**	**9+3**
Importance of materials characterization – Classification of characterization techniques – Crystalline materials – Reciprocal lattice – Theory of X-ray diffraction – Powder and Single crystal X-ray diffraction: Instrumentation (qualitative), XRD pattern, systematic procedure for structure determination (qualitative), crystallite size determination (Scherrer equation), strain calculation – Applications.		
Unit – II	**Electron Microscopy:**	**9+3**
Need of electron microscopy – Electron specimen interaction: Emission of secondary electrons, backscattered electrons, characteristic X-rays, transmitted electrons, specimen interaction volume – Resolution – Scanning electron microscope and transmission electron microscope: Schematic diagram and working – Different types of filaments–Field emission scanning electron microscope –Wavelength dispersive X-ray analysis – Three parameter equation for quantitative composition analysis.		
Unit – III	**Scanning Tunneling Microscopy:**	**9+3**
Introduction to quantum mechanical tunneling – Basic principles of scanning tunneling microscopy – Two modes of scanning: constant height mode and constant voltage mode –Instrumentation and working – Applications.		
Unit – IV	**Raman Spectroscopy:**	**9+3**
Introduction – Pure rotational Raman spectra – Vibrational Raman spectra – Polarization of light and Raman effect – Structure determination – Instrumentation and working –Near-Infra-Red Raman Spectroscopy – Applications.		
Unit – V	**Ultra Violet &Visible Spectroscopy:**	**9+3**
Regions of UV-Visible radiation – Colour and light absorption –Chromophore concept – Beer's and Lambert's laws – Theory of electronic transition – Frank-Condon principle – Instrumentation and working – Applications.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Cullity B. D. and Stock S. R, Elements of X-ray diffraction, 3rd Edition, Pearson Education, India, 2003 (Unit I)
2.	Banwell C. N, McCash E. M, Choudhury H. K, Fundamentals of Molecular Spectroscopy, 5th Edition, Tata McGraw-Hill Publ., New Delhi, 2013 (Unit II-V)

REFERENCES:

1.	Holt D. B. and Joy D. C, SEM micro characterization of semiconductors, 1st Edition, Academic Press, New Delhi, 1989
2.	Willard H. H., Merritt L. L., John A Dean, and Settle Jr. F. A, Instrumental methods of Analysis 7th Edition, Wadsworth Publishing Company, United States, 1988
3.	Elton N. Kaufman, Characterization of Materials (Volume1&2), 2nd, Wiley-Interscience, New Jersey, 2012

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply the concept of X-ray diffraction to determine the crystal structure and related structural parameters of materials.	Applying (K3)
CO2	determine the micro-structural parameters of materials and to perform surface analysis of materials using the concept of matter waves and electron microscopy.	Applying (K3)
CO3	utilize the concept and phenomenon of quantum mechanical tunneling to interpret the surface image recorded at atomic level using scanning tunneling microscopy.	Applying (K3)
CO4	make use of the concept of Raman effect and Raman spectroscopy to determine the crystal structure and related structural parameters of materials.	Applying (K3)
CO5	apply the theory of UV-Vis spectroscopy to comprehend the working of UV-Vis spectrophotometer.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2						2	2		2		
CO2	3	2	2						2	2		2		
CO3	3	2	2						2	2		2		
CO4	3	2	2						2	2		2		
CO5	3	2	2						2	2		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	25	35	40				100
CAT3	30	30	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22CYO01 - INSTRUMENTAL METHODS OF ANALYSIS

(Offered by Department of Chemistry)

Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	Instrumental methods of analysis aim to prepare the students to have all-encompassing knowledge of spectral methods in order to identify the molecules and reaction mechanism for the process to enhance application towards the industries.	
Unit – I	**Absorption and Emission Spectroscopy**	**9+3**
Basic concepts of Absorption and Emission Spectroscopy – representation of spectra – basic elements of practical spectroscopy – signal to noise ratio - techniques for signal to noise enhancement – resolving power – Fourier transform spectroscopy – evaluation of results – basic principles, instrumentation and applications of Atomic Absorption, Atomic Fluorescence and Atomic Emission Spectroscopy.		
Unit – II	**IR, Raman and NMR Spectroscopy**	**9+3**
Infrared Spectroscopy – correlation of IR Spectra with molecular structure, instrumentation, samplings technique and quantitative analysis. Raman Spectroscopy – Classical and Quantum theory instrumentation, Structural analysis and quantitative analysis. Nuclear Magnetic resonance Spectroscopy – basic principles – pulsed Fourier transform NMR spectrometer – Structural elucidation using NMR spectra and quantitative analysis.		
Unit – III	**Surface Studies**	**9+3**
Surface Study – X-Ray Emission Spectroscopy (XES), X- Ray Photo Electron Spectroscopy (XPS) - Auger Electron Spectroscopy (AES) - Transmission Electron Microscopy (TEM) - Scanning Electron Microscopy (SEM) - Surface Tunneling Microscopy (STEM) - Atomic Force Microscopy (AFM).		
Unit – IV	**Mass Spectroscopy**	**9+3**
Mass spectroscopy – Ionization methods in mass spectroscopy – mass analyzer – ion collection systems - correlation of molecular spectra with molecular structure - Instrumentation design and application of Fourier Transform Mass Spectroscopy (FT-MS) and Ion Microprobe Mass Analyzer (IMMA).		
Unit - V	**Thermal Analysis**	**9+3**
Thermal Analysis: principles and instrumentations and applications of Thermogravimetry (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), evolved gas detection, Thermo Mechanical Analysis and Thermometric Titration.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Chatwal. G. R., Anand, Sham K., “Instrumental Methods of Chemical Analysis” 5th Edition, Himalaya Publishing House, 2019.

REFERENCES:

1.	B.K. Sharma, Instrumental Method of Chemical Analysis, Krishna Prakashan Media (P) Ltd. 2019.
2.	Willard,H.H, Merritt,L.L, Dean,J.A, and Settle, F.A, “Instrumental methods of analysis” CBS Publishers & Distributors, 7 Ed, 2004.
3.	Kaur. H, “Instrumental Methods of Chemical Analysis”, XII Edition, Pragati prakashan, Meerat, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	illustrate the basics of spectroscopy to understand the instrumentation of various spectral techniques.	Understanding (K2)
CO2	apply the IR, Raman and NMR for quantitative analysis of the sample.	Applying (K3)
CO3	apply the various techniques for the better understanding of surface morphology.	Applying (K3)
CO4	explain the principle, instrumentation of mass spectroscopy for the analysis of organic sample.	Understanding (K2)
CO5	illustrate the thermal analysis for the identification of thermal stability of the compounds.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	1												
CO5	3	1												

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO02 - CHEMISTRY CONCEPTS FOR COMPETITIVE EXAMINATIONS
(Offered by Department of Chemistry)

Programme & Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	This course aims to refresh the knowledge of chemistry required for competitive examinations and equip the students with a capacity to solve the problems in chemistry while participating various competitive examinations including TNFUSRC-FORESTER (paper-II: General science-chemistry), UPSC-IAS (prelims: General science-chemistry), GATE (thermodynamics concept for chemical & mechanical engineering).	
Unit – I	**Periodic Classification of Elements**	**9+3**
Mendeleev's periodic table-Law and classification of elements- Modern periodic law-Modern periodic table and its characteristics - Periodic properties – important aspects of s, p & d block elements -Reactivity series and Uses - Alloys-Uses of Alloys- Properties of nano metals and oxides.		
Unit – II	**Chemical Equations and Bonding**	**9+3**
Chemical Equations: Types of ions and radicals- oxidation and reduction-redox reactions - balancing ionic equations. **Chemical Bonding:** Octet rule -types of chemical bond -formation of ionic and covalent bond- common properties of ionic and covalent compounds- differences between ionic and covalent compounds-Coordinate covalent bond- Coordination compounds – nomenclature and isomerism - application in analytical chemistry.		
Unit – III	**Acids, Bases, Salts and Metallurgy**	**9+3**
Acid- base theory – Bronsted- Lowry theory- conjugate acid-base- Lewis concept- HSAB- applications- pH scale- Importance of pH in everyday life-salts-classification of salts-uses of salts. **Metallurgy:** introduction-terminologies in metallurgy-differences between minerals and ores-occurrence of metals- metallurgy of aluminum, copper and iron.		
Unit – IV	**Carbon and its Compounds**	**9+3**
Introduction-compounds of carbon-modern definition of organic chemistry- bonding in carbon and its compounds-allotropy-physical nature of carbon and its compounds-chemical properties of carbon compounds-homologous series-hydrocarbons and their types-functional groups- classification of organic compounds based on functional group-ethanol-ethanoic acid.		
Unit – V	**Thermodynamics**	**9+3**
Introduction- some important terms in thermodynamics-thermodynamic system, process, properties and energy- first law of thermodynamics: mathematical expression and interpretation- applications of first law of thermodynamics-molar heat capacity-reversible isothermal expansion/compression of an ideal gas-adiabatic expansion of an ideal gas-isobaric and isochoric processes in ideal gases- second laws of thermodynamics: entropy- entropy change for isolated system (system and surroundings)- entropy change for system only (ideal gas)- entropy change for mixing of ideal gases-entropy of physical changes- entropy of chemical changes-Maxwell relations.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Steven S. Zumdahl, Susan A. Zumdahl and Donald J. DeCoste , "Chemistry", 10th Edition, Cengage Learning, 2018., for Units-I, II, III, IV.
2.	Wiley editorial board. "Wiley Engineering Chemistry". 2nd Edition, Wiley India Pvt. Ltd, New Delhi, Reprint 2019, for Units- I, II, III, V.

REFERENCES:

1.	B.R. Puri, L.R. Sharma, Principles of Inorganic Chemistry, 33rd Edition, Vishal Publishing Co., 2020.
2.	Paula Bruise, "Organic Chemistry", 8th Edition, Pearson Education, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the basic concept of periodic classification of elements to explain the periodic properties and reactivity series of s, p & d block elements.	Applying (K3)
CO2	utilize the concepts of chemical equation and bonding to solve the problems in balancing ionic equation and differentiate ionic and covalent compounds.	Applying (K3)
CO3	apply the concept of acid, base, salts and metallurgy to explain HSAB concepts, Importance of pH in everyday life, classification of salts and metallurgy of Al, Cu & Fe.	Applying (K3)
CO4	make use of the concept of carbon and its compounds to explain bonding and classification of carbon compounds.	Applying (K3)
CO5	utilize the important terms and concepts of thermodynamics to explain the first law and second law of thermodynamics with examples.	Applying (K3)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	2	1											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO03 – ORGANIC CHEMISTRY FOR INDUSTRY

(Offered by Department of Chemistry)

Programme & Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	Organic Chemistry for Industry aims to equip the students to have wide-range knowledge on organic chemistry in order to meet the industrial needs.	
Unit – I	**Basic aspects of Organic Chemistry**	**9+3**
Organic intermediates: carbocations, carbanions, free radicals, carbenes and nitrenes, their method of formation, stability and synthetic applications- Nucleophilic uni- and bimolecular reactions (SN1 and SN2)- Elimination reactions (E1 & E2; Hoffman & Saytzeff's rule).		
Unit – II	**Molecular Rearrangements**	**9+3**
Reactions involving electron deficient, carbon, nitrogen, oxygen centers, emphasis on synthetic utility of the rearrangements - Migration of carbon: Wagner-Meerwein, Pinacol-pinacolone, benzyl-benzilic acid rearrangement – Migration of nitrogen: Beckmann rearrangement, Hofmann, Curtius, Lossen rearrangements- Migration of oxygen: Bayer-Villiger oxidation.		
Unit – III	**Synthetic Reagents & Applications**	**9+3**
Lithium aluminium hydride- sodium borohydride- selenium-di-oxide- osmium tetroxide- phenyl isothiocyanate- N-bromosuccinamide (NBS)- lead tetraacetate - dicyclohexylcarbodiimide (DCC) – pyridinium chlorochromate (PCC) – Swern oxidation –p-toluenesulphonyl chloride – trifluoroacetic acid- lithium diisopropylamide (LDA) – 1,3- dithiane (reactive umpolung) - crown ethers-Trimethyl silyl iodide - dichlorodicyanobenzoquinone (DDQ) – Gilman reagent– phase transfer catalysts- Wilkinson's catalysts.		
Unit – IV	**Unit Operations**	**9+3**
Extraction: Liquid equilibria-extraction with reflux-extraction with agitation-counter current extraction. **Filtration:** Theory of filtration-pressure and vacuum filtration-centrifugal filtration. **Distillation:** Azeotropic and steam distillation. **Evaporation**: Types of evaporators-factors affecting evaporation. **Crystallization:** Crystallization from aqueous-non- aqueous solutions factors affecting crystallization-nucleation.		
Unit – V	**Unit Processes**	**9+3**
Nitration: Nitrating agents-aromatic nitration-kinetics and mechanism of aromatic nitration- process equipment for technical nitration-mixed acid for nitration. **Halogenation:** Kinetics of halogenations-types of halogenations-catalytic halogenations-Case study on industrial halogenation process.**Fermentation**: Aerobic and anaerobic fermentation. Production of Antibiotics: Penicillin and Streptomycin-Production of Vitamins: B2 and B12.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	P.S.Kalsi," Organic Reactions and their Mechanisms", 5th Edition, New Age International publishers, 2020, for Unit-I, II, III, V.
2.	Arun Bahl, B.S.Bahl, "Advanced Organic Chemistry", 6th Edition, S Chand, 2022, for Unit-IV, V.

REFERENCES:

1.	V.K.Ahluwalia, Rakesh Parashar, "Organic Reaction Mechanisms" Fourth Edition, 2011
2.	Jonathan Clayden, Nick Greeves, Stuart Warren, "Organic Chemistry", 2nd Edition, Oxford University Press, 2014.
3.	Paula Yurkanis Bruice, "Organic Chemistry",8th Edition, Pearson, 2020.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	illustrate the basic concept of organic intermediates to explain the SN1, SN2, E1 and E2 reactions.	Understanding (K2)
CO2	utilize the concepts of molecular rearrangement to explain reactions involving electron deficient, carbon, nitrogen, oxygen centers, emphasis on synthetic utility of the rearrangements.	Applying (K3)
CO3	select the suitable synthetic regents for various functional group conversions in organic synthesis.	Applying (K3)
CO4	make use of the concept of extraction, filtration, distillation, evaporation, crystallization for the purification of organic compounds.	Applying (K3)
CO5	apply the concept of nitration, halogenations and fermentation to explain the industrial unit process.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22MAO05 - GRAPH THEORY AND ITS APPLICATIONS							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	To develop rigorous logical thinking and analytical skills by graph theoretic concepts which helps for solving real time engineering problems in networks, computer architecture, compiling techniques, model checking, artificial intelligence, software engineering, expert systems, software/hardware correctness problem.	
Unit – I	**Graphs:**	**9+3**
Introduction – Definition – Types of graphs – Degree of vertex – Walk, path and cycle – Isomorphism – Connected graph – Hamiltonian graph – Euler graph – Digraph - Shortest paths – Shortest path algorithms: Dijkstra's algorithm – Warshall's algorithm.		
Unit – II	**Trees:**	**9+3**
Introduction – Properties of trees – Pendant vertices in a tree – Distances and centers in a tree – Rooted and binary trees – Spanning tree – Construction of spanning tree: BFS algorithm – DFS algorithm - Minimum Spanning tree – Minimal spanning tree algorithms: Prim's algorithm – Kruskal's algorithm.		
Unit – III	**Graph Coloring:**	**9+3**
Vertex coloring – Chromatic number – Chromatic partitioning – Independent sets – Chromatic polynomial – Matching – Covering – Four color problem (statement only) – Simple applications.		
Unit – IV	**Matrix Representation and Applications:**	**9+3**
Matrix Representation: Incidence matrix – Circuit matrix - Cut-set matrix – Path Matrix – Adjacency matrix – Properties - The Chinese Postman Problem – Fleury's Algorithm – Travelling salesman problem.		
Unit – V	**Network Flows and Applications:**	**9+3**
Flows and cuts in networks - Max-flow Min-cut Theorem – Transport networks –Residual capacity and Residual network – Ford-Fulkerson Algorithm – Edmonds-Karp Algorithm – Maximal Flow Applications: Multiple sources and sinks – Maximum Bipartite matching.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", 1st Edition, Dover Publications, New York, 2016 for Units I, II, III.
2.	S. Saha Ray, "Graph Theory with Algorithms and Its Applications in Applied Science and Technology", 1st Edition, Springer, London, 2013 for Units IV,V.

REFERENCES:

1.	Douglas B West, "Introduction to Graph Theory", 2nd Edition, Pearson Education, New Delhi, 2002.
2.	Jonathan L. Gross and Jay Yellen, "Graph Theory and its Applications", 2nd Edition, CRC Press, New York, 2006.
3.	J.A.Bondy and U.S.R. Murty ,Graph Theory and Applications , 5th Edition, Elsevier Science Publishing Co., Inc., New York,1982.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply basic graph theoretic concepts in finding shortest path.	Applying (K3)
CO2	intrepret the concepts of tress and its types.	Applying (K3)
CO3	compute the Chromatic partition, Chromatic polynomial and Matching of a given graph.	Applying (K3)
CO4	apply the concepts of matrix representation of graph structures.	Applying (K3)
CO5	identify the maximal flow in network by means of suitable algorithms.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1											
CO2	3	1												
CO3	3	1												
CO4	3	2	2											
CO5	3	2	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MAX01 - DATA ANALYTICS USING R PROGRAMMING							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**0**	**2**	**4**

Preamble	To impart the basic knowledge in R and develop skills to apply the knowledge of R programming to statistical measures, data handling, probability, testing of hypothesis and design of experiments.	
Unit – I	**Introduction to R:**	**9**
Overview of R programming – Need for R – Installing R – Environment setup with R Studio – Packages: Installing packages – Running and manipulating packages – Basic objects: Vectors – Matrix – Array – Lists – Factors – Data frames.		
Unit – II	**R Programming Structures and Functions:**	**9**
Basic expressions: Arithmetic expressions – Control Statements: if and if-else statements –– switch statement – Loops: for loop – while loop – Function: Creating a function – calling a function – Default value for function arguments – Logical functions – Math functions – Statistical functions – Apply-family functions – Getting started with strings – Formatting data and time.		
Unit – III	**Descriptive Statistics:**	**9**
Summary command – Summarizing samples – cumulative statistics – summary statistics for data frames – summary tables – Linear Modeling: Simple linear regression – Multiple regression – Curvilinear regression – Plotting linear models and curve fitting.		
Unit – IV	**Working with data:**	**9**
Reading and writing data: Text-format in a file – Excel worksheets – Native data files – built-in datasets. Visualizing data: Scatter plots – line plots – bar charts – pie charts – Cleveland dot charts –Histogram and density plots – Box-whisker plots.		
Unit – V	**Probability Distributions, Testing of hypothesis and ANOVA:**	**9**
Probability Distributions: Binomial Distribution – Poisson Distribution – Normal Distribution. Testing of Hypothesis and ANOVA: Student's t-test – Non-Parametric tests: Wilcoxon U-test – Paired t and U-tests – Correlation and covariance – Tests for association – Analysis of variance: One-way ANOVA – Two-way ANOVA.		

