KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADU INDIA

Estd : 1984

REGULATIONS, CURRICULUM & SYLLABI - 2020

(CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION)

(For the students admitted from 2020 - 2021)

BACHELOR OF TECHNOLOGY DEGREE IN CHEMICAL ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

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KONGU ENGINEERING COLLEGE
PERUNDURAI ERODE – 638 060
(Autonomous)

INSTITUTE VISION

To be a centre of excellence for development and dissemination of knowledge in Applied Science, 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 Chemical Engineering for the Nation and beyond

MISSION

Department of Chemical 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 Chemical Engineering 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	3
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 Chemical Engineering 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 2020

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 2020 – 2021 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” means authorized person who is responsible for all examination related activities of the College.

xi. “Head of the Department” means Head of the Department concerned of the College.

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 in relevant branches of study.

(OR)

The candidates who hold a BSc degree (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 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

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 Training, Industrial Training, Comprehensive Test & Viva, Entrepreneurships/Start ups and Internship 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 169.

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 8.0 CGPA and no history of arrears during the entire programme to opt for the honours degree.

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, internship and entrepreneurships/start ups during the programme to gain/exhibit the knowledge/skills.

4.3.1 Professional Skills Training/ Industrial Training/Entrepreneurships/Start Ups

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 fifth semester and phase-II in sixth 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 sixth semester vacation period. Such candidate can earn two credits for this training course in place of Professional Skills Training Phase-II in sixth semester. He/She shall attend Professional Skills Training Phase-I in fifth 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 a maximum of 2 credits per semester for two semesters each in place of either Professional Skills Training-I / II or Industrial Training-I/ II respectively. 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 & 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 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-I Phase-II 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 Value Added 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 Value Added 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.

4.4 Value Added Courses / Online Courses / Self Study Courses

The candidates may optionally undergo Value Added Courses / Online Courses / Self Study Courses as elective courses.

4.4.1 **Value Added Courses:** Value Added courses each with One / Two credits shall be offered by the college with the prior approval from the respective Board of Studies. A candidate can earn a maximum of six credits through value added 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 value added 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 eighth 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. Total number of credits of such courses during the entire programme of study cannot exceed eight.

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), 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, Project Work, Professional Skills Training / Industrial Training, Internship 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:

<table>
<tr><th>Sl. No.</th><th>Category of Course</th><th>Continuous Assessment Marks</th><th>End Semester Examination Marks</th></tr>
<tr><td>1.</td><td>Theory / Practical</td><td>50</td><td>50</td></tr>
<tr><td>2.</td><td>Theory cum Practical</td><td colspan="2">The distribution of marks shall be decided based on the credit weightage assigned to theory and practical components.</td></tr>
<tr><td>3.</td><td>Professional Skills Training / / Comprehensive Test & Viva / Entrepreneurships / Start ups / Project Work - I / Industrial Training / Mandatory Course</td><td>100</td><td>---</td></tr>
<tr><td>4.</td><td>Project Work-II Phase-I / Project Work-II Phase-II / Internships</td><td>50</td><td>50</td></tr>
<tr><td>5.</td><td>Value Added Course</td><td rowspan="2">The distribution of marks shall be decided based on the credit weightage assigned</td><td rowspan="2">---</td></tr>
<tr><td>6.</td><td>All other Courses</td></tr>
</table>

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 50 marks and the end semester examination shall be for 50 marks. However, the end semester examinations shall be conducted for 100 marks and the marks obtained shall be reduced to 50. The continuous assessment tests shall be conducted as per the schedule laid down in the academic schedule. Three tests shall be conducted for 50 marks each and reduced to 30 marks each. 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	30	Average of best two
	Test - II	30	
	Test - III	30	
2.	Tutorial	15	Should be of Open Book/Objective Type. Average of best 4 (or more, depending on the nature of the course, as may be approved by Principal)
3.	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	50	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 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 50 marks and the end semester examination shall be for 50 marks. Every exercise / experiment shall be evaluated based on the candidate’s performance during the practical class and the candidate's 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.

7.6 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 (both Phase-I and Phase-II) and the Viva-Voce Examination shall be distributed as below:

<table>
<tr><th colspan="6">Continuous Assessment
(Max. 50 Marks)</th><th colspan="4">End Semester Examination
(Max. 50 Marks)</th></tr>
<tr><th colspan="2">Zeroth Review</th><th colspan="2">Review I
(Max.. 20 Marks)</th><th colspan="2">Review II
(Max. 30 Marks)</th><th>Report Evaluation
(Max. 20 Marks)</th><th colspan="3">Viva - Voce
(Max. 30 Marks)</th></tr>
<tr><th>Rv. Com</th><th>Guide</th><th>Review Committee (excluding guide)</th><th>Guide</th><th>Review Committee (excluding guide)</th><th>Guide</th><th>Ext. Exr.</th><th>Guide</th><th>Exr.1</th><th>Exr.2</th></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>10</td><td>10</td></tr>
</table>

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 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 guide 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 Phase-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:

Continuous Assessment (Max. 100 Marks)								
Zeroth Review		Review I (Max.. 20 Marks)		Review II (Max.. 30 Marks)		Review III (Max. 50 Marks)		
						Report Evaluation (Max. 20 Marks)	Viva – Voce (Max. 30 Marks)	
Review Committee	Guide	Review Committee (excluding guide)	Guide	Review Committee (excluding guide)	Guide	Review Committee	Guide	Review Committee
0	0	10	10	15	15	20	10	20

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 4^{th} semester vacation and during 5^{th} semester. Phase-II training shall be conducted for minimum of 80 hours in 5^{th} semester vacation and during 6^{th} semester. The evaluation procedure shall be approved by 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 two credits in sixth semester respectively 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 Projects through Internships

Each candidate shall submit a brief report about the project through internship undergone and a certificate issued from the organization concerned at the time of Viva-voce examination to the review committee. The evaluation method shall be same as that of the Project Work-II as per clause 7.6.

7.12 Value Added Course

Minimum of two assessments shall be conducted during the value added course duration by the offering department concerned.

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 SF (Satisfactory). 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 Course

A candidate shall attend and complete the induction training program of duration three weeks at the beginning of the first semester. It is mandatory for all candidates who have joined in various branches of all BE/BTech programmes. No credits shall be given for such courses and shall be evaluated through continuous assessment tests only vide clause 7.1 for a maximum of 100 marks each. Since these courses have no grade points assigned, these courses will not be counted for the purpose of GPA and CGPA calculations.

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

Courses such as YVHD and UHV shall be offered to all candidates of all BE/BTech programmes. 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

Range of % of Total Marks	Letter Grade	Grade Point
91 to 100	O (Outstanding)	10
81 to 90	A+ (Excellent)	9
71 to 80	A (Very Good)	8
61 to 70	B+ (Good)	7
50 to 60	B (Average)	6
Less than 50	RA (Reappear)	0
Satisfactory	SF	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-2020 (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 A candidate who joins from other institutions on transfer and 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 7.00

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 Honours 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 8.00

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 Kongu Engineering 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

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	3		3			3		13	7.69 %
BS	11	11	4	4					30	17.75 %
ES	4	4*/4#	8	4					20	11.83 %
PC	3	4	12	8*/4#	13	12	4		56	33.13 %
PE					3		12	3	18	10.65 %
OE				4	4	3		3	14	8.28 %
EC					2	6	6	4	18	10.65 %
Semesterwise Total	22	22	24	23*/19#	22	21	25	10	169	100.00

***** 2020-21, # 2021-22

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.	20EGT11	English Language Skills	3	0	0	3	I
2.	20VEC11	Yoga and Values for Holistic Education	2	0	1	1	I
3.	20EGT21	Advanced Communication Skills	3	0	0	3	II
4.	20EGL31	English for Workplace Communication Laboratory	0	0	2	1	IV
5.	20GET31	Universal Human Values	0	0	0	2	IV
6.	20CHT71	Process Engineering and Economics	3	0	0	3	VII
		Total Credits to be earned				**13**	

BASIC SCIENCE (BS)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	20MAC11	Matrices and Differential Equations	3	1*	2*	4	I
2.	20PHT11	Applied Physics	3	0	0	3	I
3.	20CYT11	Applied Chemistry	3	0	0	3	I
4.	20PHL11	Physical Sciences Laboratory I	0	0	2	1	I
5.	20MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	II
6.	20PHT25	Physics for Chemical Engineering	3	0	0	3	II
7.	20CYT24	Industrial Chemistry	3	0	0	3	II
8.	20PHL29	Physical Sciences Laboratory II	0	0	2	1	II
9.	20MAT31	Probability and Partial Differential Equations	3	1	0	4	III
10.	20MAT41	Statistics and Numerical Methods	3	1	0	4	IV
Total Credits to be earned						**30**	

ENGINEERING SCIENCE (ES)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	20MEC11	Engineering Drawing	2	0	2	3	I
2.	20MEL11	Engineering Practices Laboratory	0	0	2	1	I
3.	20CHT22	Electrical Drives and Industrial Electronics	3	0	0	3	II
4.	20CHL21	Electrical Drives and Industrial Electronics Laboratory	0	0	2	1	II
5.	20CSC31	Programming in C	3	0	2	4	III
6.	20CHT31	Chemical Engineering Thermodynamics	3	1	0	4	III
7.	20CSC41	Python Programming	3	0	2	4	IV
Total Credits to be earned						**20**	

PROFESSIONAL CORE (PC)

S. No.	Course Code	Course Name	L	T	P	C	Sem	Domain/ Stream
1.	20CHT11	Chemical Process Industries	3	0	0	3	I	AC&RE
2.	20CHT21	Chemical Process Utilities	3	1	0	4	II	PPO
3.	20CHT32	Applied Organic Chemistry	3	0	0	3	III	AC&RE
4.	20CHT33	Fluid Mechanics	3	0	0	3	III	TTO
5.	20CHT34	Chemical Process Calculations	3	1	0	4	III	TTO
6.	20CHL31	Applied Organic Chemistry Laboratory	0	0	2	1	III	AC&RE
7.	20CHL32	Fluid Mechanics Laboratory	0	0	2	1	III	TTO
9.	20CHT41	Mechanical Operations	3	0	0	3	IV	PPO
10.	20CHT42	Process Heat Transfer	3	0	0	3	IV	TTO
11.	20CHL41	Mechanical Operations Laboratory	0	0	2	1	IV	PPO
12.	20CHL42	Process Heat Transfer Laboratory	0	0	2	1	V	TTO
13.	20CHT51	Mass Transfer I	3	1	0	4	V	TTO
14.	20CHT52	Chemical Reaction Engineering I	3	0	0	3	V	AC&RE
15.	20CHT53	Chemical Equipment Design and Drawing	3	1	0	4	V	PPO
16.	20CHL52	Chemical Reaction Engineering Laboratory	0	0	2	1	V	AC&RE
17.	20CHL53	Process Computation Laboratory	0	0	2	1	V	CSMS&C
18.	20CHT61	Mass Transfer II	3	0	0	3	VI	TTO
19.	20CHT62	Process Modeling and Simulation	3	0	0	3	VI	CSMS&C
20.	20CHT63	Process Instrumentation Dynamics and Control	3	0	0	3	VI	CSMS&C
21.	20CHL61	Mass Transfer Laboratory	0	0	2	1	V	PPO
22.	20CHL62	Process Modeling and Simulation Laboratory	0	0	2	1	VI	CSMS&C
23.	20CHL63	Process Instrumentation Dynamics and Control Laboratory	0	0	2	1	VI	CSMS&C
24.	20CHT72	Transport Phenomena	3	1	0	4	VII	T&TO
Total Credits to be earned						**56**		

PROFESSIONAL ELECTIVE (PE)

S. No.	Course Code	Course Name	L	T	P	C	Domain Stream
		Semester-V					
		Elective I					
1.	20CHE01	Chemical Process Plant Safety	3	0	0	3	PPO
2.	20CHE02	Organic Synthesis	3	0	0	3	AC&RE