List of Exercises / Experiments:

1.	Implementation of operations of data objects such as vector, list and matrix.
2.	Implementation and use of array, factors and data frames in R.
3.	Programs using decision making statements and looping structures.
4.	Programs to demonstrate programming concepts using functions (Using built-in and user-defined functions)
5.	Performing various basic statistical measures for the given data.
6.	Calculate the regression coefficient and obtain the lines of regression for the given data.
7.	Creating and reading various types of data files.
8.	Create different charts for visualization of given set of data.
9.	Computation of probability using Binomial, Poisson and Normal distributions.
10.	Perform the t-test for testing significance of mean.
11.	Perform various non-parametric tests for the given sample data.
12.	Perform One way and two way ANOVA.

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Kun Ren, "Learning R Programming", 1st Edition, Packt Publishing Ltd, UK, 2016 for Units I, II.
2.	Mark Gardener, "Beginning R-The Statistical Programming Language",1st Edition, John Wiley & Sons,Inc, USA, 2012 for Units III,IV, V.

REFERENCES:

1.	Seema Acharya, "Data Analytics using R", 1st Edition, McGraw Hill Education, Chennai, 2018.
2.	Norman Matloff, "The Art of R Programming", 1st Edition, No Starch Press, San Francisco, 2011.
3.	Paul Teetor, "R Cookbook", 1st Edition, O'Reilly Media, USA, 2011.
4.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the basics of fundamentals of R.	Understanding (K2) Manipulation (S2)
CO2	apply the concepts of decision, looping structures and functions in real time problems.	Applying (K3) Manipulation (S2)
CO3	apply R programming to descriptive statistics.	Applying (K3) Manipulation (S2)
CO4	apply the libraries for data manipulation and data visualization in R.	Applying (K3) Manipulation (S2)
CO5	use R studio to identify the probability and test statistical hypothesis.	Applying (K3) Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1											
CO2	3	1	1		2									
CO3	3	2	2	2	2									
CO4	3	3	2	3	2									
CO5	3	2	2	3	2									

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MAO06 - OPERATIONS RESEARCH								
(Offered by Department of Mathematics)								
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	To provide the skills for solving the real time engineering problems involving linear objective functions, transportation models and also impart knowledge in finding optimal solutions to problems involving limited resources, project management techniques and game theoretic concepts.	
Unit – I	**Linear Programming:**	**9+3**
Introduction to Operations research – Applications of OR – Linear Programming – Formation of Linear Programming Problem – Solution of LPP: Basic concepts – Graphical Solution – Simplex method – Artificial techniques: Big M method.		
Unit – II	**Transportation and Assignment Problems:**	**9+3**
Transportation Problem: Introduction – Mathematical formulation – Solution of transportation problem: Initial basic feasible solution: North-West Corner Rule – Vogel's Approximation Method – Optimal Solution: MODI method. Assignment Problems: Introduction – Mathematical Formulation – Hungarian Algorithm.		
Unit – III	**Game Theory:**	**9+3**
Introduction – Basic Terminology – Two-Person zero sum games – Pure strategies (Games with saddle point) – Mixed Strategies (Games without saddle points) – Rule of Dominance – Solution of Mixed Strategy games: Algebraic method – Arithmetic method – Graphical method.		
Unit – IV	**Sequencing models:**	**9+3**
Sequencing problems: Introduction – Johnson's algorithm – Processing of n jobs through two machines – Processing of n jobs through three machines – Processing of 'n' jobs through 'm' machines - Processing of two jobs through 'm' machines.		
Unit – V	**Network and Project Management:**	**9+3**
Introduction – Basic terminology **–** Rules of Network construction– Fulkerson's Rule for numbering of events – Construction of network – Critical Path Method (CPM) – Programme Evaluation and Review Technique (PERT).		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Sharma J.K, "Operations Research – Theory and Applications", 6th Edition, Trinity Press, India, New Delhi, 2017.

REFERENCES:

1.	Taha, Hamdy A., "Operation Research: An introduction", 9th edition, Pearson Education, 2010.
2.	Hiller, Frederick. S. and Lieberman, Gerald. J., "An introduction to Operations research- concepts and cases", Tata McGraw Hill (SIE) 8th edition, 2005.
3.	Ravindran, A., Phillips, D.J., and Solberg, J.J., "Operations Research- Principles and Practice", John Wiley & Sons, 2005.
4.	Kanti Swarup, P.K. Gupta, Man Mohan, "Operations Research", 15th revised Edition, S. Chand & Sons Education Publications, New Delhi, 2017.
5.	Gupta P.K. and Hira D.S., "Operations Research: An Introduction", 7th Revised Edition, S.Chand and Co. Ltd., New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	formulate and solve linear programming problems.	Applying (K3)
CO2	apply transportation and assignment algorithms in engineering problems.	Applying (K3)
CO3	use game theory concepts in practical situations.	Applying (K3)
CO4	identify the minimum processing times for sequencing problems	Applying (K3)
CO5	apply the concepts of CPM and PERT in scheduling the project networks.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	2	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	70				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MAO07 - NUMBER THEORY AND CRYPTOGRAPHY							
(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	To provide the skills for applying various number theoretic algorithms, congruences, primality tests in cryptography and network security and impart knowledge of basic cryptographic techniques.	
Unit – I	**Divisibility Theory:**	**9+3**
Division algorithm – Base-b representations – Number patterns – Prime and composite numbers – GCD – Euclidean Algorithm – Fundamental theorem of Arithmetic – LCM.		
Unit – II	**Theory of Congruences:**	**9+3**
Basic concepts – Properties of congruences – Linear congruences – Solution of linear congruences – Fermat's Little theorem – Chinese remainder theorem.		
Unit – III	**Number Theoretic Functions:**	**9+3**
Introduction – Functions τ and σ – Mobius function – Greatest integer function – Euler's Phi function – Euler's theorem – Properties of Euler's function – Applications to Cryptography.		
Unit – IV	**Primality testing and Factorization:**	**9+3**
Primality testing: Fermat's pseudo primality test – Solvay-Strassen test – Fibonacci test – Lucas test – Integer factorization: Trial division – Pollard's Rho method – Quadratic sieve method.		
Unit – V	**Classical Cryptographic Techniques:**	**9+3**
Introduction – Substitution techniques – Transposition techniques – Encryption and decryption – Symmetric and asymmetric key cryptography – Steganography.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Thomas Koshy, "Elementary Number Theory with Applications", 2nd Edition, Academic Press, Elsevier, USA, 2007 for Units I ,II, III.
2.	William Stallings, "Cryptography and Network Security: Principles and Practice", 7th Edition, Pearson Education, New Delhi, 2019 for Units IV,V.

REFERENCES:

1.	Ivan Niven, Herbert S. Zukerman, Hugh L. Montgomery, "An Introduction to the Theory of Numbers", Reprint Edition, John Wiley & Sons, New Delhi, 2008.
2.	Bernard Menezes, "Cryptography and Network Security", Cengage Learning India, 1st Edition, New Delhi, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the concepts of divisibility and canonical decompositions.	Understanding (K2)
CO2	obtain the knowledge in theory of congruences and solution of linear congruences.	Understanding (K2)
CO3	use different number theoretic function suitably in cryptography.	Applying (K3)
CO4	apply Primality test and factorisation algorithms to network security problems.	Applying (K3)
CO5	apply the suitable cryptographic techniques to handle real time security issues.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	3	1												
CO3	3	1												
CO4	3	2	1		2									
CO5	3	2	1		2									

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	60				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22PHO04-SYNTHESIS, CHARACTERIZATIONAND BIOLOGICAL APPLICATIONS OF NANOMATERIALS
(Offered by Department of Physics)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course aims to impart the knowledge on the fundamentals of nanomaterials, synthesis of nanomaterials, analysis of nanomaterials, carbon tubes and biological applications of nanomaterials.	
Unit – I	**Introduction to nanomaterials**	**9+3**
Nanoscience and nanotechnology–Scientific revolution – Nanoscale – Nanosized effects – Surface-to-volume ratio – Quantum confinement effect – Classification of nanomaterials based on dimension– Properties of nanomaterials – Metal nanoparticles – Ceramic nanoparticles – Semiconductor nanoparticles – Polymer nanomaterials.		
Unit – II	**Synthesis of nanomaterials**	**9+3**
Physical, chemical and mechanical methods of preparation – Top down approaches and bottom up approaches –Physical Vapor Deposition method – Colloidal precipitation method – Sol-Gel method – Chemical precipitation method –Green synthesis method of nanomaterials.		
Unit – III	**Characterization of nanomaterials**	**9+3**
X-ray diffraction analysis – Grain size calculation – Lattice parameters - Cell volume –Photoluminescence analysis – Emission peak analysis – UV visible spectroscopy analysis – Bandgap estimation – HRTEM & AFM analysis (qualitative) – particle size analysis – BET (qualitative).		
Unit – IV	**Carbon nanotubes**	**9+3**
Allotropes of carbon – Diamond – Graphite – Graphene – Fullerenes – Carbon nanotubes – Properties – SWCNT – MWCNT – Structure of Carbon nanotubes – Preparation: Laser ablation method – CVD – Applications.		
Unit – V	**Biological applications**	**9+3**
Antibacterial activity – Mechanism – Antifungal activity – Microorganism– Gram positive bacteria – Gram negative bacteria – Disc diffusion method – Antioxidant activity – DPPH method – Anticancer activity – Cytotoxity – MTT method–Toxicity of nanoparticles.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1. Charles P Poole Jr., and Frank J. Ownes ,. “Introduction to Nanotechnology”, John Wiley Sons, Inc., 2003.

REFERENCES:

1. C. Kittel., “Introduction to Solid State Physics”, Wiley Eastern Ltd., (2005).
2. Tamilarasan K. and Prabu K., “Materials Science”, 1st Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	describe the properties of nanomaterials using concepts such as surface to volume ratio and quantum confinement and also able to classify nanomaterials.	Applying (K3)
CO2	explain the synthesis of nanomaterials using select physical and chemical methods.	Applying (K3)
CO3	explain the characterization of nanomaterials using XRD, UV-vis, HRTEM & AFM and BET.	Applying (K3)
CO4	Illustrate the preparation of CNT and their applications.	Applying (K3)
CO5	explore the biological applications of nanomaterials such as antibacterial activity, antifungal activity, antioxidant activity and anticancer activity.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2						2	2		2		
CO2	3	2	2						2	2		2		
CO3	3	2	2						2	2		2		
CO4	3	2	2						2	2		2		
CO5	3	2	2						2	2		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	20	50	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22PHO05 - TECHNIQUES OF CRYSTAL GROWTH
(Offered by Department of Physics)

Programme& Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	1	0	4

Preamble	This course aims to impart the knowledge on crystals, physics of crystal growth and crystal growth methods.	
Unit – I	**Introduction to Crystals**	**9+3**
Classification of solids –Crystalline and amorphous – Single and polycrystalline materials – Space lattice – Bravais lattice – Lattice planes – Miller indices – Indices of crystal direction – Symmetry –Symmetry elements in cubic crystal –Physical properties.		
Unit – II	**Theories of Crystal Growth**	**9+3**
Phase rule – Phase diagrams – Binary phase diagrams – Alloy and compounds –Binary system with complete solid solution and no solid solution (eutectic) – Invariant reactions – Eutectic, peritectic and peritectoid (qualitative) – Nucleation concept – Homogeneous, heterogeneous nucleation – Classical theory – Energy of formation of nucleus – Kinetic theory of nucleation (qualitative)–Atmospheric nucleation.		
Unit – III	**Melt growth**	**9+3**
Bulk crystal growth methods –Melt growth methods –Bridgman (vertical and horizontal) and Czochralski methods – Liquid encapsulated technique (LEC) for semiconductors – Vermeil growth technique for growing gem crystals – Zone melting.		
Unit – IV	**Solution growth**	**9+3**
Low temperature solution growth – High temperature solution growth – Electro crystallization – Crystal growth in gel – Growth of biological crystals – Hydrothermal technique.		
Unit – V	**Vapour growth**	**9+3**
Physical vapour transport –chemical vapour transport. Epitaxial growth techniques – Liquid phase epitaxy – Vapour phase epitaxy: chloride, hydride, metalorganic – Molecular beam epitaxy – Chemical beam epitaxy.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Introduction to Crystallography Philips, Read Books (9 June 2011), India.

REFERENCES:

1.	B. D. Cullity Addison, Elements of X-ray diffraction, Wesley Publishers, 1977.
2.	Santhana Raghavan and Dr. P. Ramasamy, Crystal growth processes and methods, KRU publications, 1999.
3.	Leonid V. Azaroff, Introduction to Solids, Tata McGraw Hill Publishing Company.
4.	C. Kittel Wiley, Introduction to Solid State Physics, Eastern University Edition.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	describe the physical properties of crystals using the concepts of crystalline materials, amorphous material, space lattice, unit cell, Miller indices and crystal symmetry.	Applying (K3)
CO2	explain nucleation in crystal growth using the concepts of phase diagrams and formation energy.	Applying (K3)
CO3	demonstrate the growth of bulk crystalsusing melt growth techniques.	Applying (K3)
CO4	demonstrate the growth of crystalsusing solution growth techniques.	Applying (K3)
CO5	comprehend the growthof epitaxy crystal using vapour growth techniques.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2						2	2		2		
CO2	3	2	2						2	2		2		
CO3	3	2	2						2	2		2		
CO4	3	2	2						2	2		2		
CO5	3	2	2						2	2		2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	20	50	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

22CYO04 - CORROSION SCIENCE AND ENGINEERING
(Offered by Department of Chemistry)

Programme & Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	Corrosion science and engineering aims to equip the students to have a wide-range of knowledge on corrosion and prevention methods in order to meet the industrial needs.	
Unit – I	**Corrosion and its Units**	**9+3**
Introduction- electro chemical mechanism Vs chemical mechanism - emf series and Galvanic series – galvanic corrosion – area effect in anodic and cathodic metal coatings – prediction using emf series and galvanic series - Pilling Bedworth's ratio and it consequences (Problems) – units of corrosion rate: mdd (milligrams per square decimeter per day), mmpy (millie miles per year) and mpy (mils per year) –- importance of corrosion prevention in various industries: direct and indirect effects of determining corrosion rates - weight loss method, weight gain method and chemical analysis of solution.		
Unit – II	**Thermodynamics of Corrosion**	**9+3**
Electrode potentials, Electrical double layer, Gouy−Chapman model, Stern model, Bockris – Devanathan−Müller model - free energy and oxidation potential - criterion of corrosion (Problems) - basis of Pourbaix Diagrams - Pourbaix diagrams of water, magnesium, aluminium and Iron - limitations and applications.		
Unit – III	**Kinetics of Corrosion**	**9+3**
Electrochemical polarization – Evan's diagram – activation polarization – concentration polarization - mixed potential theory(Wagner and Traud) – application of mixed potential theory – effect of metal in acid solution – cathodic protection of iron in acid solution – effect of cathodic reaction – effect of cathodic area – passivity – Flade potential – theories of passivity - adsorption theory – oxide film theory – film sequence theory.		
Unit – IV	**Types of Corrosion**	**9+3**
Introduction - (i) Crevice - differential aeration corrosion (ii) pitting – mechanism and factors (iii) intergranular- chromium depletion theory, weld decay and knife line attack (iv) stress - SCC mechanism, corrosion fatique- Cavitation damage – fretting damage (v) stray current corrosion - causes and its control.		
Unit - V	**Prevention of Corrosion**	**9+3**
Inhibitors – types of inhibitors, chemisorption of inhibitors, effect of concentration, effect of molecular structure, vapour phase inhibitors – prevention of corrosion at the design stage and in service conditions – control of catastrophic oxidation and hydrogen disease – Langelier saturation index and its uses - corrosion prevention by surface coatings – phosphating and its uses -principles and procedures of cathodic protection: sacrificial anodes and external cathodic current impression- painting, vitreous enamels, plastic lining.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	E. McCafferty, Introduction to Corrosion Science,2nd Edition, Springer, 2017.

REFERENCES:

1.	R. Winston, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering, Revised 4th Edition, Wiley publisher, 2008.
2.	Fontanna, "Corrosion Engineering", (Materials Science and Metallurgy series), McGraw Hill international Ed., 2005.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	illustrate the mechanism, expression of rate of corrosion and importance of corrosion studies to familiarize for industrial needs.	Understanding (K2)
CO2	demonstrate the thermodynamics and kinetics of different models of corrosion with respect to the environment.	Applying (K3)
CO3	utilize the theories of corrosion to interpret with the real time applications.	Applying (K3)
CO4	organize the various types of corrosion to understand the corrosion problems.	Applying (K3)
CO5	summarize the corrosion prevention methods to avoid corrosion related issues.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	1												

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO05 - CHEMISTRY OF COSMETICS IN DAILY LIFE

(Offered by Department of Chemistry)

Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course aims to provide knowledge on chemistry of cosmetics for engineering students.	
Unit - I	**Formulation of Cosmetic Product**	**9+3**
Introduction - basic sciences of cleansing – surfactant and adsorption, surfactant micelles, surfactants and cleansing, surfactants and foam (foam formation, stability, drainage, rupture and collapse and defoaming) - basics of dispersions - electrical charges associated with surfaces and barriers – basics of emulsion (stability, Ostwald ripening, prevention of creaming and sedimentation).		
Unit - II	**Structuring Materials and Regulation for Cosmetics**	**9+3**
Introduction - water/hydrophilic base materials, oleaginous/hydrophobic base materials and amphiphilic substances - adding functions and effects - materials that add or improve functional value, emotional value and materials for quality control – cosmetic and personal care product safety – potential contaminants in cosmetics – regulations related to cosmetics – cosmetic regulation in india - future challenges in cosmetics material development.		
Unit - III	**Polymers in Cosmetic Products**	**9+3**
Polymers in Cosmetics - polymer solubility and compatibility, polymer conformation - polymers that modify surfaces - film-forming polymers in cosmetics and personal care products - hair-conditioning polymers - polymers for the treatment of skin - polymers as controlled release matrices - dendritic polymers - polymeric antimicrobials and bacteriostats.		
Unit - IV	**Natural Products and Fragrance in Cosmetics**	**9+3**
Introduction – natural products – extraction methods - encapsulation and controlled release - allergens in cosmetics – testing for allergens - aroma chemicals - fragrance creation and duplication - fragrance applications -– malodor – fragrance allergies and sensitivities.		
Unit - V	**Preparation of Cosmetics**	**9+3**
Cosmetics in day to day life – characteristics, types, formulation, preparation and evaluation methods of lipstick, shampoo, powder, nail lacquer, creams, toothpaste and hair dye.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Kazutami Sakamoto, Robert Y. Lochhead, Howard I. Maibach, Yuji Yamashita, Cosmetic Science and Technology: Theoretical Principles and Applications, Elsevier, 2017 , for Units- I, II, III, IV, V.
2.	Gaurav Kumar Sharma, Jayesh Gadiya, Meenakshi Dhanawat A text book of cosmetic formulation, 2018, for Unit-V.

REFERENCES:

1.	R.K. Nema, K.S. Rathore , B.K. Dubey, Textbook of Cosmetics, CBS Publishers and Distributors, 2017.
2.	Bruno Burlando, Elisa Bottini-Massa, LuisellaVerotta, Laura Cornara, Herbal Principles in Cosmetics: Properties and Mechanisms of Action, CRC Press, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the formulation of cosmetics products.	Understanding (K2)
CO2	identify the structuring materials and regulation involved in cosmetics development.	Applying (K3)
CO3	interpret the polymers and its role in cosmetics.	Understanding (K2)
CO4	develop knowledge about natural products and Fragrance in Cosmetics.	Applying (K3)
CO5	apply the knowledge of cosmetics to explain the characteristics, formulation, preparation and quality control of different cosmetic products used in day to day life.	Applying (K3)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	3	2	1											
CO3	3	1												
CO4	3	2	1											
CO5	3	2	1											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO06 – NANOCOMPOSITE MATERIALS
(Offered by Department of Chemistry)

Programme& Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course aims to equip the students to have knowledge on processing,characterization, properties, features and applications of nanocomposites.	
Unit – I	**Introduction of nanocomposites**	**9+3**
Introduction – nanocomposites – nanocomposites past and present – nomenclature – composite materials: introduction to solids - atomic and molecular solids – role of statistics in materials – primary, secondary and tertiary structure – transitions.		
Unit - II	**Properties and features of nanocomposites**	**9+3**
Properties: physics of modulus – continuum measurements – yield – fracture – rubbery elasticity and viscoelasticity – composites and nanocomposites – surface mechanical properties –diffusion and permeability – features of nanocomposites: basics of polymer nanocomposites - nano reinforcements – matrix materials – hazards of particles.		
Unit - III	**Processing of nanocomposites**	**9+3**
Viscosity: types of flow, experimental viscosity, non-newtonian flow -low-viscosity processing: solvent processing, particle behavior, in situ polymerization, post-forming, hazards of solvent processing - melt, high shear and direct processing: melting and softening, melt processes with small shears or low-shear rates flow, meltprocesses with large deformations or high-shear rates, thermo-kinetic processes.		
Unit - IV	**Characterization of nanocomposites**	**9+3**
Introduction to characterization – experiment design – sample preparation – imaging –structural characterization – scales in nanocomposites – texture – electromagnetic energy –visualization – physicochemical analysis – characterization of physical properties.		
Unit - V	**Applications of nanocomposites**	**9+3**
Nanocomposites – optical, structural applications – nanoparticulate systems with organic matrices – applications – biodegradable protein nanocomposites – applications-polypropylene nanocomposites – application as exterior automatic components – hybrid nanocomposite materials – application for corrosion protection.		
		Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Thomas E. Twardowski, “Introduction to Nanocomposite Materials – Properties, Processing, Characterization”, DesTech Publications, April 2007, for Units-I, II, III, IV.
2.	Klaus Friedrich, Stoyko Fakivov, Zhony Shang, “Polymer Composites from Nano – to Macro – scale”, Springer USA, 2005, for Units-I, II, V.

REFERENCES:

1.	Pulickel M. A, Linda S. S, Paul V.B, “Nanocomposite Science and Technology”, Wiley-VCH, 2006.
2.	Vikas Mittal, Characterization techniques for polymer nanocomposites, Wiley-VCH, 2012.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	identify the knowledge of nanocomposites and to explain its structure.	Applying (K3)
CO2	apply the knowledge on various properties and features of nanocomposites.	Applying (K3)
CO3	choose the various concepts involving in the processing of nanocomposites.	Applying (K3)
CO4	apply the acquired knowledge on characterization of nanocomposites.	Applying (K3)
CO5	organize the applications of nanocomposites in various fields.	Applying (K3)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

<table>
<tr><td colspan="8">22MAO08 - NON-LINEAR OPTIMIZATION</td></tr>
<tr><td colspan="8">(Offered by Department of Mathematics)</td></tr>
<tr><td>Programme & Branch</td><td>All B.E/.BTech Branches</td><td>Sem.</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td></tr>
<tr><td>Prerequisites</td><td>Nil</td><td>7</td><td>OE</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Preamble</td><td colspan="7">The course focuses on the basic concepts, various techniques and applications of engineering optimization.</td></tr>
<tr><td>Unit – I</td><td colspan="6">Classical Optimization Techniques:</td><td>9</td></tr>
<tr><td colspan="8">Introduction to Optimization – Statement of an Optimization problem – Mathematical formulation – Multi variable optimization with equality constraints – Lagrange multipliers method – Multi variable optimization with inequality constraint – Kuhn Tucker conditions.</td></tr>
<tr><td>Unit – II</td><td colspan="6">Non-Linear Programming: One-Dimensional Minimization Method:</td><td>9</td></tr>
<tr><td colspan="8">Introduction – Unimodal function – Elimination Methods: Unrestricted search – Exhaustive search – Dichotomous search – Interval halving method – Fibonacci method – Golden section method – Direct root methods: Newton method – Secant method.</td></tr>
<tr><td>Unit – III</td><td colspan="6">Non-Linear Programming: Unconstrained Optimization Techniques:</td><td>9</td></tr>
<tr><td colspan="8">Introduction to Unconstrained optimization – Direct Search Methods: Grid search method – Univariate method – Hookes and Jeeve’s method – Powell’s method.</td></tr>
<tr><td>Unit – IV</td><td colspan="6">Unconstrained Optimization Techniques (Indirect Methods):</td><td>9</td></tr>
<tr><td colspan="8">Gradient of a Function – Indirect Search Methods: Steepest descent method – Fletcher-Reeves method – Newton’s method – Marquardt method.</td></tr>
<tr><td>Unit – V</td><td colspan="6">Non-Linear Programming: Constrained Optimization Techniques:</td><td>9</td></tr>
<tr><td colspan="8">Introduction – Characteristics of a Constrained Problem – Direct Methods: Random search method – Sequential linear programming – Indirect methods: Transformation techniques – Exterior penalty function method – Interior penalty function method.</td></tr>
<tr><td colspan="8" align="right">Total:45</td></tr>
</table>

TEXT BOOK:	
1.	S.S.Rao, Engineering Optimization Theory and Practice, 5th Edition, John Wiley & Sons Ltd, USA, 2020.

REFERENCES:	
1.	David Luenberger and Yinyu Ye, Linear and Nonlinear Programming, 4th edition, Springer-Verlag, 2015
2.	A.Ravindran, K.M.Ragsdell, G.V.Reklaitis, Engineering Optimization: Methods and applications, 2nd Edition, Wiley India Pvt. Ltd., 2006.
3.	Yang, Xin-She. Optimization Techniques and Applications with Examples. 1st Edition, John Wiley & Sons, United Kingdom, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	solve problems with equality and inequality constraints.	Applying (K3)
CO2	solve nonlinear programming problems of functions of single variable.	Applying (K3)
CO3	use methods of unconstrained optimization to solve non linear problems	Applying (K3)
CO4	solve nonlinear optimization problems in the presence of inequality and equality constraints.	Applying (K3)
CO5	apply several modern methods of optimization for solving engineering problems	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2											
CO2	3	2												
CO3	3	3	1											
CO4	3	3	3											
CO5	3	2	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	10	80				100
CAT2	10	10	80				100
CAT3	10	10	80				100
ESE	10	10	80				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MAO09 - OPTIMIZATION FOR ENGINEERS

(Offered by Department of Mathematics)							
Programme & Branch	**All B.E/.BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	To provide the skills for solving the real time engineering problems involving linear and non-linear objective functions and also impart knowledge in finding optimal solutions to problems involving multi-level decision making and analyzing queuing models.	
Unit – I	**Linear Programming:**	**9**
Introduction to Operations research – Applications of OR – Linear Programming – Formation of Linear Programming Problem – Solution of LPP: Basic concepts – Graphical Solution – Simplex method – Artificial techniques: Big M method.		
Unit – II	**Integer Programming:**	**9**
Introduction – Types of Integer Programming Problems – Solution of Integer programming problems – Gomory's all integer cutting plane method - Gomory's Mixed-Integer Cutting Plane Method – Branch and Bound method.		
Unit – III	**Dynamic programming:**	**9**
Introduction – Characteristics – Formulation of Dynamic programming problems –Dynamic programming Algorithm – Solution of Discrete Dynamic programming problem – Solution of LPP by Dynamic programming.		
Unit – IV	**Queueing Theory:**	**9**
Characteristics of a queueing system – Kendall's notation – Queuing model I (Infinite capacity single server Poisson queue model) (M/M/1) : (∞/FIFO) – Little's formulae – Queuing model II (Infinite capacity multiple server Poisson queue model (M/M/C): (∞/FIFO) – Queuing model III (Finite capacity single server Poisson queue model) (M/M/1): (N/FIFO) – Queueing model IV (Finite capacity multiple server Poisson model) (M/M/C) : (N/ FIFO)..		
Unit – V	**Non-Linear Programming:**	**9**
Introduction – Mathematical formulation of Non-linear programing problems – Non-linear programing problem with equality constraints – Lagrange multipliers method – Non-linear programing problem with inequality constraint – Kuhn Tucker conditions.		
		Total:45

TEXT BOOK:

1.	Sharma J.K, "Operations Research – Theory and Applications", 6th Edition, Trinity Press, India, New Delhi, 2017.

REFERENCES:

1.	Taha, Hamdy A., "Operation Research: An introduction", 9th edition, Pearson Education, 2010.
2.	Hiller, Frederick. S. and Lieberman, Gerald. J., "An introduction to Operations research- concepts and cases", Tata McGraw Hill (SIE) 8th edition, 2005.
3.	Ravindran, A., Phillips, D.J., and Solberg, J.J., "Operations Research- Principles and Practice", John Wiley & Sons, 2005.
4.	Kanti Swarup, P.K. Gupta, Man Mohan, "Operations Research", 15th revised Edition, S. Chand & Sons Education Publications, New Delhi, 2017.
5.	Gupta P.K. and Hira D.S., "Operations Research: An Introduction", 7th Revised Edition, S.Chand and Co. Ltd., New Delhi, 2014.

COURSE OUTCOMES: **On completion of the course, the students will be able to**	**BT Mapped (Highest Level)**

CO1	formulate and solve linear programming problems.	Applying (K3)
CO2	solve Integer Programming problems that exist in real time applications.	Applying (K3)
CO3	demonstrate the theoretical workings of dynamic programming method to find shortest path for given network.	Applying (K3)
CO4	use the appropriate queuing model for a given practical application.	Applying (K3)
CO5	apply the concept of non-linear programming for solving the problems involving non-linear constraints and objectives.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	2	3											

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	70				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22CYO07 - WASTE AND HAZARDOUS WASTE MANAGEMENT
(Offered by Department of Chemistry)

Programme & Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	Waste and Hazardous waste management aims to equip the students to have a wide-range of knowledge on waste management.	
Unit – I	**Solid Waste Management**	**9**
Solid wastes: definition, sources, types, composition of solid waste- Solid waste management system: collection, separation, processing and transformation of solid waste – combustion, aerobic composting, vermicomposting, pyrolysis, landfill-classification, types, methods and control of leachate in landfills - recycling of material found in municipal solid waste- recycling of paper and cardboard, recycling of plastics, recycling of glass.		
Unit – II	**Hazardous Waste Management**	**9**
Hazardous wastes: definition, nature and sources of hazardous waste, classification and characteristics of hazardous waste-chemical class of hazardous waste, generation, segregation, treatment and disposal: waste reduction, waste minimization, recycling-chemical treatment: acid base neutralization, chemical precipitation, oxidation/reduction, hydrolysis, electrolysis, chemical extraction and leaching, ion exchange, photolytic reaction- thermal treatment methods: incineration – biodegradation of hazardous waste: aerobic, anaerobic, reductive dehalogenations-land treatment and composting.		
Unit – III	**E- Waste& Biomedical Waste Management**	**9**
E-Waste Management:definition, sources, classification, collection, segregation, treatment and disposal. **Biomedical Waste Management :** Introduction-definition –components of biomedical waste-waste generation –waste identification and waste control-waste storage-labeling and color coding-handling and transportation-waste treatment and disposal- autoclave, hydroclave , microwave treatments- chemical disinfection – sanitary and secure landfill.		
Unit – IV	**Pollution From Major IndustriesAnd Management**	**9**
Introduction- sources and characteristics - waste treatment flow sheets for selected industries such as textiles, tanneries, pharmaceuticals, sugar, petroleum refinery, fertilizer and dairy industries.		
Unit – V	**Solid Waste Management and Legislation**	**9**
Solid waste management plan - solid waste (management and handling) rules - biomedical waste (management and handling) rules-plastic waste management rules - e-waste management rules - hazardous and other wastes (management and transboundary movement) rules - construction and demolition waste management rules.		
		Total: 45

TEXT BOOK:

1.	George Tchobanoglous, Hillary Theisen, Samuel a Vigil, Integrated solid waste management (Engineering principle and management issues) McGraw hill Education (India) Pvt. Ltd., 2015, for Unit-I, II, V.
2.	SC Bhatia, Handbook of Industrial pollution and control (Volume-1), CBS Publisher and Distributers, New Delhi, 2002, for Unit-II, III, IV, V.

REFERENCES:

1.	Manual on Municipal Solid Waste management, Central public Health and Environmental Engineering Organization (CPHEEO), Govt. of India, May 2000.
2.	Michael D. LaGrega, Phillip L. Buckingham, Jeffrey C. Evans, Hazardous waste management, MEDTEC, 2015.
3.	Majeti Narasimha Vara Prasad, Meththika Vithanage, Anwesha Borthakur, “Handbook of Electronic Waste Management: International Best Practices and Case Studies” 1st Edition, Butterworth-Heinemann,2019.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply the technical points that are required to set up a solid waste management system.	Applying (K3)
CO2	explain the various disposal and treatment methods of hazardous wastes.	Understanding (K2)
CO3	organize the appropriate method for managing e-waste and biomedical waste.	Applying (K3)
CO4	identifythe hazards from various industries and apply the waste management techniques for its treatment.	Applying (K3)
CO5	relate the legal legislation to solid waste management.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1			3							
CO2	2	1					3							
CO3	3	2	1	1			3							
CO4	3	2	1	1			3							
CO5	2	1					3							

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO08 - CHEMISTRY IN EVERY DAY LIFE
(Offered by Department of Chemistry)

Programme& Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course aims to prepare the students to have the knowledge on oils,fats,sugar, adulterants in food, creams, milk powder, soil, fertilizer, pesticides, insecticides, fungicides and herbicides in order to know its chemistry in our everyday activities.	
Unit – I	**Oils, Fats and Sugar**	**9**
Distinction between oils and fats – properties – classification – edible oils – vegetable oils –animal oils – manufacture of oils by solvent extraction – refining of crude vegetable oils – processing of animal fats – manufacture of cane sugar – manufacture of sucrose from beet root.		
Unit – II	**Adulterants in food**	**9**
Food Adulteration and prevention – common food adulterants – food additives – food colorants– preservatives – flavourants – food poisoning – analysis of adulterants in edible oils, coffee powder, chilli powder, turmeric powder, meat , fish, ghee and milk – harmful effects of food adulterants		
Unit – III	**Creams and Milk powder**	**9**
Creams: Composition-chemistry of creaming process- Factors influencing cream separation (Mention the factors only) - Estimation of fat in cream - Milk powder: Need for making powder-drying process- spraying, drum drying, jet drying and foam drying-principles involved in each.		
Unit – IV	**Soil and Fertilizers**	**9**
Soil analysis: Composition of soil - Organic and Inorganic constituents-Soil acidity - buffering capacity of soils -Liming of soil - Fertilizers:primary nutrients –role of Nitrogen, potassium and phosphorous on plant growth –Complex fertilizers and mixed fertilizers and its composition - Secondary nutrients – micronutrients and their functions in plants -optimal addition of Fertilizers to obtain estimated yield.		
Unit – V	**Pesticides, Insecticides, Fungicides and Herbicides**	**9**
Pesticides – Classification – general methods of application and toxicity, Safety measures when using pesticides-Insecticides: Inorganic pesticides – borates - Organic pesticides – D.D.T. and BHC-Plant derivatives: pyrethrin and Nicotine - Synthetic organic pesticides: Endrin and Aldrin (Chemical name - Structure- functions and uses)-Fungicides: Inorganic (Bordeaux mixture) and organic (dithiocarbamate) fungicides - Industrialfungicides: Creosote fractions - Herbicides: Selective and non-selective - 2, 4-dicholorophenoxyacetic acid and 2,4,5-tricholorophenoxyaceticacid (structure and function).		
		Total: 45

TEXT BOOK:

1.	Sharma B K , Industrial Chemistry, Goel publishing house, New Delhi, 2011, for Units- I, II, IV
2.	Alex V Ramani, Food Chemistry, MJP Publishers, Chennai, 2009, for Units -II, III, V.