3.	20CHE03	Instrumental Methods of Analysis	3	0	0	3	AC&RE
4.	20CHE04	Chemical Analysis	3	0	0	3	AC&RE
5.	20CHE05	Bio Chemical Engineering	3	0	0	3	CT
		Semester-VII					
		Elective II					
6.	20CHE06	Pulp and Paper Technology	3	0	0	3	CT
7.	20CHE07	Chemical Reaction Engineering -II	3	0	0	3	AC&RE
8.	20CHE08	Surface Coating Technology	3	0	0	3	CT
9.	20CHE09	Energy Technology	3	0	0	3	E&E
10.	20CHE10	Modern Separation Processes	3	0	0	3	PPO
		Elective III					
11.	20CHE11	Air Pollution Control	3	0	0	3	E&E
13.	20CHE12	Process Instrumentation	3	0	0	3	CSMS&C
14.	20CHE13	Fertilizer Technology	3	0	0	3	CT
15.	20CHE14	Corrosion Technology	3	0	0	3	CT
16.	20GEE01	Fundamentals of Research	3	0	0	3	GE
		Elective IV					
17.	20CHE15	Natural Gas Engineering	3	0	0	3	CT
18.	20CHE16	Nano materials and composite materials for Chemical Engineers	3	0	0	3	AC&RE
19.	20CHE17	Fundamentals of Computational Fluid Dynamics	3	0	0	3	CSMS&C
20.	20CHE18	Pharmaceutical Process Technology	3	0	0	3	CT
21.	20CHE19	Process Optimization	3	0	0	3	CSMS&C
22.	20CHE20	Total Quality Management	3	0	0	3	GE
		Elective V					
23.	20CHE21	Nuclear Engineering for Chemical Engineers	3	0	0	3	CT
24.	20CHE22	Numerical techniques in Chemical Engineering	3	0	0	3	CSMS&C
25.	20CHE23	Petroleum Refinery Engineering	3	0	0	3	CT
26.	20CHE24	Industrial Waste Water Treatment	3	0	0	3	E&E
27.	20CHE25	Piping Engineering	3	0	0	3	T&TO
		Semester-VIII					
		Elective VI					
28.	20CHE26	Battery and Fuel Cell Technology	3	0	0	3	E&E
29.	20CHE27	Fluid Movers	3	0	0	3	T&TO
30.	20CHE28	Advanced Process Control	3	0	0	3	CSMS&C
31.	20CHE29	Ores and Mineral Processing	3	0	0	3	PPO

32.	20CHE30	Polymer Technology	3	0	0	3	CT
Total Credits to be earned						**18**	

***** Domain/Stream Abbreviations: T&TO-Thermodynamics & Transport Operations, CSM&S-Chemical Systems Modeling & Simulation & Control, AC&RE –Applied Chemistry & Reaction Engineering, PPO-Process Plant Operation, CT-Chemical Technology, E&E-Energy & Environment

EMPLOYABILITY ENHANCEMENT COURSES (EC)

S. No.	Course Code	Course Name	L	T	P	C	Sem
1.	20GEL51/ 20GEI51	Professional Skills Training I / Industrial Training I	---	---	---	2	V
2.	20GEL61/ 20GEI61	Professional Skills Training II / Industrial Training II	---	---	---	2	VI
3.	20CHP61	Project Work I	0	0	4	2	VI
4.	20GEP61	Comprehensive Test and Viva	---	---	---	2	VII
5.	20CHP71	Project Work II Phase I	0	0	12	6	VII
6.	20CHP81	Project work II Phase II	---	---	8	4	VIII
Total Credits to be earned						**18**	

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)

(Common to all departments except offering department)

S.No.	Course Code	Course Title	Hours/Week			Credit	Sem
			L	T	P		
1.	20CHO01	Drugs and Pharmaceuticals Technology	3	1	0	4	IV
2.	20CHO02	Process Automation	3	1	0	4	IV
3.	20CHO03	Renewable Bioenergy Resources	3	1	0	4	V
4.	20CHO04	Intelligent Controllers	3	1	0	4	V
5.	20CHO05	Food as Medicine	3	0	0	3	VI
6.	20CHO06	Organic Farming	3	0	0	3	VI
7.	20CHO07	Cosmetics and Personal health Care Products	3	0	0	3	VIII
8.	20CHO08	Brewing and Alcohol Technology	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.
		SEMESTER - IV					
1.	20CEO01	Remote Sensing and its Applications	3	0	2	4	CIVIL
2.	20MEO01	Renewable Energy Sources	3	0	2	4	MECH
3.	20MTO01	Design of Mechatronics Systems	3	1	0	4	MTS
4.	20AUO01	Automotive Engineering	3	0	2	4	AUTO
5.	20ECO01	Wearable Technology	3	1	0	4	ECE
6.	20ECO02	Basics of Electronics in Automation Appliances	3	1	0	4	ECE
7.	20ECO03	Principles of Quantum Computing	3	0	2	4	ECE
8.	20EEO01	Solar and Wind Energy Systems	3	1	0	4	EEE
9.	20EEO02	Electrical Wiring and Lighting	3	1	0	4	EEE
10.	20EEO03	Electrical Safety	3	1	0	4	EEE
11.	20EIO01	Digital Image Processing and Its Applications	3	1	0	4	EIE
12.	20CSO01	Fundamentals of Databases	3	0	2	4	CSE
13.	20CSO02	Python Programming and Frameworks	3	0	2	4	CSE
14.	20ITO01	Artificial Intelligence	3	1	0	4	IT
15.	20ITO02	Web Technologies	3	1	0	4	IT
16.	20ITO03	Introduction to Operating Systems	3	1	0	4	IT
17.	20ITO04	Programming in Python	3	1	0	4	IT
18.	20FTO01	Baking Technology	3	0	2	4	FT
19.	20FTO02	Food Processing Technology	3	1	0	4	FT
20.	20CDO01	Fundamentals of User Experience Design	3	1	0	4	CSD
21.	20ADO01	Data Warehousing and Data Mining	3	0	2	4	AIDS
22.	20ALO01	Business Intelligence	3	1	0	4	AIML
23.	20PHO01	Thin Film Technology	3	1	0	4	PHY
24.	20CYO01	Instrumental Methods of Analysis	3	1	0	4	CHEMIS
		SEMESTER - V					
25.	20CEO02	Disaster Management	3	1	0	4	CIVIL
26.	20MEO02	Design of Experiments	3	0	2	4	MECH
27.	20MTO02	Factory Automation	3	0	2	4	MTS
28.	20MTO03	Data Acquisition and Virtual Instrumentation	3	0	2	4	MTS
29.	20AUO02	Automotive Electronics	3	0	2	4	AUTO
30.	20ECO04	PCB Design and Fabrication	3	0	2	4	ECE
31.	20EEO04	Energy Conservation and Management	3	1	0	4	EEE