REFERENCES:

1.	Dilip Kumar Das, Introductory Soil Science, 1st Edition, Kalyani Publishers, Reprint 2002.
2.	K. Bagavathi Sundari– “Applied Chemistry”, MJP Publishers, Chennai, 2006.
3.	Ashutosh Kar, Medicinal Chemistry, Wiley Eastern limited, New Delhi, 1993.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	outline the importance of oils, fats and sugar.	Understanding (K2)
CO2	identify the harmful effects of adulterants in food.	Applying (K3)
CO3	develop the knowledge on creams and milk powder.	Applying (K3)
CO4	interpret the nature and composition of soil and fertilizers.	Understanding (K2)
CO5	illustrate the difference of pesticides, insecticides, fungicides and herbicides.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	1												
CO5	3	1												

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22CYO09 - CHEMISTRY OF NUTRITION FOR WOMEN HEALTH
(Offered by Department of Chemistry)

Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course aims to provide knowledge for engineering students on components of health, fitness and also the role of nutrition for women health.	
Unit - I	**Nutrition**	**9**
Energy- functions, sources and concept of energy balance - recommended dietary allowances, dietary sources - effects of deficiency and/ or excess consumption on health of the following nutrients: carbohydrates and dietary fiber – lipids – proteins - fat soluble vitamins: A, D,E and K - water soluble vitamins: Thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin C –minerals: calcium, iron, zinc and iodine.		
Unit - II	**Women Health**	**9**
Disease pattern and reproductive health- menopause – hypothyroid- PCOD-diabetes - policies and programs for promoting maternal and child nutrition and health - concept of small family - methods of family planning - merits and demerits.		
Unit - III	**Nutrition for Nursing Mother and Infants**	**9**
Physiology and psychology of lactation, hormonal control, composition of colostrums and breast milk, nutritional requirements of a nursing mother, advantages of breast feeding, food and nutritional requirements for infants, weaning and supplementary foods for infants and immunization.		
Unit - IV	**Nutrition for Physical Fitness**	**9**
Significance of physical fitness and nutrition in the prevention and management of weight control, obesity, diabetes mellitus, CV disorders, bone health and cancer - nutrition and exercise regimes for pre and postnatal fitness - nutritional and exercise regimes for management of obesity - critical review of various dietary regimes for weight and fat reduction - prevention of weight cycling.		
Unit - V	**Role of Women in National Development**	**9**
Women in family and community: Demographic changes menarche, marriage, fertility, morbidity, mortality, life expectancy, sex ratio, aging, widowhood. Women in society: Women’s role, their resources, and contribution to family, and effect of nutritional status.		
		Total: 45

TEXT BOOK:

1.	Srilakshmi, B., Nutrition Science, New Age International (P) Ltd., New Delhi, 2017, for Units- I, IV, V.
2.	Arpita Verma, Women's Health and Nutrition: Role of State and Voluntary Organizations, Rawat Publishers, 2017, for Units - II, III, IV.

REFERENCES:

1.	Shubhangini A Joshi , Nutrition and Dietetics, TataMacGraw Hill, 2010.
2.	Rujuta Diwekar, Women and The Weight Loss Tamasha, Westland ltd, 2010.
3.	Swaminathan, M., Advanced Textbook on Food and Nutrition, Vol. 1, Second Edition, Bangalore Printing and Publishing Co. Ltd., Bangalore, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	make use of the knowledge of dietary sources in day to day life.	Applying (K3)
CO2	explain the disease pattern and policies towards women health.	Understanding (K2)
CO3	develop knowledge about nutrition during lactation and for infants.	Applying (K3)
CO4	utilize the knowledge of physical fitness and nutrition towards good health.	Applying (K3)
CO5	interpret the various role of women in society.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1											
CO2	3	1												
CO3	3	2	1											
CO4	3	2	1											
CO5	3	1												

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

GENERAL OPEN ELECTIVE
(Common to All BE/BTech branches)

SNo	Course Code	**Course Title**	L	T	P	C	Offering Department	Semester
1.	22GEO01	German Language Level 1	4	0	0	4	ECE	ALL
2.	22GEO02	Japanese Language Level 1	4	0	0	4	ECE	ALL
3.	22GEO03	Design Thinking for Engineers	3	1	0	4	CSE	5
4.	22GEO04	Innovation and Business Model Development	3	1	0	4	MTS	6
5.	22GEO05	German Language Level 2	4	0	0	4	ECE	ALL
6.	22GEO06	German Language Level 3	3	0	0	3	ECE	ALL
7.	22GEO07	German Language Level 4	3	0	0	3	ECE	ALL
8.	22GEO08	Japanese Language Level 2	4	0	0	4	ECE	ALL
9.	22GEO09	Japanese Language Level 3	3	0	0	3	ECE	ALL
10.	22GEO10	Japanese Language Level 4	3	0	0	3	ECE	ALL
11.	22GEO11	French Language Level 1	4	0	0	4	ECE	ALL
12.	22GEO12	French Language Level 2	4	0	0	4	ECE	ALL
13.	22GEO13	French Language Level 3	3	0	0	3	ECE	ALL
14.	22GEO14	Spanish Language Level 1	4	0	0	4	ECE	ALL
15.	22GEO15	Spanish Language Level 2	4	0	0	4	ECE	ALL
16.	22GEO16	Spanish Language Level 3	3	0	0	3	ECE	ALL
17.	22GEO17	Entrepreneurship Development	3	0	0	3	MTS	7
18.	22GEX01	NCC Studies (Army Wing) - I	3	0	2	4	EEE	5 / 6
19.	22GEX02	NCC Studies (Air Wing) - 1	3	0	2	4	IT	5 / 6
20.	22MBO01	Cost Accounting for Engineers	3	1	0	4	MBA	5
21.	22MBO02	Economic Analysis for Decision Making	3	1	0	4	MBA	6
22.	22MBO03	Marketing Analytics	3	1	0	4	MBA	7

22GEO01 - GERMAN LANGUAGE LEVEL 1							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course serves as an introduction to the German language and awareness towards German lifestyle and cultural aspects of Germany and German speaking countries. One can learn to introduce oneself and able to gain the basic day to day vocabulary. On keen learning one would be able to understand the sentence structure and be able to reciprocate to basic questions	
Unit – I	**Good Day (Guten Tag)**	**12**
Greetings, Self-introduction and introducing others, Numbers, Alphabets, Countries and languages spoken. Grammar – W questions, Simple sentences, Verb conjugation and personal pronoun.		
Unit – II	**Friends & Colleague (Freund und Kollegen):**	**12**
Hobbies, Profession, Week, Months, Season and Generate Profile. Grammar – Articles, Plural, Verbs – have and to be, Yes/No questions.		
Unit – III	**n the City (In der Stadt):**	**12**
Name of places/buildings in the city, asking for directions, Understanding means of transport. Grammar – definite and indefinite articles, Negation articles and Imperative		
Unit – IV	**Food and Appointment (Essen und Termin):**	**12**
Food, Shopping, initiate conversations to understand and do shopping. Grammar – Accusative case, Verbs with Accusative. Understanding time and reciprocating, Appointments, Asking excuse, Family. Grammar – Prepositions: *am, um, von...bis,* Possessive articles- *mein, dein*.., Modal verbs- *müssen, können, wollen*		
Unit – V	**Socializing (Zeit mit Freunden):**	**12**
Planning together, Birthday, Invitation, Restaurant, looking for specific information in texts. Grammar – Separable verbs, Prepositions with Accusative case, Past tense of have and to be, Personal pronoun with Accusative.		
		Total:60

TEXT BOOK:

1.	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, “Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch und Glossar with 2 CDs”, Goyal Publishers, Delhi, 2015.

REFERENCES:

1.	https://ocw.mit.edu – Massachusetts Institute of Technology Open Courseware
2.	https://www.dw.com/en/learn-german - Deutsche Welle, Geramany’s International Broadcaster

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand structure of language and introducing each other	Remembering (K1)
CO2	understand vocabulary on seasons and basic verbs	Understanding (K2)
CO3	ask for directions in a new place and avail transport as required	Understanding (K2)
CO4	understand food habits of German and ask for appointments.	Understanding (K2)
CO5	learn to socialize in a German speaking country	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO02 - JAPANESE LANGUAGE LEVEL 1							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**All**	**OE**	**4**	**0**	**0**	**4**
Preamble	The basic level of Japanese which provides understanding of Hiragana, Katakana and 55 Kanjis also enables one to greet, introduce oneself and other person and also provides the ability to understand basic day to day conversations						
Unit – I	**Introduction to Hiragana and Katakana:**						**12**
Chart 1, Chart 2, Chart 3, Annexures 1 and 2 and basic Japanese rules along with similar sounded vocabularies for each chart.							
Unit – II	**Introduction to Nouns, various particles and usages:**						**12**
Forming simple sentences, asking questions, positioning differentiation and owning fundamentals – new particles and usages							
Unit – III	**Introduction of Verbs, time and place markers:**						**12**
Usage of action words in sentences and framing them – place and time markers usages – giving and receiving – omission of certain particles in a sentence.							
Unit – IV	**Introduction of Adjectives, Adverbs and usages:**						**12**
Describing nouns and verbs and framing them to relate day to day conversations- positive and negative ending of the same – introduction of the likes and dislikes expressions							
Unit – V	**Introduction to Counters and Kanji:**						**12**
How to use numbers-How to use quantifiers-Present form of adjectives and Nouns-Other necessary particles-How to use numbers and quantifiers – 55 kanji characters							
							Total:60

TEXT BOOK:

1.	"MINNA NO NIHONGO–Japanese for Everyone", 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1.	Margherita Pezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2.	Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	read and understand typical expression in Hiragana and Katakana	Remembering (K1)
CO2	greet and introduce oneself and other	Understanding (K2)
CO3	communicate day to day conversations – basic level	Understanding (K2)
CO4	understand the Kanjis in Japanese Script	Understanding (K2)
CO5	comprehend concept of numbers, days, months, time and counters	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO03 - DESIGN THINKING FOR ENGINEERS							
(Offered by Department of Computer Science and Engineering)							
Programme & Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	Design Thinking is human-centered problem solving tool which emphasize on empathy, collaboration, co-creation and stakeholder feedback to unlock creativity and innovation, to devises feasible and viable idea/solutions.	
Unit – I	**Design Thinking and Explore:**	**9+3**
Design Thinking: Key Principles and Mindset – Five Phases, Methods and Tools of Design Thinking – User Guide – Foundation Building for Design Thinking – **Explore**: Methods & Tools – STEEP Analysis – Strategic Priorities – Activity System – Stakeholder Mapping – Opportunity Framing.		
Unit – II	**Empathize**	**9+3**
Empathize: Methods & Tools – Field Observation – Deep User Interview – Empathy Map – User Journey Map - Need Finding – User Insights - User Persona Development.		
Unit – III	**Experiment**	**9+3**
Experiment: Methods & Tools – Ideation – SCAMPER – Analogous Inspiration – Deconstruct & Reconstruct – User Experience Journey – Prototyping– Idea Refinement.		
Unit – IV	**Engage**	**9+3**
Engage: Methods & Tools – Story Telling – Art of Story Telling – Storyboarding – Co-Creation with Users – Collect Feedback from Users.		
Unit – V	**Evolve**	**9+3**
Evolve: Methods & Tools – Concept Synthesis – Strategic Requirements –Evolved Activity Systems – Activity System Integration – Viability Analysis – Innovation Tools using User Needs, CAP, 4S – Change Management - Quick Wins.		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Lee Chong Hwa, "Design Thinking The Guidebook", Design Thinking Master Trainers of Bhutan, 2017. (E-Book)

REFERENCES:

1.	Jeanne Liedtka and Tim Ogilvie, "Designing for Growth: A Design Thinking Tool Kit for Managers", Columbia University Press, 2011.
2.	Jeanne Liedtka, Tim Ogilvie, and Rachel Brozenske, "The Designing for Growth FieldBook: A Step-by-Step Project Guide", Columbia University Press, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Construct design challenge and reframe the design challenge into design opportunity.	Applying (K3)
CO2	Interview the user, and know the feelings of users to foster deep user understanding and be able to uncover the deep user insights and needs.	Applying (K3)
CO3	Develop ideas and prototypes by brain storming using the ideation tools.	Applying (K3)
CO4	Organize the user walkthrough experience using ideal user experience journey.	Applying (K3)
CO5	Develop smart strategies & implementation plan that will deliver/achieve the idea/solution deduced from earlier phases.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1					3	2	1		3	1
CO2	3	3	3	1					3	2	1		3	1
CO3	3	3	3	1					3	2	1		3	1
CO4	3	3	3	1					3	2	1		3	1
CO5	3	3	3	1					3	2	1		3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Tests	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT 1	10	20	70				100
CAT 2	10	15	75				100
CAT 3	10	15	75				100
ESE	10	15	75				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO04 - INNOVATION AND BUSINESS MODEL DEVELOPMENT							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course will inspire the students to think innovation concepts and ideas for business model developments.	
Unit - I	**Innovation and Design Thinking:**	**9+3**
Innovation and Creativity– Types of innovation – challenges in innovation- steps in innovation management- 7 concerns of design. Design Thinking and Entrepreneurship – Design Thinking Stages: Empathize – Define – Ideate – Prototype – Test. Design thinking tools: Analogies – Brainstorming – Mind mapping		
Unit - II	**User Study and Contextual Enquiry:**	**9+3**
Explanatory research – primary and secondary data – classification of secondary data – sources of secondary data – qualitative research – focus groups – depth interviews – analysis of qualitative data – survey methods – observations- Process of identifying customer needs –organize needs into a hierarchy –establish relative importance of the needs- Establish target specifications		
Unit - III	**Product Design:**	**9+3**
Techniques and tools for concept generation, concept evaluation – Product architecture –Minimum Viable Product (MVP)- Product prototyping – tools and techniques– overview of processes and materials – evaluation tools and techniques for user-product interaction		
Unit - IV	**Business Model Canvas (BMC):**	**9+3**
Lean Canvas and BMC - difference and building blocks- BMC: Patterns – Design – Strategy – Process–Business model failures: Reasons and remedies		
Unit - V	**IPR and Commercialization:**	**9+3**
Need for Intellectual Property- Basic concepts - Different Types of IPs: Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design– Patent Licensing - Technology Commercialization – Innovation Marketing		
		Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Rishikesha T.Krishnan, “8 Steps To Innovation: Going From Jugaad To Excellence”, Collins India, 2013.

REFERENCES:

1.	Peter Drucker, “Innovation and Entrepreneurship”, Routledge CRC Press, London, 2014.
2.	Eppinger, S.D. and Ulrich, K.T. “Product design and development”, 7th edition, McGraw-Hill Higher Education, 2020.
3.	Alexander Osterwalder, “Business model generation: A handbook for visionaries, game changers, and challengers”, 1st edition, John Wiley and Sons; 2010
4.	Indian Innovators Association, “Patent IPR Licensing – Technology Commercialization – Innovation Marketing: Guide Book for Researchers, Innovators”, Notion Press, Chennai, 2017

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand innovation need and design thinking phases	Understanding (K2)
CO2	identify, screen and analyse ideas for new products based on customer needs	Analysing (K4)
CO3	develop and analyse the product concepts based on the customer needs and presents the overall architecture of the product.	Analysing (K4)
CO4	predict a structured business model for MVP	Applying (K3)
CO5	practice the procedures for protection of their ideas' IPR	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1			2			2						3		
CO2	3	3	3	3	2	2	2	2	3	3	3	3		
CO3	2	2	3	3	3	3	3	3	3	3	3	3		
CO4				3	2	2	2	3	3	3	3	3		
CO5				3	2	2		3	2	3	3	3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	40	10			100
CAT2	20	30	40	10			100
CAT3	30	30	40				100
ESE	20	30	30	20			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

<table>
<tr><td colspan="8">22GEO05-GERMAN LANGUAGE LEVEL 2</td></tr>
<tr><td colspan="8">(Offered by Department of Electronics and Communication Engineering)</td></tr>
<tr><td>Programme& Branch</td><td>All BE/BTech Engineering and Technology Branches</td><td>Sem.</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td></tr>
<tr><td>Prerequisites</td><td>German Language Level 1</td><td>All</td><td>OE</td><td>4</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Preamble</td><td colspan="7">This course aims to help the learner to acquire the vocabulary as per the Common European framework of German language A1 level competence. This course will help to assimilate the basic grammar structures and gain vocabulary to understand and reciprocate in daily life situations on a broader sense. A thorough learner will be able to gain a comprehensive understanding of the German grammar and confidently articulate in day today situations</td></tr>
<tr><td>Unit – I</td><td colspan="6">Contacts(Kontakte):</td><td>12</td></tr>
<tr><td colspan="8">Understanding Letters, simple instructions, speaking about language learning, finding specific information in text, Acknowledging the theme and understanding conversations, Making appointments. Grammar – Preposition with Dative, Articles in Dative and Accusative possessive articles.</td></tr>
<tr><td>Unit – II</td><td colspan="6">Accomodation(Die Wohnung):</td><td>12</td></tr>
<tr><td colspan="8">Understanding Accommodation advertisements, describing accommodation and directions, responding to an invitation, Expressing feelings, Colours. Grammar – Adjective with to be verb, Adjective with sehr/zu, Adjective with Accusative, prepositions with Dative</td></tr>
<tr><td>Unit – III</td><td colspan="6">Are you Working?(Arbeiten Sie):</td><td>12</td></tr>
<tr><td colspan="8">Daily Schedule, speaking about past, understanding Job openings advertisements, Opinions, Telephonic conversations, Speaking about Jobs. Grammar – Perfect tense, Participle II – regular and irregular verbs, Conjunctions – und, oder, aber</td></tr>
<tr><td>Unit – IV</td><td colspan="6">Clothes and Style(Kleidung und mode):</td><td>12</td></tr>
<tr><td colspan="8">Clothes, Chats on shopping clothes, reporting on past, Orienting oneself in Supermarkets, Information and research about Berlin. Grammar – Interrogative articles and Demonstrative articles, Partizip II – separable and non-separable verbs, Personal pronouns in Dative, Verbs with Dative</td></tr>
<tr><td>Unit – V</td><td colspan="6">Health and Vacation(Gesundheit und Urlaub):</td><td>12</td></tr>
<tr><td colspan="8">Personal information, Human Body parts, Sports, Understanding instructions and prompts, health tips. Grammar – Imperative with du/Ihr, Modal verbs – sollen, müssen, nicht dürfen, dürfen. Suggestions for travel, Path, Postcards, weather, Travel reports, Problems in hotel, Tourist destinations. Grammar – Pronoun: man, Question words – Wer, Wen, Was, Wem, Adverbs – Zuerst, dann, Später, Zum Schl</td></tr>
<tr><td colspan="8" align="right">Total:60</td></tr>
</table>

TEXT BOOK:

1.	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, “Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch und Glossar with 2 CDs”, Goyal Publishers, Delhi, 2015.
2.	

REFERENCES:

1.	https://ocw.mit.edu – Massachusetts Institute of Technology Open Courseware
2.	https://www.dw.com/en/learn-german - Deutsche Welle , Geramany’s International Broadcaster

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand letters and simple texts	Remembering (K1)
CO2	assimilate vocabulary on Accommodation and invitation	Understanding (K2)
CO3	comprehend concept of time, telephonic conversation and job-related information	Understanding (K2)
CO4	understand how to do shopping in a German store	Understanding (K2)
CO5	understand body parts and how to plan personal travel	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

<table>
<tr><td colspan="8">22GEO06-GERMAN LANGUAGE LEVEL 3</td></tr>
<tr><td colspan="8">(Offered by Department of Electronics and Communication Engineering)</td></tr>
<tr><td>Programme& Branch</td><td>All BE/BTech Engineering and Technology Branches</td><td>Sem.</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td></tr>
<tr><td>Prerequisites</td><td>German Language Level 2</td><td>All</td><td>OE</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Preamble</td><td colspan="7">This course provides enriching information about various everyday situations in personal and professional life and enhances the vocabulary and speaking ability to respond to and also seek information in those situations. It also equips one to express opinions and negotiate appointments. With diligent learning one can capture all basic grammatical structure to answer confidently in everyday situations.</td></tr>
<tr><td>Unit – I</td><td colspan="6">All about food (Rund Ums Essen):</td><td>9</td></tr>
<tr><td colspan="8">Understand information about person, Speak about food, Introduce self and others, Understand and explain a picture base story, To justify something, To speak about feelings, To express opinions, To answer questions on a text, To describe a restaurant. Grammar: Possessive Articles in Dative, Yes/No questions, Reflexive verbs, Sentence with ‘weil’</td></tr>
<tr><td>Unit – II</td><td colspan="6">School days (Nach der Schulzeit):</td><td>9</td></tr>
<tr><td colspan="8">Understand School reports, Speak and write comments about schooldays, To speak about habits, Understand and provide City-Tipps, To Understand School types in Germany and speak about it. Grammar: Modal verbs in Past tense, Positional Verbs, Two-way prepositions in Dativ and Akkusativ.</td></tr>
<tr><td>Unit – III</td><td colspan="6">Media in everyday life (Medien in Alltag):</td><td>9</td></tr>
<tr><td colspan="8">To speak about advantages and disadvantages of Media, formulate comparisons, Express your own opinion, Talk about Movies, Understand and Write Movie reviews. Grammar: Comparative degree, Comparative Sentences with ‘Als’ and ‘Wie’, Subordinate clause with ‘dass’, Superlative degree.</td></tr>
<tr><td>Unit – IV</td><td colspan="6">Feelings and expressions (Gefühle):</td><td>9</td></tr>
<tr><td colspan="8">Express thanks and congratulations, Talk about feelings, To understand information about festivals and speak about it, To describe a city, Express joy and regrets, Understand and write Blog entries, Write appropriate heading. Grammar: Subordinate Clause with ‘Wenn’, Adjectives to be used along with definite articles.</td></tr>
<tr><td>Unit – V</td><td colspan="6">Profession and Travel (Beruf und Reisen):</td><td>9</td></tr>
<tr><td colspan="8">To have a conversation at ticket counter, To talk about leisure activities, To gather information from Texts, Introduce people, Express career preferences, Ideate the dream job, To prepare and make telephone calls, To understand text about Workplace. Ask for information, Express uncertainty, Understand and give directions, Understand a newspaper article, Say your own opinion, Talk about the way to work, Describe a statistic, Understand information about a trip, Talk about travel. Grammar: Adjective to be used along with indefinite articles, Prepositions, verb – ‘werden’, Subordinate clause – indirect questions, All units will include elements for reading, writing, speaking and listening.</td></tr>
<tr><td colspan="8" align="right">Total:45</td></tr>
</table>

TEXT BOOK:	
1.	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, “Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch und Glossar with 2 CDs”, Goyal Publishers, Delhi, 2015
2.	
REFERENCES:	
1.	Rosa-Maria Dallapiazza , Eduard von Jan, Till Schonherr, “Tangram 2 (German)” , Goyal Publishers, Delhi, 2011.
2.	https://www.dw.com/en/learn-german - Deutsche Welle , Geramany’s International Broadcaster

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand German food style, restaurant and be able express oneself.	Remembering (K1)
CO2	understand German school system and discuss about habits and provide City-Tipps	Understanding (K2)
CO3	analyze and compare media in everyday life.	Understanding (K2)
CO4	express feelings, describe a city and write blog entries.	Understanding (K2)
CO5	seek and provide information in a professional setup, give directions to others and talk about travel	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO07-GERMAN LANGUAGE LEVEL 4							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**German Language Level 3**	**All**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course imparts knowledge about interacting with external world, understanding various cultural aspects, behaviour and addressing relationships in personal and professional front. It helps one to understand reports from various media and at work. Enhance learner's grammatical exposure and cover the core basic grammatical concepts which would lay the foundation to have a better hold of the language. With focused learning one should be able to read and respond to reports, write simple formal and informal letters and text messages and be able to engage in simple conversations in known situations.

Unit – I	**Learning (Lernen):**	**9**
Understanding and describing learning problems, Understanding and giving advice, Giving reasons, Understanding reports about everyday work life, Talking about everyday working life, Understanding a radio report, Understanding and making a mini-presentation. Grammar: Conjunctions- denn,weil, Konjuntiv II: Sollte(suggestions), Genitive, Temporal prepositions – bis, über + Akkusativ,ab+dativ		
Unit – II	**Athletic (Sportlich):**	**9**
Expressing enthusiasm, hope, disappointment, Understanding and writing fan comments, Formulating follow-ups, Making suggestions and reacting, Making an appointment, Understanding a report about an excursion, Understanding difficult texts, Introducing a tourist attraction. Grammar: Conjunctions – deshalb, trotzdem, Verbs with Dativ and Akkusativ		
Unit – III	**Living Together (Zusammen Leben):**	**9**
To complain, apologize & give in, As for something, Understand experience reports, Report on the past, Talk about pets, Respond to information, Write and correct a story. Grammatik: Konjunctiv II- könnte, Subordinate clauses – als and Wenn.		
Unit – IV	**Good Entertainment (Gute Unterhaltung):**	**9**
Talk about music style, Buy concert tickets, Introduce a musician / band, Understand newspaper reports, Give more detailed information about a person, Understand information about painting, Understand description of a picture, Describe a picture. Grammatik: Interrogative Articles: Was fuer eine? , Pronouns – man/jemand/niemand and alles/etwas/nichts , Relative sentences in Nominativ		
Unit – V	**Passage of time and Culture (Zeitablauf & Kultur):**	**9**
Talk about wishes, Express wishes, Give Suggestions, Understand a conversation, Plan something together, To ask others something, Understand a text, Exchange information, Talk about proverbs, write a story. Understand information about other cultures, Discuss about behavior, Express intentions, Use the appropriate salutation, Understand tips in a text, Talk about forms of addressing others, Give more information, Discuss about clichés and write about them. All units will include elements for reading, writing, speaking and listening. Grammatik: Konjunctiv II (Wishes, Suggestions), Verbs with prepositions, W- questions with prepositions, Relative sentences in Akkusativ, Subordinate clauses with damit and Um…Zu.		
		Total:45

TEXT BOOK:

1.	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, "Netzwerk Deutsch als Fremdsprache A1–ursbuch, Arbeitsbuch", Goyal Publishers, Delhi, 2015.

REFERENCES:

1.	Rosa-Maria Dallapiazza, Eduard von Jan, Till Schonherr, "Tangram 2 (German)", Goyal Publishers, Delhi, 2011.
2.	https://www.dw.com/en/learn-german - Deutsche Welle, Geramany's International Broadcaster

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	leverage learning in Workplace, understanding reports and make presentation.	Remembering (K1)
CO2	reciprocate to different situations, make appointment and understand texts.	Understanding (K2)
CO3	handle relationships and respond appropriately to exchange information	Understanding (K2)
CO4	familiarize to various channels of entertainment	Understanding (K2)
CO5	know about various cultural aspects, usage of proverbs and cliches.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

<table>
<tr><td colspan="8">22GEO08 - JAPANESE LANGUAGE LEVEL 2</td></tr>
<tr><td colspan="8">(Offered by Department of Electronics and Communication Engineering)</td></tr>
<tr><td>Programme& Branch</td><td>All BE/BTech Engineering and Technology Branches</td><td>Sem.</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td></tr>
<tr><td>Prerequisites</td><td>Japanese Language Level 1</td><td>All</td><td>OE</td><td>4</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Preamble</td><td colspan="7">The basic level of Japanese which provides understanding of Hiragana, Katakana and 110 Kanjis and provides the ability to understand basic conversations and also enables one to request other person and also understand Casual form</td></tr>
<tr><td>Unit – I</td><td colspan="6">Introduction to groups of verbs:</td><td>12</td></tr>
<tr><td colspan="8">tai form-Verb groups-te form-Give and ask permission to do an action-Present continuous form-Restrict other person from doing an action-nouns-Basic Questions</td></tr>
<tr><td>Unit – II</td><td colspan="6">Introduction to Casual Form:</td><td>12</td></tr>
<tr><td colspan="8">nai form-Dictionary form-ta form-Polite style and Casual style differences-Conversation in plain style-Place of usage of Polite style and Casual style</td></tr>
<tr><td>Unit – III</td><td colspan="6">Express opinions and thoughts:</td><td>12</td></tr>
<tr><td colspan="8">Introduction to new particle-Express someone one’s thought-Convey the message of one person to another-Ask someone if something is right -Noun modifications</td></tr>
<tr><td>Unit – IV</td><td colspan="6">Introduction to If clause and remaining Kanjis:</td><td>12</td></tr>
<tr><td colspan="8">If clause tara form-Express gratitude for an action done by other person-Hypothetical situation-Particles to use in case of Motion verbs-50 Kanjis</td></tr>
<tr><td>Unit – V</td><td colspan="6">Introduction to giving and receiving with te form and “when, even if” usages:</td><td>12</td></tr>
<tr><td colspan="8">Providing to and getting from differences - Understanding of situations and framing sentences using when and even if..etc.</td></tr>
<tr><td colspan="8" align="right">Total:60</td></tr>
<tr><td colspan="8">TEXT BOOK:</td></tr>
<tr><td>1.</td><td colspan="7">“MINNA NO NIHONGO–Japanese for Everyone”, 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017</td></tr>
<tr><td colspan="8">REFERENCES:</td></tr>
<tr><td>1.</td><td colspan="7">Margherita Pezzopane, “Try N5”, 2nd Edition, Tankobon Softcover, Japan, 2017.</td></tr>
<tr><td>2.</td><td colspan="7">Sayaka Kurashina, “Japanese Word Speedmaster”, 2nd Edition, Tankobon Softcover, Japan, 2018.</td></tr>
<tr><td colspan="8"></td></tr>
</table>

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	differentiate groups of verbs and its forms	Remembering (K1)
CO2	understand Polite form and Casual form of Japanese	Understanding (K2)
CO3	comprehend personal communication and express greetings	Understanding (K2)
CO4	understand the Kanjis in Japanese Script and If clause	Understanding (K2)
CO5	comprehend concept of “even if”, “when” and job-related information	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO09 - JAPANESE LANGUAGE LEVEL 3							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Japanese Language Level 2**	**All**	**OE**	**3**	**0**	**0**	**3**
Preamble	The intermediate level of Japanese which provides understanding of all forms ofverbs, adverbs, conjunctions, etc. which includes 150 Kanji's and provides the ability to comprehend conversations encountered in daily life						
Unit – I	**Introduction to Potential verbs:**						**9**
Causes and Reasons-Favouring Expressions-Expressing a State-Potential Verb Sentences-Simultaneous actions-Verb Groups-te Form-Customary Actions-Nouns-Basic Questions and Kanji's.							
Unit – II	**Introduction to Transitive and Intransitive verbs:**						**9**
Consequence of verbs- Embarrassment about Facts- Consequence of Verbs with an Intentions-Affirmative Sentences- Conjunctions-Basic Questions and kanji's.							
Unit – III	**Introduction to Volitional forms:**						**9**
Expressions of Speakers Intention-Expressing Suggestion or Advice-Usage of Adverbs and Quantifiers-Basic Questions and kanji's.							
Unit – IV	**Introduction to Imperative and Prohibitive verbs:**						**9**
Commanding person- Interrogatives-Expressions of Third Person-Actions and its Occurrence - Possibilities of an Action-Changing of States Basic Questions and Kanji's.							
Unit – V	**Introduction to Conditional form and Passive verbs:**						**9**
Description of Requirement and Speaker's Judgement, HabitualActions, Directions and suggestions-Passive forms of Verbs-Basic Questions and Kanji's.							
							Total:45

TEXT BOOK:

1.	"MINNA NO NIHONGO–Japanese for Everyone", 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1.	Margherita Pezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2.	Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	read and understand BasicVocabularies.	Remembering (K1)
CO2	understand Conversations used in daily life.	Understanding (K2)
CO3	comprehend personal communication and express greetings.	Understanding (K2)
CO4	understand the Kanji's in Japanese Script.	Understanding (K2)
CO5	comprehend Coherent conversations in everyday situations.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO10 -JAPANESE LANGUAGE LEVEL 4							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**JAPANESE LANGUAGE LEVEL 3**	**All**	**OE**	**3**	**0**	**0**	**3**

Preamble	The intermediate level of Japanese provides understanding of expressions of verbs, its pattern, Relationships which also includes 150 Kanji's and also provides the ability to understand relationship among the people.	
Unit – I	**Introduction to Reasoning:**	**9**
Causes and Sequences-Causes and Effects-Interrogative Patterns-Adjective as a Noun -Basic Questions and Kanji's		
Unit – II	**Introduction to Exchanging of things:**	**9**
Expressions for Giving and Receiving of Things-Polite Expression of Request-Indicating a Purpose of Actions-Basic Quantifiers-Basic Questions and kanji's.		
Unit – III	**Introduction to States of an Action:**	**9**
Sentence Pattern to Indicate Appearance-Degree of Action and State-Adjectives as Adverbs- Convey information -Basic Questions and kanji's.		
Unit – IV	**Introduction to Causative Verbs:**	**9**
Causative Forms of Verbs-Asking Opportunity to do something-Hypothetical Questions-Judgement and Course of an actions-Basic Questions and Kanji's.		
Unit – V	**Introduction to Relationship in Social Status:**	**9**
Honorific expressions- Respectful expressions- Humble expressions-Polite expressions-Basic Questions and Kanji's.		
		Total:45

TEXT BOOK:

1.	"MINNA NO NIHONGO–Japanese for Everyone", 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1.	Margherita Pezzopane, "Try N5", 2nd Edition, Tankobon Softcover, Japan, 2017.
2.	Sayaka Kurashina, "Japanese Word Speedmaster", 2nd Edition, Tankobon Softcover, Japan, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	read and Understand Relationship of a Person.	Remembering (K1)
CO2	understand Conversations Used in Everyday Activities.	Understanding (K2)
CO3	comprehend Contents at Near Natural Speed.	Understanding (K2)
CO4	understand the Kanji's in Japanese Script..	Understanding (K2)
CO5	comprehend Orally Presented Materials.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO11 -FRENCH LANGUAGE LEVEL 1							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of French Language**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course provides a foundation of the French language as well as an understanding of the French culture and lifestyle of France and other French-speaking nations. The student will be learning how to introduce him/herself and acquire basic everyday vocabulary. By following the structured curriculum and practicing the same as per the learning process, one can comprehend the structure of sentences and respond to basic communications	
Unit – I	**Introduction**	**12**
French and French culture, alphabets, pronunciation, accents, rules, and terms for pronunciation (mas-fem), Salutations, numbers.		
Unit – II	**Daily Life**	**12**
Subject Pronoun, Francophonie's, adjectives – colors, week, months, seasons.		
Unit – III	**Articles and Verbs**	**12**
Articles - Indefinite, definite, partitive, and contracted, (examples), introductions to verbs, 1st group of verb		
Unit – IV	**In the City**	**12**
2nd group of verbs, irregular verbs (avoir, etre, faire …..) present yourself & negative sentences. (faire and Jouer verb with the expressions)		
Unit – V	**Food and Culture**	**12**
Prepositions – preposition of places (country, cities and etc), Imperative mode, invitations, culture – food (wine, cheese ….) Future (recent future)		
		Total:60

TEXT BOOK:	
1.	A1 – saison
REFERENCES:	
1.	Apprenons les francais – 0 and 1
2.	Grammaire – langue et de civilization francaises – Mauger G, Les idees – 0 and 1

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Understand the grammatical structure of the language and introduce self to others.	Remembering (K1)
CO2	Understand basic verbs and appropriate vocabulary.	Understanding (K2)
CO3	Ask for directions and arrange for transportation, etc, as needed.	Understanding (K2)
CO4	Understand the food habits of France and ask for appointments	Understanding (K2)
CO5	Learn to socialize in French-speaking countries	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		**2**
CO2								1	2	3		3		2
CO3								1	2	3		3		2
CO4								1	2	3		3		2
CO5								1	2	3		3		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO12 -FRENCH LANGUAGE LEVEL 2							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of French Language**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course is designed to assist students in developing vocabulary in accordance with the Common European Framework of Reference for Languages at the A2 level. This course will aid in the integration of basic grammar structures as well as the acquisition of vocabulary necessary to comprehend and respond in everyday circumstances. The learner will be able to develop a thorough comprehension of French grammar and confidently express themselves in everyday circumstances.	
Unit – I	**French and You**	**12**
Habits, Strengths & Weakness, Recommendations, Sentiments, Motivations, about favorite films and Types of screens in the movie world, Verbs (Regulars and irregulars), Reflexive Verbs, Prepositions		
Unit – II	**Eat and Repeat**	**12**
Favorite foods, Recopies, Types of meals, Describing House and Kitchen, Presentation of the recipe, Comparatives, Possessive pronouns, Present continuous tense, Simple conditional form		
Unit – III	**Vacation**	**12**
Invitations, presentation, Greetings, Goodbyes, Activities on vacation, past experiences, Describing favorite place, Recommendations on various tours, Past perfect, Past imperfect tense		
Unit – IV	**Likes and Views**	**12**
Favorite persons & things, Giving advice, Experience, Moods, Illness, Discomforts, Symptoms, Roleplay (Doctor & Patient, Guide & Tourist, Pharmacist & Patient), Past perfect, Past indefinite, Imperative		
Unit – V	**Then and Now**	**12**
Habits, customs, circumstances of the past and present, Debates on past and present situations and feelings. Past imperfect tense, Past perfect and Present comparatives.		
		Total:60