32.	20EIO02	Industrial Automation	3	1	0	4	EIE
33.	20EIO03	Measurements and Instrumentation	3	1	0	4	EIE
34.	20CSO03	Computational Science for Engineers	3	1	0	4	CSE
35.	20CSO04	Formal Languages and Automata	3	1	0	4	CSE
36.	20ITO05	Data Science	3	1	0	4	IT
37.	20ITO06	Advanced Java Programming	3	1	0	4	IT
38.	20FTO03	Processing of Milk and Milk Products	3	0	2	4	FT
39.	20FTO04	Processing of Fruits and Vegetables	3	0	2	4	FT
40.	20CDO02	Fundamentals of User Interactive Design	3	0	2	4	CSD
41.	20ADO02	Computer Vision	3	0	2	4	AIDS
42.	20ALO02	Data Exploration and Visualization Techniques	3	0	2	4	AIML
43.	20PHO02	High Energy Storage Devices	3	0	0	3	PHY
44.	20CYO02	Corrosion Science and Engineering	3	1	0	4	CHEMIS
45.	20CYO03	Chemistry of Cosmetics in Daily Life	3	1	0	4	CHEMIS
46.	20CYO04	Chemistry of Nutrition for Women Health	3	1	0	4	CHEMIS
47.	20MAO01	Mathematical Foundations for Machine Learning	3	1	0	4	MATHS
48.	20MAO02	Graph Theory and its Applications	3	1	0	4	MATHS
		SEMESTER - VI					
49.	20CEO03	Introduction to Smart Cities	3	0	0	3	CIVIL
50.	20CEO04	Environmental Health and Safety	3	0	0	3	CIVIL
51.	20MEO03	Fundamentals of Ergonomics	3	0	0	3	MECH
52.	20MEO04	Principles of Management and Industrial Psychology	3	0	0	3	MECH
53.	20MTO04	3D Printing and Design	3	0	0	3	MTS
54.	20MTO05	Drone System Technology	3	0	0	3	MTS
55.	20MTO06	Virtual and Augument Reality in Industry 4.0	3	0	0	3	MTS
56.	20AUO03	Vehicle Maintenance	3	0	0	3	AUTO
57.	20ECO05	Electronic Hardware and Troubleshooting	2	0	2	3	ECE
58.	20ECO06	Bioinspired Computing Technologies	2	0	2	3	ECE
59.	20EEO05	Micro Grid and Smart Grid	3	0	0	3	EEE
60.	20EEO06	E-Waste Management	3	0	0	3	EEE
61.	20EIO04	Biomedical Instrumentation and Applications	3	0	0	3	EIE
62.	20EIO05	PLC Programming and Its Applications	3	0	0	3	EIE
63.	20EIO06	Instrumentation for Industry 4.0	3	0	0	3	EIE
64.	20CSO05	Java Programming	2	0	2	3	CSE
65.	20CSO06	Web Engineering	2	0	2	3	CSE
66.	20CSO07	Nature Inspired Optimization Techniques	3	0	0	3	CSE

67.	20ITO07	Bio Natural Language Processing	3	0	0	3	IT
68.	20ITO08	Disaster Management for Information Technology	3	0	0	3	IT
69.	20FTO05	Principles of Food Safety	3	0	0	3	FT
70.	20FTO06	Fundamentals of Food Packaging and Storage	3	0	0	3	FT
71.	20CDO03	Introduction to Mobile Game Design	3	0	0	3	CSD
72.	20ADO03	Neural Networks and Deep Learning	3	0	0	3	AIDS
73.	20ALO03	Industrial Machine Learning	3	0	0	3	AIML
74.	20PHO03	Structural and Optical Characterization of Materials	3	0	0	3	PHY
75.	20CYO05	Chemistry Concepts for Competitive Examinations	3	0	0	3	CHEMIS
76.	20CYO06	Waste and Hazardous Waste Management	3	0	0	3	CHEMIS
77.	20MAO03	Data Analytics using R Programming	3	0	2	4	MATHS
78.	20MAO04	Number Theory and Cryptography	3	1	0	4	MATHS
		SEMESTER - VIII					
79.	20CEO05	Infrastructure Planning and Management	3	0	0	3	CIVIL
80.	20CEO06	Environmental Laws and Policy	3	0	0	3	CIVIL
81.	20MEO05	Safety Measures for Engineers	3	0	0	3	MECH
82.	20MEO06	Energy Conservation in Thermal Equipments	3	0	0	3	MECH
83.	20MTO06	Robotics	3	0	0	3	MTS
84.	20MTO07	Virtual and Augment Reality in Industry 4.0	3	0	0	3	MTS
85.	20AUO04	Public Transport Management	3	0	0	3	AUTO
86.	20AUO05	Autonomous Vehicles	3	0	0	3	AUTO
87.	20ECO07	Optical Engineering	3	0	0	3	ECE
88.	20EEO07	Electric Vehicle	3	0	0	3	EEE
89.	20EIO07	Graphical Programming using Virtual Instrumentation	3	0	0	3	EIE
90.	20EIO08	Testing of Materials	3	0	0	3	EIE
91.	20CSO08	Fundamentals of Internet of Things	3	0	0	3	CSE
92.	20CSO09	Machine Translation	3	0	0	3	CSE
93.	20CSO10	Fundamentals of Blockchain	3	0	0	3	CSE
94.	20ITO09	Modern Application Development	3	0	0	3	IT
95.	20ITO10	Object Oriented System Development using UML	3	0	0	3	IT
96.	20ITO11	Reinforcement Learning	3	0	0	3	IT
97.	20FTO07	Food Ingredients	3	0	0	3	FT
98.	20FTO08	Food and Nutrition	3	0	0	3	FT
99.	20CDO04	Introduction to Graphics Design	3	0	0	3	CSD
100.	20ADO04	Business Analytics	3	0	0	3	AIDS
101.	20ALO04	Machine Learning for Smart Cities	3	0	0	3	AIML

102.	20MAO05	Advanced Linear Algebra	3	0	0	3	MATHS
103.	20MAO06	Optimization Techniques	3	0	0	3	MATHS

GENERAL OPEN ELECTIVE

(Common to All BE/BTech branches)