TEXT BOOK:

1.	A2 – Saison

REFERENCES:

1.	Apprenons les francais – 0 and 1
2.	Grammaire – langue et de civilization francaises – Mauger G .Les idees – 0 and 1

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Understand the French language in deep and its usage	Remembering (K1)
CO2	Preparation of their Favorite recipes, Know the Objects used in Kitchen and house.	Understanding (K2)
CO3	Converse about their vacation, their Favorite Destination	Understanding (K2)
CO4	Understand complex verbs and be able to communicate about their past experiences	Understanding (K2)
CO5	Know the difference between Past and Present and Compare them.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		
CO2								1	2	3		3		
CO3								1	2	3		3		
CO4								1	2	3		3		
CO5								1	2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO13- FRENCH LANGUAGE LEVEL 3							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of French Language**	**All**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course gives knowledge regarding a variety of personal and professional circumstances, as well as improving vocabulary and speaking abilities to reply to and seek information in those settings. It also gives you the ability to articulate yourself and arrange appointments. With perseverance, one can master all of the essential grammatical structures needed to respond confidently in everyday circumstances. It almost gives you an idea of how Natives communicate.	
Unit – I	**Start Over**	**9**
Use of periphrases, Discuss a day in life, work, problems in the world, Predictions about the future (actions and situations), Hypothetical situations, Imperfect and future tense.		
Unit – II	**Prohibitions and More**	**9**
Prohibitions, Obligations, Habits to change, social customs, Use of the subjunctive, Describe synopsis of Movie and its relation to real life, Debate on books vs movies, usage of connectors, Object Direct and Indirect.		
Unit – III	**Let's be Creative**	**9**
Write a letter by describing the problem, talk about desires and Necessities, propose solutions, Recommendations and Suggestions, Create an Advertisement, Give Instructions, Imperative negative, Use of Object Direct, and Indirect		
Unit – IV	**Travel and Communication**	**9**
Talk about Tours, Types of tourism and communication, Send messages, petitions, Talk to people on the telephone, Roleplay (Tourists and Guide, Tourists and Travel agents), Past Pluscumperfect, All Past tenses.		
Unit – V	**Let's Talk**	**9**
Expression of Interests, Sentiments, Feelings, Sensations, Manias etc. Certain suggestions to make a better future, the use of superlatives, Exclamatory phrases, subjunctives.		
		Total:45

TEXT BOOK:

1.	B1 – Saison

REFERENCES:

1.	Apprenons les francais – 0 and 1
2.	Grammaire – langue et de civilization francaises – Mauger G Les idees – 0 and 1

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Learn on Future tense.	Remembering (K1)
CO2	Understand Permissions and Prohibitions.	Understanding (K2)
CO3	Knowing about Letter writing, Creating Ads, Expressing Desires, and Instructing Others.	Understanding (K2)
CO4	Understanding rules for travel and Enhancing communications.	Understanding (K2)
CO5	Expressing the feelings and emotions using advanced grammar	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		**2**
CO2								1	2	3		3		2
CO3								1	2	3		3		2
CO4								1	2	3		3		2
CO5								1	2	3		3		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO14 - SPANISH LANGUAGE LEVEL 1							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of Spanish Language**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course provides a foundation of the Spanish language as well as an understanding of the Spanish culture and lifestyle of Spain and other Spanish-speaking nations. The student will be learning how to introduce him/herself and acquire basic everyday vocabulary. By following the structured curriculum and practicing the same as per the learning process, one can comprehend the structure of sentences and respond to basic communications.	
Unit – I	**Greetings and Good byes (Los Saludos y Despidirse):**	**12**
Greetings,Self-Introduction , Formal and Informal ways of introducing oneself and others, Alphabets& Numbers, Countries and Languages Spoken, Parts of Grammar – Noun, Personal Pronoun, Describe surroundings and its vocabulary		
Unit – II	**Vida Cotidiana (Daily Life):**	**12**
Time of the day, Days of the week, Months of the year, Seasons, Verb (To be, To Have), Adverbs, Likes and Dislikes, Personality and physical description, simple sentences		
Unit – III	**Friends and Family (Amigos y La Familia):**	**12**
Vocabulary of family, Animals, Professions, Parts of the body, Opinions on family cultures, Articles – Definite and Indefinite, Hobbies, Regular and Irregular verbs.		
Unit – IV	**In the City (En la Cuidad):**	**12**
Buildings in the city, Name of the places, asking for directions, Helping each other, Description of house and its components, Modes of Transport, Grammar - Possessive articles, prepositions		
Unit – V	**Food and Culture(La comida y cultura):**	**12**
Food (types and varieties) , shopping, ordering at a restaurant, inviting to parties, Roleplay (as diner and customer, salesman and customer…etc.) Past tense (all three tenses-Past Participle, Indefinite past and past imperfect- (to be and to have)		
		Total:60

TEXT BOOK:

1.	Chicos Chicas Libro de Alumno nivel 1, Ma Angeles Palomino , edelsa, GRUPO DIDASCALIA, S.A., plaza cuidad de salta,3-28043 MADRID(ESPANA).

REFERENCES:

1.	https://nuevadelhi.cervantes.es/en/spanish_courses/students/spanish_general_courses/spanish_courses_level_a1.htm

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the grammatical structure of the language and introduce self to others.	Remembering (K1)
CO2	understand basic verbs and appropriate vocabulary.	Understanding (K2)
CO3	ask for directions and arrange for transportation, etc, as needed.	Understanding (K2)
CO4	understand the food habits of Spain and Latin countries and ask for appointments	Understanding (K2)
CO5	learn to socialize in Spanish speaking countries	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		**2**
CO2								1	2	3		3		2
CO3								1	2	3		3		2
CO4								1	2	3		3		2
CO5								1	2	3		3		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO15 - SPANISH LANGUAGE LEVEL 2							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of Spanish Language**	**All**	**OE**	**4**	**0**	**0**	**4**

Preamble	This course aims to help the Learner to acquire the vocabulary as per theframework of Spanish language A2 level competence. This course will help to assimilate the basicgrammar structures and gain vocabulary to understand and reciprocate in daily life situations on a broader sense. A thorough learner will be able to gain a comprehensive understanding of the Spanish grammar and confidently articulate in day today situations.	
Unit – I	**Spanish and You (El Español y tú)**	**12**
Habits, Strengths & Weakness, Recommendations, Sentiments, Motivations, About favorite films and Types of screens in the movie world, Verbs(Regulars and irregulars), Reflexive Verbs, Prepositions		
Unit – II	**Eat and Repeat (**Comer y repetir**)**	**12**
Favorite foods, Recipies, Types of meals, Describing House and Kitchen, Presentation of recipe, Comparatives, Possessive pronouns, Present continuous tense, Simple conditional form		
Unit – III	**Its Vacation Time (**Tiempo de vacaciones)	**12**
Invitations, presentation, Greetings, Goodbyes, Activities on vacation, past experiences, Describing favorite place, Recommendations on various tours, Past perfect, Past imperfect tense, Usage of Todavia or No		
Unit – IV	**Likes and Views (**Gustasyvistas)	**12**
Favorite persons & things, Giving advices, Experience, Moods, Illness, Discomforts, Symptoms, Roleplay (Doctor & Patient, Guide & Tourist, Pharmacist & Patient), Past perfect, Past indefinite, Imperative		
Unit – V	**Then and Now(Antes y Ahora)**	**12**
Habits, customs, circumstances of the past and present, Debates on past and present situations and feelings. Past imperfect tense, Past perfect and Present comparatives.		
		Total:60

TEXT BOOK:

1.	AULA INTERNACIONAL 2 (A2) Jaime Corpas, AgusinGarmendia, Nuria Sanchez, Carmen Soriano Goyal Publishers and Distributors Pvt LTD, 86, UB Jawahar Nagar, Kamla Nagar, Delhi-110007.

REFERENCES:

1.	https://nuevadelhi.cervantes.es/en/spanish_courses/students/spanish_general_courses/spanish_courses_level_a1.htm

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the Spanish language in deep and its usage	Remembering (K1)
CO2	prepare for their Favorite recipes, Know the Objects used in Kitchen and house.	Understanding (K2)
CO3	converse about their vacation, their Favorite Destination	Understanding (K2)
CO4	understand complex verbs and be able to communicate about their past experiences	Understanding (K2)
CO5	know the difference between Past and Present and Comparing them.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		**2**
CO2								1	2	3		3		2
CO3								1	2	3		3		2
CO4								1	2	3		3		2
CO5								1	2	3		3		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO16 - SPANISH LANGUAGE LEVEL 3							
(Offered by Department of Electronics and Communication Engineering)							
Programme& Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of Spanish Language**	**All**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course provides enriching information about various everyday situations in personal and professional life and enhances the vocabulary and speaking ability to respond to and also seek information in those situations. It also equips one to express opinions and negotiate appointments. With diligent learning one can capture all basic grammatical structure to answer confidently in everyday situations. It almost gives a basic idea on how Natives speak.
Unit – I	**Start Over(Volver a Empezar)** **9**
Use of periphrases, Discuss a day in life, work, problems in the world, Predictions about future (actions and situations),Hypothetical situations, Imperfect and future tense.	
Unit – II	**Prohibitions and More(Prohibiciones y mas)** **9**
Prohibitions, Obligations, Habits to change, social customs, Use of subjunctive, Describe synopsis of Movie and its relation to real life, Debate on books vs movies, usage of connectors, Object Direct and Indirect.	
Unit – III	**Let's be Creative (Seamoscreatives)** **9**
Write a letter by describing the problem,talk about desires and Necessities, propose solutions, Recommendations and Suggestions, Create an Advertisement, Give Instructions, Imperative negative, Use of Object Direct and Indirect.	
Unit – IV	**Travel and Communication (Viajar y comunicar)** **9**
Talk about Tours, Types of tourism and communication, Send messages, petitions, Talk to people on telephone, Role play(Tourists and Guide, Tourists and Travel agents), Past Pluscumperfect, All Past tenses.	
Unit – V	**Let's Talk(Hablemos)** **9**
Expression of Interests, Sentiments, Feelings, Sensations, Manias etc. Certain suggestions to make a better future, use of superlatives, Exclamatory phrases, subjunctive.	
	Total:45

TEXT BOOK:

1. Aula International 3 (B1) [Paperback] Jaime Corpas, Agusin Garmendia, Nuria Sanchez, Carmen Soriano Goyal Publishers and Distributors Pvt LTD, 86, UB Jawahar Nagar, Kamla Nagar, Delhi-110007.

REFERENCES:

1. https://nuevadelhi.cervantes.es/en/spanish_courses/students/spanish_general_courses/spanish_courses_level_a1.htm

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	learn on Future tense.	Remembering (K1)
CO2	understand about Permissions and Prohibitions.	Understanding (K2)
CO3	knowing about Letter writing, Creating Ads, Expressing Desires and Instructing Others.	Understanding (K2)
CO4	understanding rules for travel and Enhance communications.	Understanding (K2)
CO5	expressing the feelings and emotions using advanced grammar	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	3		3		**2**
CO2								1	2	3		3		2
CO3								1	2	3		3		2
CO4								1	2	3		3		2
CO5								1	2	3		3		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	75	25					100
CAT2	25	75					100
CAT3	25	75					100
ESE	25	75					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO17 - ENTREPRENEURSHIP DEVELOPMENT							
(Offered by Department of Mechatronics Engineering)							
Programme & Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Engineering Economics & Management**	**7**	**OE**	**3**	**0**	**0**	**3**

Preamble	The purpose of this course to create entrepreneurial awareness among engineering students.	
Unit – I	**Entrepreneurship Concepts:**	**9**
Entrepreneurship & Entrepreneur- Role in Economic Development - Factors affecting Entrepreneurship- Creativity and Innovation - Entrepreneurship vs Intrapreneurship- Entrepreneurial Motivation factors – Types of Entrepreneurship & Entrepreneurs - Characteristics of Entrepreneurs -Entrepreneurship Development in India		
Unit – II	**Entrepreneurial Ventures and opportunity assessment:**	**9**
New venture creation – Bootstrapping,Minipreneurship, Start-ups, Acquiring, Franchising & Social venturing - Venture development stages - Models of market opportunity- Opportunity assessment: Critical Factors In Opportunity Assessment, Idea vs Opportunity, Evaluation process, Global opportunities for entrepreneurs.		
Unit – III	**Business Plan:**	**9**
Designing Business Model- Business Model Canvas- Objectives of a Business Plan - Business Planning Process – Structure of a Business Plan – Technical, Marketing, Financial Feasibility assessment - Competitive analysis - Common errors in Business Plan formulation - Presentation of the Business Plan: The 'Pitch'- case studies		
Unit – IV	**Financing and accounting:**	**9**
Forms of entrepreneurial capital – Sources of Financial capital: debt financing- Commercial banks and other sources, equity financing: Initial Public offering (IPO), Private placement - Venture capitalists - Angel investors-New forms of financing: Impact investors, Micro-financing, Peer-to-Peer Lending, Crowd funding - Natural capital. Preparing Financial Budget, Break even analysis, Taxation-Direct and indirect taxes, Insolvency and Bankruptcy- Case Study		
Unit – V	**Small Business Management:**	**9**
Definition of Small Scale Industries: Strengths and Weaknesses, Sickness in Small Enterprises: Symptoms -Causes and remedies- Indian Startup Ecosystem – Institutions supporting small business enterprises, Business Incubators – Government Policy for Small Scale Enterprises - Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger, FDI and Sub-Contracting		
		Total:45

TEXT BOOK:

1.	Donald F. Kuratko,"Entrepreneurship: Theory, Process, Practice", 11th Edition, Cengage Learning, Boston, 2020.

REFERENCES:

1.	Robert D. Hisrich, Michael P. Peters & Dean A. Shepherd, Sabyasachi Sinha "Entrepreneurship", 11th Edition, McGraw Hill, Noida, 2020.
2.	Charantimath Poornima .M, "Entrepreneurship Development and Small Business Enterprises", 3rd Edition, Pearson Education, Noida, 2018.
3.	Gordon E & Natarajan K, "Entrepreneurship Development", 6th Edition, Himalaya Publishing House, Mumbai, 2017.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the importance of entrepreneurship and demonstrate the traits of an entrepreneur	Applying (K3)
CO2	identify suitable entrepreneurial ventures and business opportunity	Applying (K3)
CO3	assess the components of business plan	Analyzing (K4)
CO4	appraise the sources of finance and interpret accounting statements	Applying (K3)
CO5	interpret the causes of sickness of small scale enterprises and its remedies	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						2	2	1	1		3	2		
CO2	1	2	2	2		2	2	1	1		3	2		
CO3	2	2	2	2	2	2	2	2	2	2	3	2		
CO4	1	1	2	1		2	1	1	1	2	3	2		
CO5	1	1	2	1		2	1	1	1	2	3	2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	30	30	20			100
CAT3	30	30	40				100
ESE	10	30	40	20			100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22GEO18 - FUNDAMENTALS OF HINDI LANGUAGE								
(Offered by Department of English)								
Programme & Branch	**All B.E/B.Tech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**MP**	**Credit**
Prerequisites	**Nil**	**5 / 6**	**OE**	**4**	**0**	**0**	**NE**	**4**
Preamble	This course is designed to provide a strong foundation in Hindi language and equip the learners with the skills required to communicate effectively in workplace and various real- life situations.							
Unit – I	**Basics of Hindi Language**							**12**
Vowels and Consonants - Two letter words - Three letter words - Four letter words - Barah Khadi - Names: Fruits - Vegetables - Colours - Birds - Animals - Taste - Parts of the body								
Unit – II	**Numerals, Vocabulary and Verbs**							**12**
Numerals - Meanings and Opposites - Singular and Plural words - Gender - Relationships - Days of the week - Time - Weather - Subject - Verb - Object - Noun - Pronoun - Adverb - Commanding verbs - Simple sentences								
Unit – III	**Basic Grammar and Translation**							**12**
Conjunction - Interrogative words - Present tense - Present continuous tense. - Past tense - Past continuous tense - Future tense - Future continuous tense - Translation								
Unit – IV	**Greetings and Conversations**							**12**
Self introduction - Formal and informal greetings - Conversations - Hotel Manager and Traveller - College Student and Professor - Telephonic conversations - Name of the groceries and recipes								
Unit – V	**Reading and Writing**							**12**
Name of the Professions - Months - Sentiment words in Hindi - Dialogue writing - Letter writing – Reading Comprehension - Sharing one's own experience								
								Total:60

TEXT BOOK:

1.	Shanthi Vishwanathan, Spoken Hindi, ADORO Multi Media Publication, Coimbatore, 2020.

REFERENCES:

1.	V.Anbumani, Neengalum Pesalaam Hindi, Kaakitham Publication, Tamilnadu, 2017.
2.	Rajiv Ranjan, Basic Hindi I, Michigan state University Libraries, 2021.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the basics of Hindi language.	Understanding (K2)
CO2	read sentences and construct simple sentences in Hindi language.	Understanding (K2)
CO3	apply rules of Hindi grammar to write in Hindi language.	Applying (K3)
CO4	listen and express ideas using appropriate vocabulary in Hindi.	Applying (K3)
CO5	speak confidently in Hindi in different professional and real time contexts.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1									1	3		1		
CO2									2	3		2		
CO3									2	3		2		
CO4									2	3		3		
CO5									2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**-**	**50**	**50**	**-**	**-**	**-**	**100**
CAT2	**-**	**50**	**50**	**-**	**-**	**-**	**100**
CAT3	**-**	**33**	**67**	**-**	**-**	**-**	**100**
ESE	**-**	**47**	**53**	**-**	**-**	**-**	**100**