S.No.	Course Code	Course Title	L	T	P	C	Offering Dept.	Semester
1	20GEO01	German Language Level 1	4	0	0	4	IV/V/VII/VIII	ECE
2	20GEO02	Japanese Language Level 1	4	0	0	4	IV/V/VII/VIII	ECE
3	20GEO03	Design Thinking for Engineers	3	1	0	4	V	CSE
4	20GEO04	Innovation and Business Model Development	3	1	0	4	VI	MTS
5	20GEO05	German Language Level 2	4	0	0	4	IV/V/VII/VIII	ECE
6	20GEO06	German Language Level 3	3	0	0	3	IV/V/VII/VIII	ECE
7	20GEO07	German Language Level 4	3	0	0	3	IV/V/VII/VIII	ECE
8	20GEO08	Japanese Language Level 2	4	0	0	4	IV/V/VII/VIII	ECE
9	20GEO09	Japanese Language Level 3	3	0	0	3	IV/V/VII/VIII	ECE
10	20GEO10	Japanese Language Level 4	3	0	0	3	IV/V/VII/VIII	ECE
11	20GEO11	NCC Studies (Army Wing) - I	3	0	2	4	V/VI	EEE
12	20GEO12	NCC Studies (Air Wing) - I	3	0	2	4	V/VI	IT
13	20GEO13	French Language Level 1	4	0	0	4	IV/V/VII/VIII	ECE
14	20GEO14	French Language Level 2	4	0	0	4	IV/V/VII/VIII	ECE
15	20GEO15	French Language Level 3	3	0	0	3	IV/V/VII/VIII	ECE
16	20GEO16	Spanish Language Level 1	4	0	0	4	IV/V/VII/VIII	ECE
17	20GEO17	Spanish Language Level 2	4	0	0	4	IV/V/VII/VIII	ECE
18	20GEO18	Spanish Language Level 3	3	0	0	3	IV/V/VII/VIII	ECE
19	20GEO19	Entrepreneurship Development	3	0	0	3	VIII	MTS

KEC R2020: SCHEDULING OF COURSES – BTech (Chemical Engineering) Total Credits: 169

Sem.	Course1	Course2	Course3	Course4	Course5	Course6	Course7	Course8	Course9	Course10	Credits
I	20EGT11 English Language Skills (3-0-0-3)	20MAC11 Matrices and Differential Equations (3-1*-2*-4)	20PHT11 Applied Physics (3-0-0-3)	20CYT11 Applied Chemistry (3-0-0-3)	20CHT11 Chemical Process Industries (3-0-0-3)	20MEC11 Engineering Drawing (2-0-2 -3)	20MEL11 Engineering Practices Laboratory (0-0-2-1)	20PHL11 Physical Sciences Laboratory - I (0-0-2-1)	Induction Training Program (0-0-0-0)	20VEC11 Yoga and Values for Holistic Development (1-0-1-1)	22
II	20EGT21 Advanced Communication Skills (3-0-0-3)	20MAC21 Multivariable Calculus and Complex Analysis (3-1*-2*-4)	20PHT25 Physics for Chemical Engineering (3-0-0-3)	20CYT24 Industrial Chemistry (3-0-0-3)	20CHT21 Chemical Process Utilities (3-1-0-4)/ 20CSC31 Programming in C (3-0-2-4)	20CHT22 Electrical Drives and Industrial Electronics (3-0-0-3)	20CHL21 Electrical Drives and Industrial Electronics Laboratory (0-0-2-1)	20PHL22 Physical Sciences Laboratory II(0-0-2-1)			22
III	20MAT31 Probability and Partial Differential Equations (3-1-0-4)	20CSC31 Programming in C / 20CSC41 Python Programming (3-0-2-4)	20CHT31 Chemical Engineering Thermodynamics (3-1-0-4)	20CHT32 Applied Organic Chemistry (3-0-0-3)	20CHT33 Fluid Mechanics (3-0-0-3)	20CHT34 Chemical Process Calculations (3-1-0-4)	20CHL31 Applied Organic Chemistry Laboratory (0-0-2-1)	20CHL32 Fluid Mechanics Laboratory (0-0-2-1)	20MNT31 Environmental Science (2-0-0-0)		24
IV	20MAT41 Statistics and Numerical Methods (3-1-0-4)	20CSC41 Python Programming (3-0-2-4)/ 20CHT21 Chemical Process Utilities (3-1-0-4)	20CHT41 Mechanical Operations (3-0-0-3)	20CHT42 Process Heat Transfer (3-0-0-3)	Open Elective I (3-1-0-4)	20CHL41 Mechanical Operations Laboratory (0-0-2-1)	20CHL42 Process Heat Transfer Laboratory (0-0-2-1)	20EGL31 English for Workplace Communication Laboratory (0-0-2-1)	20GET31 Universal Human Values (2-0-0-2)		23
V	20CHT51 Mass Transfer I (3-1-0-4)	20CHT52 Chemical Reaction Engineering I (3-0-0-3)	20CHT53 Chemical Equipment Design and Drawing (3-1-0-4)	Professional Elective I (3-0-0-3)	Open Elective II (3-1-0-4)	20CHL51 Chemical Reaction Engineering Laboratory (0-0-2-1)	20CHL52 Process Computation Laboratory (0-0-2-1 (0-0-2-1)	20GEL51/ 20GEI51 Professional Skills Training- I / Industrial Training- I (0-0-0-2)			22
VI	20CHT61 Mass Transfer II (3-0-0-3)	20CHT62 Process Modeling and Simulation (3-0-0-3)	20CHT63 Process Instrumentation Dynamics and Control (3-0-0-3)	Open Elective III (3-0-0-3)	20CHL61 Mass Transfer Laboratory (0-0-2-1)	20CHL62 Process Modeling and Simulation Laboratory (0-0-2-1)	20CHL63 Process Instrumentation and Control Lab (0-0-2-1)	20CHP61 Project Work I (0-0-4-2)	20GEL61/ 20GEI61 Professional Skills Training II / Industrial Training II (0-0-0-2)	20GEP61 Comprehensive Test / Viva (0-0-0-2)	21
VII	20CHT71 Process Engineering and Economics (3-0-0-3)	20CHT72 Transport Phenomena (3-1-0-4)	Professional Elective II (3-0-0-3)	Professional Elective III (3-0-0-3)	Professional Elective IV (3-0-0-3)	Professional Elective V (3-0-0-3)	20CHP71 Project Work II Phase I (0-0-12-6)				22
VIII	Open Elective IV (3-0-0-3)	Professional Elective VI (3-0-0-3)	20CHP81 Project Work II Phase II (0-0-8-4)								13

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	20EGT11	English Language Skills						✓			✓	✓	✓	✓		
1	20MAC11	Matrices and Differential Equations	✓	✓	✓	✓	✓									
1	20PHT11	Applied Physics	✓	✓	✓											
1	20CYT11	Applied Chemistry	✓	✓	✓	✓										
1	20CHT11	Chemical Process Industries	✓	✓	✓		✓	✓	✓	✓				✓	✓	✓
1	20MEC11	Engineering Drawing	✓	✓	✓	✓						✓	✓	✓	✓	✓
1	20MEL11	Engineering Practices Laboratory	✓		✓	✓	✓	✓			✓	✓		✓		
1	20PHL11	Physical Sciences Laboratory I				✓										
1	20MNT11	Induction Training Program #	✓	✓	✓		✓									
1	20VEC11	Yoga and Values for Holistic Education						✓		✓	✓			✓		
2	20EGT21	Advanced Communication Skills						✓			✓	✓	✓	✓		
2	20MAC21	Multivariable Calculus and Complex Analysis	✓	✓	✓		✓						✓			
2	20PHT25	Physics for Chemical Engineering	✓	✓	✓											
2	20CYT24	Industrial Chemistry	✓	✓	✓	✓										
2	20CHT21	Chemical Process Utilities	✓	✓	✓			✓						✓	✓	✓
2	20CSC31	Programming in C	✓	✓	✓	✓	✓				✓	✓		✓		
2	20CHT22	Electrical Drives and Industrial Electronics	✓	✓	✓	✓										
2	20CHL21	Electrical Drives and Industrial Electronics Laboratory	✓	✓	✓	✓									✓	✓
2	20PHL29	Physical Sciences Laboratory II			✓											
3	20MAT31	Probability and Partial Differential Equations	✓	✓	✓											
3	20CSC31	Programming in C	✓	✓	✓	✓	✓				✓	✓		✓		
3	20CHT31	Chemical Engineering Thermodynamics	✓	✓	✓	✓								✓	✓	✓
3	20CHT32	Applied Organic Chemistry	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓
3	20CHT33	Fluid Mechanics	✓	✓	✓	✓								✓	✓	✓
3	20CHT34	Chemical Process Calculations	✓	✓	✓	✓								✓	✓	✓
3	20CHL31	Applied Organic Chemistry Laboratory	✓	✓				✓	✓	✓	✓	✓		✓	✓	✓
3	20CHL32	Fluid Mechanics Laboratory	✓	✓	✓			✓	✓	✓	✓	✓		✓	✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
3	20MNT31	Environmental Science	✓	✓	✓				✓					✓	✓	✓
4	20MAT41	Statistics and Numerical Methods	✓	✓	✓	✓										
4	20CSC41	Python Programming	✓	✓	✓	✓										
4	20CHT41	Mechanical Operations	✓	✓	✓	✓	✓		✓	✓				✓	✓	✓
4	20CHT42	Process Heat Transfer	✓	✓	✓		✓							✓	✓	✓
4	20CHL41	Mechanical Operations Laboratory	✓	✓				✓	✓	✓	✓	✓		✓	✓	✓
4	20CHL42	Process Heat Transfer Laboratory	✓	✓				✓	✓	✓	✓	✓		✓	✓	✓
4	20EGL31	English for Workplace Communication Laboratory									✓	✓		✓		
4	20GET31	Universal Human Values						✓	✓	✓	✓	✓				
5	20CHT51	Mass Transfer I	✓	✓	✓	✓								✓	✓	✓
5	20CHT52	Chemical Reaction Engineering I	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓
5	20CHT53	Chemical Equipment Design and Drawing	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓
5	20CHL51	Chemical Reaction Engineering Laboratory	✓	✓		✓	✓			✓	✓	✓		✓	✓	✓
5	20CHL52	Process Computation Laboratory	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
5	20GEL51/ 20GEI51	Professional Skills Training I / Industrial Training I $	✓	✓				✓	✓		✓	✓	✓	✓		
6	20CHT61	Mass Transfer- II	✓	✓	✓	✓								✓	✓	✓
6	20CHT62	Process Modeling and Simulation	✓	✓	✓		✓						✓	✓	✓	✓
6	20CHT63	Process Instrumentation Dynamics and Control	✓	✓	✓									✓	✓	✓
6	20CHL61	Mass Transfer Laboratory	✓	✓		✓	✓			✓	✓	✓		✓	✓	✓
6	20CHL62	Process Modeling and Simulation Laboratory	✓	✓		✓	✓				✓		✓	✓	✓	✓
6	20CHL63	Process Instrumentation Dynamics and Control Laboratory	✓	✓		✓	✓			✓	✓	✓		✓	✓	✓
6	20CHP61	Project Work -I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	20GEL61/20GEI61	Professional Skills Training -II / Industrial Training- II @	✓	✓				✓	✓		✓	✓	✓	✓		
6	20GEP71	Comprehensive Test / Viva	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓
7	20CHT71	Process Engineering and Economics	✓	✓	✓				✓				✓		✓	
7	20CHT72	Transport Phenomena	✓	✓	✓	✓								✓	✓	✓
7	20CHP71	Project Work -II Phase -I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	20CHP81	Project work -II Phase- II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
5	20CHE01	Chemical Process Plant Safety	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓
5	20CHE02	Organic Synthesis	✓	✓	✓			✓	✓	✓				✓	✓	✓
5	20CHE03	Chemical Analysis	✓	✓	✓										✓	✓
5	20CHE04	Bio Chemical Engineering	✓	✓					✓					✓	✓	✓
6	20CHE05	Pulp and Paper Technology	✓	✓					✓						✓	✓
6	20CHE06	Chemical Reaction Engineering- II	✓	✓	✓	✓	✓	✓	✓	✓					✓	✓
6	20CHE07	Surface Coating Technology	✓	✓	✓				✓						✓	✓
6	20CHE08	Energy Technology	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓
6	20CHE09	Modern Separation Processes	✓	✓	✓	✓		✓	✓					✓	✓	✓
7	20CHE10	Air Pollution Control	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓
7	20CHE12	Process Instrumentation	✓	✓										✓	✓	
7	20CHE13	Fertilizer Technology	✓					✓	✓					✓	✓	✓
7	20CHE14	Corrosion Technology	✓	✓			✓	✓	✓						✓	✓
7	20CHE15	Natural Gas Engineering	✓	✓			✓	✓	✓						✓	✓
7	20CHE16	Nano Materials and Composite Materials for Chemical Engineers	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓
7	20CHE17	Fundamentals of Computational Fluid Dynamics	✓	✓	✓	✓	✓							✓	✓	✓
7	20CHE18	Pharmaceutical Process Technology	✓	✓				✓						✓	✓	✓
7	20CHE19	Process Optimization	✓	✓	✓	✓	✓							✓		
7	20CHE20	Nuclear Engineering for Chemical Engineers	✓	✓					✓						✓	✓
8	20CHE21	Numerical Techniques in Chemical Engineering	✓	✓	✓	✓	✓							✓		
8	20CHE22	Petroleum Refinery Engineering	✓	✓					✓						✓	✓
8	20CHE23	Industrial Waste Water Treatment	✓	✓	✓		✓		✓				✓	✓	✓	✓
8	20CHE24	Piping Engineering	✓	✓	✓		✓							✓	✓	✓
8	20CHE25	Battery and Fuel Cell Technology	✓	✓										✓	✓	✓
8	20CHE26	Fluid Movers	✓	✓										✓	✓	✓
8	20CHE27	Advanced Process Control	✓	✓	✓		✓							✓	✓	✓
8	20CHE28	Ores and Mineral Processing	✓	✓		✓			✓	✓					✓	✓
8	20CHE29	Polymer Technology	✓	✓					✓						✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		OPEN ELECTIVE														
4	20CEO01	Remote Sensing and its Applications	✓	✓	✓	✓		✓			✓			✓		
4	20MEO01	Renewable Energy Sources	✓	✓		✓			✓		✓	✓				
4	20MTO01	Design of Mechatronics Systems	✓	✓	✓	✓	✓							✓		
4	20AUO01	Automotive Engineering	✓	✓	✓		✓				✓	✓				
4	20ECO01	Wearable Technology	✓	✓	✓	✓		✓		✓				✓		
4	20ECO02	Basics of Electronics in Automation Appliances	✓	✓	✓	✓		✓	✓	✓			✓	✓		
4	20ECO03	Principles of Quantum Computing	✓	✓	✓	✓	✓				✓	✓		✓		
4	20EEO01	Solar and Wind Energy Systems	✓	✓	✓				✓							
4	20EEO02	Electrical Wiring and Lighting	✓	✓	✓	✓	✓									
4	20EEO03	Electrical Safety	✓	✓	✓											
4	20EIO01	Digital Image Processing and Its Applications	✓	✓	✓	✓	✓									
4	20CSO01	Fundamentals of Databases	✓	✓	✓	✓	✓									
4	20CSO02	Python Programming and Frameworks														
4	20ITO01	Artificial Intelligence	✓	✓	✓	✓										
4	20ITO02	Web Technologies	✓	✓	✓											
4	20ITO03	Introduction to Operating Systems	✓	✓	✓	✓										
4	20ITO04	Programming in Python			✓		✓							✓		
4	20CHO01	Drugs and Pharmaceuticals Technology	✓	✓	✓	✓	✓									
4	20CHO02	Process Automation	✓	✓	✓		✓									
4	20FTO01	Baking Technology	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		
4	20FTO02	Food Processing Technology	✓	✓	✓	✓								✓		
4	20CDO01	Fundamentals of User Experience Design	✓	✓	✓	✓					✓	✓	✓			
4	20ADO01	Data Warehousing and Data Mining	✓	✓	✓											
4	20ALO01	Business Intelligence	✓	✓	✓											
4	20PHO01	Thin Film Technology	✓	✓	✓											