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22GEO18 - FUNDAMENTALS OF HINDI LANGUAGE								
(Offered by Department of English)								
Programme & Branch	**All B.E/B.Tech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**MP**	**Credit**
Prerequisites	**Nil**	**5 / 6**	**OE**	**4**	**0**	**0**	**NE**	**4**
Preamble	This course is designed to provide a strong foundation in Hindi language and equip the learners with the skills required to communicate effectively in workplace and various real- life situations.							
Unit – I	**Basics of Hindi Language**							**12**
Vowels and Consonants - Two letter words - Three letter words - Four letter words - Barah Khadi - Names: Fruits - Vegetables - Colours - Birds - Animals - Taste - Parts of the body								
Unit – II	**Numerals, Vocabulary and Verbs**							**12**
Numerals - Meanings and Opposites - Singular and Plural words - Gender - Relationships - Days of the week - Time - Weather - Subject - Verb - Object - Noun - Pronoun - Adverb - Commanding verbs - Simple sentences								
Unit – III	**Basic Grammar and Translation**							**12**
Conjunction - Interrogative words - Present tense - Present continuous tense. - Past tense - Past continuous tense - Future tense - Future continuous tense - Translation								
Unit – IV	**Greetings and Conversations**							**12**
Self introduction - Formal and informal greetings - Conversations - Hotel Manager and Traveller - College Student and Professor - Telephonic conversations - Name of the groceries and recipes								
Unit – V	**Reading and Writing**							**12**
Name of the Professions - Months - Sentiment words in Hindi - Dialogue writing - Letter writing – Reading Comprehension - Sharing one's own experience								
								Total:60

TEXT BOOK:

1.	Shanthi Vishwanathan, Spoken Hindi, ADORO Multi Media Publication, Coimbatore, 2020.

REFERENCES:

1.	V.Anbumani, Neengalum Pesalaam Hindi, Kaakitham Publication, Tamilnadu, 2017.
2.	Rajiv Ranjan, Basic Hindi I, Michigan state University Libraries, 2021.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the basics of Hindi language.	Understanding (K2)
CO2	read sentences and construct simple sentences in Hindi language.	Understanding (K2)
CO3	apply rules of Hindi grammar to write in Hindi language.	Applying (K3)
CO4	listen and express ideas using appropriate vocabulary in Hindi.	Applying (K3)
CO5	speak confidently in Hindi in different professional and real time contexts.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1									1	3		1		
CO2									2	3		2		
CO3									2	3		2		
CO4									2	3		3		
CO5									2	3		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**-**	**50**	**50**	**-**	**-**	**-**	**100**
CAT2	**-**	**50**	**50**	**-**	**-**	**-**	**100**
CAT3	**-**	**33**	**67**	**-**	**-**	**-**	**100**
ESE	**-**	**47**	**53**	**-**	**-**	**-**	**100**

* ±3% may be varied (CAT 1, 2 & 3 – 50 marks & ESE – 100 marks)

22GEX01 – NCC STUDIES (ARMY WING) – I							
(Offered by Department of Electrical and Electronics Engineering)							
Programme & Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5 / 6**	**OE**	**3**	**0**	**2**	**4**

Preamble	This course is designed especially for NCC Cadets. This course will help develop character, camaraderie, discipline, secular outlook, the spirit of adventure, sportsman spirit and ideals of selfless service amongst cadets by working in teams, learning military subjects including weapon training.	
Unit - I	**NCC Organisation & National Integration**	**9**
NCC Organisation – History of NCC- NCC Organisation- NCC Training- NCC Uniform – Promotion of NCC cadets – Aim and advantages of NCC Training- NCC badges of Rank- Honours and Awards – Incentives for NCC cadets by central and state govt. National Integration- Unity in diversity- contribution of youth in nation building- national integration council- Images and Slogans on National Integration.		
Unit - II	**Basic physical Training & Drill**	**9**
Basic physical Training – various exercises for fitness(with Demonstration)-Food – Hygiene and Cleanliness. Drill- Words of commands- position and commands- sizing and forming- saluting- marching- turning on the march and wheeling- saluting on the march- side pace, pace forward and to the rear- marking time- Drill with arms- ceremonial drill- guard mounting. (WITH DEMONSTRATION)		
Unit - III	**Weapon Training**	**9**
Main Parts of a Rifle- Characteristics of 5.56mm INSAS rifle- Characteristics of .22 rifle- loading and unloading – position and holding- safety precautions – range procedure- MPI and Elevation- Group and Snap shooting- Long/Short range firing(WITH PRACTICE SESSION) - Characteristics of 7.62mm SLR- LMG- carbine machine gun.		
Unit - IV	**Social Awareness and Community Development**	**9**
Aims of Social service-Various Means and ways of social services- family planning – HIV and AIDS- Cancer its causes and preventive measures- NGO and their activities- Drug trafficking- Rural development programmes - MGNREGA-SGSY-JGSY-NSAP-PMGSY- Terrorism and counter terrorism- Corruption – female foeticide -dowry –child abuse-RTI Act- RTE Act- Protection of children from sexual offences act- civic sense and responsibility		
Unit - V	**Specialized Subject (ARMY)**	**9**
Basic structure of Armed Forces- Military History – War heroes- battles of Indo-Pak war- Param Vir Chakra- Career in the Defence forces- Service tests and interviews-Fieldcraft and Battlecraft-Basics of Map reading including practical.		
		Lecture :45, Practical:30, Total:75

TEXT BOOK:

1.	National Cadet Corps- A Concise handbook of NCC Cadets by Ramesh Publishing House, New Delhi, 2014

REFERENCES:

1.	Cadets Handbook – Common Subjects SD/SW published by DG NCC, New Delhi.
2.	Cadets Handbook- Specialized Subjects SD/SW published by DG NCC, New Delhi
3.	NCC OTA Precise published by DG NCC, New Delhi.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	display sense of patriotism, secular values and shall be transformed into motivated youth who will contribute towards nation building through national unity and social cohesion.	Applying (K3)
CO2	demonstrate Health Exercises, the sense of discipline, improve bearing, smartness, turnout, develop the quality of immediate and implicit obedience of orders..	Applying (K3)
CO3	basic knowledge of weapons and their use and handling.	Applying (K3)
CO4	understanding about social evils and shall inculcate sense of whistle blowing against such evils and ways to eradicate such evils	Applying (K3)
CO5	acquaint, expose & provide knowledge about Army/Navy/ Air force and to acquire information about expansion of Armed Forces, service subjects and important battles.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3	3	3	3	3				
CO2					3									
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	-	-	-	-	-	-
CAT2	-	-	-	-	-	-	-
CAT3	-	-	-	-	-	-	-
ESE	The examination and award of marks will be done by the Ministry of Defence, Government of India which includes all K1 to K6 knowledge levels. The maximum marks for the End Semester Examination is 500 marks. It will be converted to 100 marks.						

22GEX02 - NCC STUDIES (AIR WING) – I							
(Offered by Department of Information Technology)							
Programme & Branch	**All BE/BTech Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5 / 6**	**OE**	**3**	**0**	**2**	**4**

Preamble	This course is designed especially for NCC Cadets. This course will help develop character, camaraderie, discipline, secular outlook, the spirit of adventure, sportsman spirit and ideals of selfless service amongst cadets by working in teams, honing qualities such as self-discipline, self-confidence, self-reliance and dignity of labour in the cadets.	
Unit–I	**NCC Organization and National Integration**	**9+3**
NCC Organization – History of NCC- NCC Organization- NCC Training- NCC Uniform – Promotion of NCC cadets – Aim and advantages of NCC Training - NCC badges of Rank - Honors' and Awards – Incentives for NCC cadets by central and state govt. History and Organization of IAF - Indo-Pak War-1971 - Operation Safed Sagar. National Integration - Unity in diversity - contribution of youth in nation building - national integration council - Images and Slogans on National Integration.		
Unit–II	**Drill and Weapon Training**	**9+3**
Drill- Words of commands - position and commands - sizing and forming - saluting - marching - turning on the march and wheeling - saluting on the march - side pace, pace forward and to the rear - marking time - Drill with arms - ceremonial drill - guard mounting.(WITH DEMONSTRATION). Main Parts of a Rifle - Characteristics of .22 rifle - loading and unloading – position and holding - safety precautions – range procedure - MPI and Elevation - Group and Snap shooting - Long/Short range firing (WITH PRACTICE SESSION).		
Unit–III	**Principles of Flight**	**9+3**
Laws of motion-Forces acting on aircraft – Bernoulli's theorem - Stalling - Primary control surfaces – secondary control surfaces - Aircraft recognition.		
Unit-IV	**Aero Engines**	**9+3**
Introduction of Aero engine -Types of engine - piston engine - jet engines - Turbo prop engines-Basic Flight Instruments - Modern trends.		
Unit–V	**Aero Modeling**	**9+3**
History of aeromodeling - Materials used in Aero-modeling - Types of Aero-models – Static Models - Gliders - Controlline models - Radio Control Models - Building and Flying of Aero-models.		
		Lecture:45, Tutorial:30, Total:75

TEXT BOOK:

1.	"National Cadet Corps - A Concise handbook of NCC Cadets", Ramesh Publishing House, NewDelhi, 2014.

REFERENCES/ MANUAL / SOFTWARE:

1.	"Cadets Handbook – Common Subjects SD/SW", DGNCC, New Delhi.
2.	"Cadets Handbook – Specialised Subjects SD/SW", DGNCC, New Delhi.
3.	"NCCOTA Precise", DGNCC, New Delhi.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	build sense of patriotism, secular values and shall be transformed into motivated youth who will carry out nation building through national unity and social cohesion.	Applying (K3)
CO2	demonstrate the sense of discipline with smartness and have basic knowledge of weapons and their use and handling	Applying (K3)
CO3	illustrate various forces and moments acting on aircraft	Applying (K3)
CO4	outline the concepts of aircraft engine and rocket propulsion	Applying (K3)
CO5	design, build and fly chuck gliders/model air planes and display static models.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3	3	3	3	3				
CO2					3									
CO3	3	2	1	1										
CO4	3	2	1	1										
CO5	3	2	1	1										

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	-	-	-	-	-	-
CAT2	-	-	-	-	-	-	-
CAT3	-	-	-	-	-	-	-
ESE	The examination and award of marks will be done by the Ministry of Defence, Government of India which includes all K1 to K6 knowledge levels. The maximum marks for the End Semester Examination is 500 marks. It will be converted to 100 marks.						

22MBO01 - COST ACCOUNTING FOR ENGINEERS
(Offered by Department of Management)

Programme& Branch	All BE/B. Tech Programme	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	OE	3	1	0	4

Preamble	To provide an In-depth study of the Cost Accounting principles and techniques for identification, analysis and classification of costs components to facilitate decision Making.	
Unit – I	**Introduction to Cost Accounting**	**9 + 3**
Introduction to Cost Accounting: Meaning - Scope, objectives and significance of Cost Accounting its relationship with financial accounting and management accounting– cost centres – cost units – Elements of cost – classification of cost – preparation of cost sheet.		
Unit – II	**Cost Ascertainment – Elements of cost**	**9 + 3**
Material Costs: Procurement of materials – Inventory management and control – scrap, spoilage, defectives and wastage **Labour Costs:** Time Keeping, Time booking and payroll – Labour turnover – principles and methods of remuneration and incentive schemes. **Overheads:** Collection, classification and apportionment and allocation of overheads.		
Unit – III	**Basic Costing Methods**	**9 + 3**
Operating Costing - Meaning - Preparation of Operating Cost Sheet - Transport Costing - Power Supply Costing - Hospital Costing.		
Unit – IV	**Advanced Costing Methods**	**9 + 3**
Features of Job Costing - Batch Costing - Preparation of Cost Sheet Under Job Costing, and Batch Costing - Process Costing - Process Loss - Normal and Abnormal Loss.		
Unit – V	**Cost Accounting Techniques**	**9 + 3**
Budget and Budgetary Control: Budgetary control as a management Tool – Installation of Budgetary control system classification of budgets – Fixed and Flexible Budgeting. **Standard Costing and Variance Analysis:** Budgetary control and standard costing – Suitability of standard costing – Standard costing as a management Tool – Cost variances – Direct material cost variances – Direct labour cost variances – Overhead variances – Sales variance.		
		Lecture: 45, Tutorial: 15, Total:60

TEXT BOOKS

1.	JawaharLal, SeemaSrivastava, Manisha Singh, “ Cost Accounting, Text, Problems and Cases”, 6th Edition, McGraw Hill Education, New Delhi, 2020.
2.	William Lanen, Shannon Anderson and Michael Maher, “Fundamentals of cost Accounting”,7th Edition, McGraw Hill Education, New Delhi, 2020.

REFERENCES

1.	M.N.Arora and PriyankaKatyal, “Cost Accounting”, 5th Edition, Vikas publishing House, New Delhi, 2023.
2.	Ravi M.Kishore, “ Cost and Management Accounting”, 6th Edition, Taxmann, New Delhi, 2021
3.	M.N.Arora, “Cost and Management Accounting”,11th Edition, Vikas Publishing, New Delhi, 2021.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the conceptual frame work of cost accounting	Understanding (K2)
CO2	understand the basic concepts and process in determination of cost of product and services	Understanding (K2)
CO3	use the basic costing methods in different business situation	Applying (K3)
CO4	demonstrate the advanced costing methods in various decision making situation	Applying (K3)
CO5	prepare various types of budgets and determine variance in different situations.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1										2	3	1		
CO2										2	3	1		
CO3										2	3	1		
CO4										2	3	1		
CO5										2	3	1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	--	40	60	--	--	--	100
CAT2	--	40	60	--	--	--	100
CAT 3	--	40	60	--	--	--	100
ESE	--	20	80	--	--	--	100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MBO02 - ECONOMIC ANALYSIS FOR DECISION MAKING
(Offered by Department of Management)

Programme& Branch	All BE/B. Tech Programme	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	The course aims at introducing a few vital techniques required for carrying out economic analysis for making informed managerial decisions.	
Unit – I	**Economic Optimization**	**9 + 3**
Economic Optimization: Theory of firm – Business versus Economic profit – Revenue relations – Cost relations – Profit relations – Marginal versus incremental concept.		
Unit – II	**Forecasting**	**9 + 3**
Forecasting: Forecasting applications – Techniques –Naive method – Moving average – Exponential smoothing - Trend analysis – Linear Trend – Growth Trend – Sales, cost and revenue forecasting.		
Unit – III	**Production and Cost Analysis**	**9 + 3**
Production: Production function – Returns to scale and returns to factor – Total, managerial and average product – Law of diminishing returns – Optimal input usage – Production function estimation. **Cost Analysis:** Economic and Accounting costs – Time in cost analysis – Short run cost – Long run cost – cost relations – cost volume – profit analysis.		
Unit – IV	**Competitive Market Analysis**	**9 + 3**
Competitive Market Analysis: Characteristics of competitive markets – Profit maximisation – Marginal analysis in competition – competitive market supply curve – Equilibrium in competitive markets - Monopoly – Monopolistic competition.		
Unit – V	**Game theory and Competitive Strategy**	**9 + 3**
Game Theory Basics - Prisoner's Dilemma - Saddle Point - Two Person Zero Sum Game - Games without Saddle Points - Dominance Rule - Mixed Strategies.		
		Lecture: 45, Tutorial: 15, Total:60

TEXT BOOKS

1.	Mark Hirschey, “Managerial Economics”, 12th Edition, Cengage Learning, New Delhi, 2022.
2.	Geetika, PiyaliGhosh, Purba Roy Choudhury, “Managerial Economics”, 3rd Edition, McGraw Hill Education, New Delhi, 2019.

REFERENCES

1.	Gupta. G, “Managerial Economics”, 2nd Edition, McGraw Hill Education, New Delhi, 2019.
2.	Ahuja. H. L, “Principles of Microeconomics”, 22nd Edition, S. Chand Publishing, New Delhi, 2019.
3.	PanneerSelvam R, P. Sivasankaran, P. Senthilkumar., “Managerial Economics”, 1st Edition, Cengage Learning, New Delhi, 2018.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Understand revenue, cost and profit relations and apply techniques to find best course of action.	Applying (K3)
CO2	Apply appropriate forecasting techniques for estimating sales, cost and revenue.	Applying (K3)
CO3	Understand the relation between inputs and output of production system and perform cost – volume – profit analysis	Applying (K3)
CO4	Apply market equilibrium concepts in monopoly and monopolistically competitive markets.	Applying (K3)
CO5	Understand game theory and apply in different strategic decisions	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1									3	1				
CO2									3	1				
CO3									3	2				
CO4									3		2			
CO5									3		1			

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	--	40	60	--	--	--	100
CAT2	--	40	60	--	--	--	100
CAT 3	--	50	50	--	--	--	100
ESE	--	20	80	--	--	--	100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

22MBO03 - MARKETING ANALYTICS
(Offered by Department of Management)

Programme& Branch	**All BE/B. Tech Programme**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**6**	**OE**	**3**	**1**	**0**	**4**

Preamble	Marketing analytics enables marketers to measure, manage and analyze marketing performance to maximize its effectiveness and optimize return on investment (ROI). This course exposes the students with the tools to measure customer value and apply analytic tools to various marketing decisions.	
Unit – I	**Market & Marketing Analytics**	**9 + 3**

Introduction - Introduction to marketing analytics, Models & Metrics
Market Insight - Market sizing.
Market Segmentation –Segmentation, Targeting & Positioning

Unit – II	**Business & Competition**	**9 + 3**

Competitive Analysis - Competitor identification, analysis, and actions
Business Strategy –Scenarios, Decision Model, Metrics
Business Operations - Forecasting

Unit – III	**Product and Price**	**9 + 3**

Product and Service Analytics - Conjoint analysis and product/service metrics
Price Analytics - Pricing techniques and assessment

Unit – IV	**Distribution & Promotion**	**9 + 3**

Distribution Analytics –Characteristics, Channel evaluation and selection, Multichannel distribution and metrics.
Promotion Analytics - Promotion budget estimation and allocation, Metrics

Unit – V	**Sales**	**9 + 3**

Sales Analytics - Metrics for sales, profitability, and support

Lecture: 45, Tutorial: 15, Total:60

TEXT BOOKS

1.	Stephen Sorger, "Marketing Analytics: Strategic Models and Metrics", 1st Edition, Admiral Press, UK, 2016.
2.	Wayne L. Winston, "Marketing Analytics: Data-Driven Techniques with Microsoft Excel", 1st Edition, Wiley, New Delhi, 2018.