4	20CYO01	Instrumental Methods of Analysis	✓	✓	✓	✓										
5	20CEO02	Disaster Management	✓	✓	✓			✓	✓					✓		
5	20MEO02	Design of Experiments	✓	✓	✓	✓	✓						✓			
5	20MTO02	Factory Automation	✓	✓	✓	✓	✓	✓			✓	✓		✓		
5	20MTO03	Data Acquisition and Virtual Instrumentation	✓	✓	✓	✓	✓				✓	✓		✓		
5	20AUO02	Automotive Electronics	✓	✓	✓	✓	✓				✓	✓		✓		
5	20ECO04	PCB Design and Fabrication	✓	✓	✓		✓			✓	✓	✓		✓		
5	20EEO04	Energy Conservation and Management	✓	✓	✓		✓									
5	20EIO02	Industrial Automation	✓	✓	✓	✓	✓									
5	20EIO03	Measurements and Instrumentation	✓	✓	✓	✓	✓									
5	20CSO03	Computational Science for Engineers	✓	✓	✓											
5	20CSO04	Formal Languages and Automata	✓	✓	✓											
5	20ITO05	Data Science	✓	✓	✓	✓										
5	20ITO06	Advanced Java Programming	✓	✓	✓											
5	20CHO03	Renewable Bioenergy Resources	✓	✓	✓	✓			✓							
5	20CHO04	Intelligent Controllers	✓		✓	✓		✓								
5	20FTO03	Processing of Milk and Milk Products	✓	✓	✓		✓	✓		✓	✓	✓		✓		
5	20FTO04	Processing of Fruits and Vegetables	✓	✓	✓		✓	✓		✓	✓	✓		✓		
5	20CDO02	Fundamentals of User Interactive Design	✓	✓	✓											
5	20ADO02	Computer Vision	✓	✓	✓	✓	✓									
5	20ALO02	Data Exploration and Visualization Techniques	✓	✓	✓	✓	✓									
5	20PHO02	High Energy Storage Devices	✓	✓	✓											
5	20CYO02	Corrosion Science and Engineering	✓	✓	✓	✓										
5	20CYO03	Chemistry of Cosmetics in Daily Life	✓	✓	✓											
5	20CYO04	Chemistry of Nutrition for Women Health	✓	✓	✓											
5	20MAO01	Mathematical Foundations for Machine Learning	✓	✓		✓	✓									
5	20MAO02	Graph Theory and its Applications	✓	✓	✓											