REFERENCES

1.	Tommy Blanchard, "Data Science for Marketing Analytics", 1st Edition, Packt Publishing, UK, 2019.
2.	Mike Grigsby, "Marketing Analytics", 2nd Edition, Kogan Page, UK, 2018.
3.	David A. Aaker, V. Kumar, Robert P. Leone, George S. Day., "Marketing Research", 1st Edition, Wiley, New Delhi, 2019.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Understand the importance of Analytics in Marketing, size and segment the market	Understanding (K2)
CO2	Understand the Business, competition and its related decisions.	Understanding (K2)
CO3	Identify important features of a product and suitable pricing methods.	Applying (K3)
CO4	Assess Channel performance and Promotion Metrics.	Applying (K3)
CO5	Assess sales performance.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1									3	1				
CO2									3	1				
CO3									3	2				
CO4									3		2			
CO5									3		1			

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	--	40	60	--	--	--	100
CAT2	--	40	60	--	--	--	100
CAT 3	--	40	60	--	--	--	100
ESE	--	20	80	--	--	--	100

* ±3% may be varied (CAT 1,2 & 3 – 50 marks & ESE – 100 marks)

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE-638060

(AUTONOMOUS)

BOARD OF CHEMICAL ENGINEERING

DEGREE & PROGRAMME: **B.Tech– Chemical Engineering**

HONOURS DEGREE TITLE:**Petroleum and Petrochemical Engineering**

The following courses are identified to earn additional 18 credits to get an Honours degree with specialization in Petroleum and Petrochemical Engineering

S.No	Course Code	Course Title	Credits	Prerequisites	Semester
1.	22CHJ01	Testing and Analysis of Petroleum Products	4	Nil	5
2.	22CHH01	Petroleum Production and Artificial Lift Systems	3	Nil	5
3.	22CHJ02	Petroleum Refinery Modeling and Simulation	4	Nil	6
4.	22CHH02	Petroleum Reservoir and Natural Gas Engineering	4	Nil	6
5.	22CHH03	Petrochemical Technology	3	Nil	7
		TOTAL	**18**		

22CHJ01 - TESTING AND ANALYSIS OF PETROLEUM PRODUCTS

Programme & Branch	**B.Tech Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5/6/7**	**HN**	**3**	**0**	**2**	**4**

Preamble	This course discusses various testing and analytical techniques for petroleum products

Unit – I | Introduction: | 9

Petroleum and its products –Classes of feedstock and products, Key Properties. Foundations of Analytical Methods – Chemical and Physical Analyses, Chromatography, Spectroscopy, Molecular weight determination, Recent advancements. ASTM and API Standards

Unit – II | Crude Oil Testing: | 9

Crude oil Sampling, Preliminary Evaluation – Gravity, Sulfur, Salt Content, Water and Sediments, Viscosity, Pour Point, LH analysis, Characterization factor. Comprehensive analysis

Unit – III | Sampling techniques: | 9

Liquid Sampling – Types of sampling, Volumetric Measurement, Validation, Assay and Specifications. Gas Sampling – Types of gases and sampling techniques, storage and test methods.

Unit – IV | Testing of Petro-products I: | 9

Naphtha and Solvents – Introduction, key properties, Test Methods, Storage. Gasoline – Introduction, Key properties, Volatility requirements, Octane rating, additives, Test Methods, Aviation and Marine fuel – Test methods

Unit – V | Testing of Petro-products II: | 9

Key Properties and Testing Methods - Kerosene, Diesel, White Oil, Fuel Oil, Lubricating Oil, Grease, Was, Asphalt, Coke, Carbon Black

LIST OF EXPERIMENTS / EXERCISES:

1.	Perform ASTM Distillation process for the given oil
2.	Determine Octane number and Cetane number of fuels
3.	Determine smoke point of given liquid fuel
4.	Determine calorific value of liquid fuel
5.	Identify flash and fire points of petrol and diesel
6.	Determine viscosity for the given fuel and lubricant
7.	Identify cloud and pour point for liquid fuel and lubricant
8.	Measure vapor pressure for gasoline fuel
9.	Measure carbon residue for liquid fuel
10.	Conduct corrosion test for liquid fuel and lubricant
11.	Identify drop point of grease
12.	Conduct mechanical penetration test of grease

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	B.K. Bhaskara Rao, “Modern Petroleum Refining Processes”, CBS Publishers, 6th Edition, 2018.
2.	James G Speight, “Handbook of Petroleum Product Analysis”, Wiley, USA, 2015.

REFERENCES/ MANUAL / SOFTWARE:	
1.	R. A. Nadkarni, "'Guide to ASTM Test Methods for the Analysis of Petroleum Products and Lubricants", ASTM, USA, 2000.
2.	ASTM Committee D2,"Significance of Tests for Petroleum Products", ASTM, USA, 1977.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Understand the foundation aspects of analytical techniques and key properties of petroleum products	Understanding (K2)
CO2	Perform variousstandard testson crude oil and determine octane number, cetane number, smoke point and calorific value for the given liquid fuel	Applying (K3)/ Manipulating(S2)
CO3	Discuss various sampling techniques for gas and liquid hydrocarbons	Understanding (K2)
CO4	Perform various testing procedures on naphtha, gasoline and aviation fuels	Applying (K3)/ Manipulating(S2)
CO5	Perform variousstandard testson Kerosene, diesel, Lubricating oil and other petroleum productsand find the carbon residue, corrosive nature of liquid fuel/ lubricant and the mechanical properties of grease	Applying (K3)/ Manipulating(S2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	1				1	1			3	2
CO2	3	3	2	1	1				1	1			3	2
CO3	3	3	2	1	1				1	1			3	2
CO4	3	3	2	1	1				1	1			3	2
CO5	3	3	2	1	1				1	1			3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		70	30				100
CAT2		70	30				100
CAT3		70	30				100
ESE		70	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHH01 -PETROLEUM PRODUCTION AND ARTIFICIAL LIFT SYSTEMS							
Programme & Branch	**B.Tech Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5/6/7**	**HN**	**3**	**0**	**0**	**3**

Preamble	This course discusses the fundamentals of Petroleum production and its air lift systems	
Unit – I	**Petroleum production systems and wellbore flow:**	**9**
Introduction to oil and gas, drilling and well completion, Production facilities – Types of facilities, Well head and Manifold, Stage separation and selection of stages, Well performance testing, Wellbore flow fundamentals, density and viscosity correlations, sanding, liquid loading, Inflow performance relationships, multiphase flow		
Unit – II	**Introduction to Artificial lift:**	**9**
Overview of artificial lifts, selection criteria of artificial lift systems.Sucker rod pumping system systems, surface and subsurface equipment, power requirements, rod design and selection, design calculations.Pump fillage, Gas lock, fluid pound, problems in SRP.		
Unit – III	**Progressive cavity pumps system:**	**9**
Progressive cavity pumps system, surface and subsurface equipment, stage calculations, viscosity effect, elastomeric and metallic PCP concept, power requirement, design calculations.		
Unit – IV	**Electric submersible pumps:**	**9**
Electric submersible pumps (ESPs), impeller, diffuser, stage calculation, NPSH, Performance curves.ESPs: Design of surface and subsurface equipment, protector, motor, cable, stage calculations, design calculations		
Unit – V	**Gas lift, Hydraulic and surface pumping systems:**	**9**
Gas lift system, valves, valve opening sequence, surface unit, plunger lift, design calculations.Hydraulic jet pump fundamentals, hydraulic engine pump, design calculations, Surface pumping unit for Jet pump, Surface compressor for gas lift.		
		Total:45

TEXT BOOK:

1. B. Guo, W.C. Lyons and A. Galambhor, “Petroleum Production Engieering”, Elsevier, 2007.
2. Kermit Brown, “The Technology of Artificial Lift Methods”, Pennwell Books, 1984.

REFERENCES:

1. Michael J. Economides,”Petroleum Production Systems”, Prentice Hall, USA, 1994.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Understand the Petroleum production systems and wellbore flow characteristics	Understanding (K2)
CO2	Apply various techniques for oil pumping and lift systems from reservoirs	Applying (K3)
CO3	Discuss the aspects of Progressive cavity pumps system	Understanding (K2)
CO4	Perform design calculations for electric submersible pumps.	Applying (K3)
CO5	Discuss the pumping using Gas lift, Hydraulic and surface pumping systems and its design considerations	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**3**	**2**	**2**	**1**								**3**	**3**
CO2	**3**	**2**	**2**	**1**	**2**								**3**	**3**
CO3	**3**	**2**	**2**	**1**	**2**								**3**	**3**
CO4	**3**	**2**	**2**	**1**	**2**								**3**	**3**
CO5	**3**	**2**	**2**	**1**	**2**								**3**	**3**

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		70	30				100
CAT2		70	30				100
CAT3		70	30				100
ESE		70	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHJ02 - PETROLEUM REFINERY MODELING AND SIMULATION

Programme & Branch	**B.Tech Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5/6/7**	**HN**	**3**	**0**	**2**	**4**

Preamble	This course discusses the modeling and simulation of petroleum refinery operations

Unit – I | Introduction: | 9

Physical and Thermodynamic Properties of Petroleum Fractions - Crude Assay, Bulk Properties, Distillation Curves, Pseudocomponent generation, Property requirements for refinery process models, Approaches for estimation fuel properties

Unit – II | Modeling of Crude Distillation Units: | 9

CDU – Model Development, Overall Column Efficiency and Murphree Efficiency, Algorithm, Model Development and Simulation using Aspen HYSYS. VDU – Data requirements, Feedstock representation, Model Development and Simulation using Aspen HYSYS

Unit – III | Modeling of Cracking I: | 9

Process Description – FCC, Riser-Regenerator Complex, Downstream Fractionation, Kinetic Models, Data requirements, Model building, Basic FCC model, Side-stripper, Absorber, Sensitivity analysis of variables.

Unit – IV | Modeling of Cracking II: | 9

Introduction of Modeling of Catalyst Regenerator – Kinetic Models and Networks, Unit Level Models, Catalytic Reformer Model using Aspen HYSYS. HCR process – Modeling Tools, MP and HP HCR Models using Aspen HYSYS.

Unit – V | Modeling of Miscellaneous Operations: | 9

Alkylation – Feed Components, Alkylation Kinetics, Simulation of HF Alkylation Process using Aspen HYSYS. Coking – Feed Characterization, Kinetic Lumps, Coking Reactions, Simulation of Delayed Coking Process using Aspen HYSYS. Refinery Wide Simulation – Introduction of Integrated Process Modeling, Tools , Example Cases.

LIST OF EXPERIMENTS / EXERCISES:

1.	Interconvert Distillation Curves and Extrapolate an IncompleteDistillation Curve
2.	Calculate MeABP of a Given Assay
3.	Construct, run, analyze and manipulate an Atmospheric Crude Column simulation
4.	Calculate the reflux ratio and the distillate rate under the specified conditions using HYSYS optimization tool
5.	Build a Model and Construct a basic Fluid Catalytic Cracking unit
6.	Construct an NGL Plant consisting of three column: De-Methanizer, De-Ethanizer, and De-Propanizer
7.	Build a Model and Construct a basic Continuous catalytic regeneration unit
8.	Build a Downstream Fractionation System
9.	Simulate Hydrofluoric Acid Alkylation Process
10.	Simulate a Delayed CokingProcess
11.	Optimize the oil stabilization and calculate the total liquid product and total gas product of the system
12.	Model a refrigerated gas plant to calculate duty rejected and adsorbed from the system

Lecture:45, Practical:30, Total:75

TEXT BOOK:	
1.	Liu, Y.A., Chang, A.F. and Pashikanti, K., “Petroleum Refinery Process Modeling: Integrated Optimization Tools and Applications”, Wiley VCH, USA, 2018.
REFERENCES/ MANUAL / SOFTWARE:	
1.	Juma Hayday, “Chemical Process Design and Simulation – Aspen Plus and Aspen Hysys Applications”, AICHE – Wiley, USA, 2019.
2.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Comprehend the importance of properties and thermodynamic packages for simulation of Petroleum refinery operations	Understanding (K2)
CO2	Simulate Crude Oil Distillation Units using Aspen HYSYS	Applying (K3)/ Manipulating(S2)
CO3	Simulate Cracking unit using Aspen HYSYS	Applying (K3)/ Manipulating(S2)
CO4	Develop Models for Catalyst Regenerator and HCR unit using Aspen HYSYS	Applying (K3)/ Manipulating(S2)
CO5	Perform simulation of auxiliary processes and a complete refinery	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	3				1	1			3	2
CO2	3	3	2	2	3				1	1			3	2
CO3	3	3	2	2	3				1	1			3	2
CO4	3	3	2	2	3				1	1			3	2
CO5	3	3	2	2	3				1	1			3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

ASSESSMENT PATTERN – THEORY

Test / Bloom’s Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		50	50				100
CAT2		50	50				100
CAT3		50	50				100
ESE		50	50				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHH02 - PETROLEUM RESERVOIR AND NATURAL GAS ENGINEERING

Programme & Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5/6/7**	**HN**	**3**	**1**	**0**	**4**

Preamble	This course discusses the fundamentals in petroleum reservoir and natural gas engineering

Unit – I	**Petroleum Reserves and Basic Reservoir Engineering:**	**9+3**

Petroleum Reserves: Origin and Composition, Petroleum Geology- Reservoir Deposition, Basic Reservoir Engineering, Oil Migration and Traps, Reservoir Drive Mechanisms, Phase Diagram, Reservoir Fluid Properties- Gas, Oil, water and Reservoir Rock Properties.

Unit – II	**Conventional Petroleum Production System:**	**9+3**

Conventional Petroleum Production System, Fundamental of Oil and Gas Flow in Porous Media, Reservoir Deliverability, General Equation for radial flow of Oil and Gas in Reservoir, Inflow Performance Relationship Steady and Unsteady Sates, Material balance in Oil and Gas Reservoirs- Volumetric basis.

Unit – III	**Oil and Gas Well Testing Methods andEnhanced Oil Recovery:**	**9+3**

Oil and Gas Well Testing Methods, Predicting Reservoir Performance, Production Decline Curve Analysis, Enhanced Oil Recovery (EOR)- Thermal and Non-Thermal, Introduction to Reservoir Simulation, Unconventional Natural Gas Production: Shale Gas, Gas Hydrates, Coal bed Methane, Oil Shale, Pyrolysis of Carbonaceous Materials.

Unit – IV	**Introduction to Natural Gas Engineering:**	**9+3**

Introduction, Gas Production: Upstream, Reservoir- Well Completion, Properties of Natural Gas: Phase Behavior, Well inflow performance relationship (IPR), Skin factor, Productivity Index, Gas well testing, TPR Curve, Single Phase & Multi Phase flow, Choke Performance: CPR Curve, Sonic and Subsonic Flow, Well Deliverability: Nodal Analysis.

Unit – V	**Natural Gas production, processing and transportation:**	**9+3**

Natural Gas Production: Downstream, Surface Facilities, Principle of Separator, Design of Separator: Vertical, Horizontal; Two Phase Separation, Three Phase Separation, Natural Gas Processing: Dehydration of Natural Gas, Design of Dehydration, Sweeting Processes, Compressor design and energy calculation, Transportation and Measurement, Pipeline Design, Flow through pipeline, issues and solutions.

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	R.E Terry, M Hawkins and B.C. Craft, “Applied Petroleum Reservoir Engineering”, Prentice Hall 1991
2.	B. Guo and A. Ghalambor, “Natural Gas Engineering Handbook”, Gulf Publishing Company, 2005

REFERENCES:

1.	T. Ahmed and P. Mckinney,”Advanced Reservoir Engineering”, Elsevier, 2004.
2.	D.L. Katz and R.L. Lee, “Natural Gas Engineering”, McGraw Hill, 1990.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Understand the foundations of petroleum formation and basic of reservoir engineering	Understanding (K2)
CO2	Comprehend various conventional petroleum production system	Understanding (K2)
CO3	Appreciate the supremacy of oil and gas well testing methods and enhanced oil recovery	Understanding (K2)
CO4	Understand the fundamental aspects of natural gas engineering	Understanding (K2)
CO5	Discuss the aspects of natural gas production, processing and transportation	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1								**3**	**3**
CO2	3	2	2	1	2								**3**	**3**
CO3	3	2	2	1	2								**3**	**3**
CO4	3	2	2	1	2								**3**	**3**
CO5	3	2	2	1	2								**3**	**3**

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	80					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22CHH03 - PETROCHEMICAL TECHNOLOGY							
Programme & Branch	**B.Tech Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**5/6/7**	**HN**	**3**	**0**	**0**	**3**

Preamble	This course discusses the production of various petrochemical products	
Unit – I	**Introduction:**	**9**
Petrochemical Industry – Structure of petrochemical complexes, Feedstocks, Petrochemical end products – Polymers, Synthetic Fiber, Rubber, Detergents, Petroleum Base Intermediates		
Unit – II	**Processing of Olefins and Aromatics:**	**9**
Processing of Olefins – Steam Cracking Technology, Demethanizer, Deethanizer, Debutanizer, Emerging Technologies. Processing of Aromatics – Catalytic Reforming, extraction and separation, BP-UOP Cyclar process, Aromatic Conversion Processes.		
Unit – III	**Hydrocarbon Derivatives I:**	**9**
Processing of Methane – Steam reforming for Syn Gas production, Fischer Tropsch Syn Gas process, Production of Methanol. Ethylene Derivatives – Production of Ethylene oxide, Ethylene glycol, Vinyl Chloride and Vinyl Acetate.		
Unit – IV	**Hydrocarbon Derivatives II:**	**9**
Propylene Derivatives – Propylene recovery, Dehydrogenation, Propylene Oxide, IPA, Acrylonitrile processes. C4 & C5 – Butadiene, Isobutylene, Chloroprene, Isoprene, Cyclopentadiene processes.		
Unit – V	**BTX Derivatives:**	**9**
Process technology of Ethyl benzene and styrene, Pthalic Anhydride, LAB, Phenol, Maleic Anhydride, Nitrobenzene and Aniline, Hydroquinone and Anthraquinone.		
		Total:45

TEXT BOOK:

1.	I.D Mall, " Petrochemical Process Technology", MacMillan India Ltd, India, 2007.

REFERENCES:

1.	James G. Speight, "Handbook of Petrochemical Processes", CRC Press, UK, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Understand the structure of petrochemical industry and importance of petrochemical products	Understanding (K2)
CO2	Comprehend the processing of olefins and aromatics	Understanding (K2)
CO3	Discuss various processes involved in treatment of methane and ethylene derivatives	Understanding (K2)
CO4	Understand the production of propylene, C4 and C5 derivatives	Understanding (K2)
CO5	Explain the production of multiple products from BTX derivatives	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**2**	**2**										**3**	**2**
CO2	**3**	**2**	**2**										**3**	**2**
CO3	**3**	**2**	**2**										**3**	**2**
CO4	**3**	**2**	**2**										**3**	**2**
CO5	**3**	**2**	**2**										**3**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	80					100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)