6	20CEO03	Introduction to Smart Cities	✓	✓	✓											
6	20CEO04	Environmental Health and Safety	✓	✓	✓	✓										
6	20MEO03	Fundamentals of Ergonomics	✓	✓	✓	✓	✓	✓	✓					✓		
6	20MEO04	Principles of Management and Industrial Psychology						✓		✓	✓	✓	✓			
6	20MTO04	3D Printing and Design	✓	✓	✓	✓	✓						✓	✓		
6	20MTO05	Drone System Technology	✓	✓	✓	✓	✓						✓	✓		
6	20MTO06	Virtual and Augument Reality in Industry 4.0														
6	20AUO03	Vehicle Maintenance	✓	✓	✓	✓								✓		
6	20ECO05	Electronic Hardware and Troubleshooting	✓	✓	✓	✓	✓	✓								
6	20ECO06	Bioinspired Computing Technologies	✓	✓	✓		✓				✓					
6	20EEO05	Micro Grid and Smart Grid	✓	✓	✓	✓										
6	20EEO06	E-Waste Management	✓	✓	✓	✓										
6	20EIO04	Biomedical Instrumentation and Applications	✓	✓	✓	✓	✓	✓								
6	20EIO05	PLC Programming and Its Applications	✓	✓	✓	✓	✓									
6	20EIO06	Instrumentation for Industry 4.0	✓	✓	✓	✓	✓									
6	20CSO05	Java Programming	✓	✓	✓	✓	✓									
6	20CSO06	Web Engineering	✓	✓	✓	✓	✓									
6	20CSO07	Nature Inspired Optimization Techniques	✓	✓	✓											
6	20ITO07	Bio Natural Language Processing	✓	✓	✓	✓										
6	20ITO08	Disaster Management for Information Technology	✓	✓	✓	✓										
6	20CHO05	Food as Medicine	✓	✓	✓	✓		✓						✓		
6	20CHO06	Organic Farming	✓		✓			✓	✓	✓	✓		✓	✓		
6	20FTO05	Principles of Food Safety	✓	✓	✓		✓	✓	✓	✓				✓		
6	20FTO06	Fundamentals of Food Packaging and Storage	✓	✓	✓		✓	✓		✓				✓		
6	20CDO03	Introduction to Mobile Game Design	✓	✓	✓											
6	20ADO03	Neural Networks and Deep Learning	✓	✓	✓											

6	20ALO03	Industrial Machine Learning	✓	✓	✓											
6	20PHO03	Structural and Optical Characterization of Materials	✓	✓	✓											
6	20CYO05	Chemistry Concepts for Competitive Examinations	✓	✓	✓											
6	20CYO06	Waste and Hazardous Waste Management	✓	✓	✓	✓			✓							
6	20MAO03	Data Analytics using R Programming	✓	✓	✓	✓	✓									
6	20MAO04	Number Theory and Cryptography	✓	✓	✓		✓									
8	20CEO05	Infrastructure Planning and Management	✓	✓	✓											
8	20CEO06	Environmental Laws and Policy	✓	✓	✓	✓										
8	20MEO05	Safety Measures for Engineers	✓			✓		✓	✓	✓						
8	20MEO06	Energy Conservation in Thermal Equipments	✓	✓												
8	20MTO06	Robotics	✓	✓	✓	✓	✓							✓		
8	20MTO07	Virtual and Augment Reality in Industry 4.0	✓	✓	✓	✓	✓	✓						✓		
8	20AUO04	Public Transport Management	✓	✓				✓	✓	✓	✓	✓	✓	✓		
8	20AUO05	Autonomous Vehicles	✓	✓	✓											
8	20ECO07	Optical Engineering	✓	✓	✓	✓		✓		✓	✓			✓		
8	20EEO07	Electric Vehicle	✓	✓	✓	✓										
8	20EIO07	Graphical Programming using Virtual Instrumentation	✓	✓	✓	✓	✓									
8	20EIO08	Testing of Materials	✓	✓	✓	✓	✓									
8	20CSO08	Fundamentals of Internet of Things	✓	✓	✓		✓									
8	20CSO09	Machine Translation	✓	✓	✓											
8	20CSO10	Fundamentals of Blockchain	✓	✓	✓											
8	20ITO09	Modern Application Development	✓	✓	✓	✓										
8	20ITO10	Object Oriented System Development using UML	✓	✓	✓	✓										
8	20ITO11	Reinforcement Learning	✓	✓	✓	✓										
8	20CHO07	Cosmetics and Personal Health Care Products	✓		✓			✓		✓				✓		
8	20CHO08	Brewing and Alcohol Technology	✓	✓												

8	20FTO07	Food Ingredients	✓	✓	✓			✓						✓		
8	20FTO08	Food and Nutrition	✓	✓	✓			✓						✓		
8	20CDO04	Introduction to Graphics Design	✓	✓	✓											
8	20ADO04	Business Analytics	✓	✓	✓											
8	20ALO04	Machine Learning for Smart Cities	✓	✓	✓											
8	20MAO05	Advanced Linear Algebra	✓	✓	✓											
8	20MAO06	Optimization Techniques	✓	✓	✓											
		GENERAL OPEN ELECTIVE														
4,5,6,8	20GEO01	German Language Level 1								✓	✓	✓		✓		
4,5,6,8	20GEO02	Japanese Language Level 1								✓	✓	✓		✓		
5	20GEO03	Design Thinking for Engineers	✓	✓	✓											
6	20GEO04	Innovation and Business Model Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
4,5,6,8	20GEO05	German Language Level 2								✓	✓	✓		✓		
4,5,6,8	20GEO06	German Language Level 3								✓	✓	✓		✓		
4,5,6,8	20GEO07	German Language Level 4								✓	✓	✓		✓		
4,5,6,8	20GEO08	Japanese Language Level 2								✓	✓	✓		✓		
4,5,6,8	20GEO09	Japanese Language Level 3								✓	✓	✓		✓		
4,5,6,8	20GEO10	Japanese Language Level 4								✓	✓	✓		✓		
4,5,6,8	20GEO11	NCC Studies (Army Wing) - I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
4,5,6,8	20GEO12	NCC Studies (Air Wing) - I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
4,5,6,8	20GEO13	French Language Level 1								✓	✓	✓		✓		
4,5,6,8	20GEO14	French Language Level 2								✓	✓	✓		✓		
4,5,6,8	20GEO15	French Language Level 3								✓	✓	✓		✓		
4,5,6,8	20GEO16	Spanish Language Level 1								✓	✓	✓		✓		
4,5,6,8	20GEO17	Spanish Language Level 2								✓	✓	✓		✓		
4,5,6,8	20GEO18	Spanish Language Level 3								✓	✓	✓		✓		
8	20GEO19	Entrepreneurship Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		

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(For the candidates admitted in the academic year 2020-21)

SEMESTER – I

Course Code	Course Title	Hours/ Week L	T	P	Credit	Maximum Marks CA	ESE	Total	CBS
Theory/Theory with Practical									
20EGT11	English Language Skills	3	0	0	3	50	50	100	HS
20MAC11	Matrices and Differential Equations	3	1*	2*	4	50	50	100	BS
20PHT11	Applied Physics	3	0	0	3	50	50	100	BS
20CYT11	Applied Chemistry	3	0	0	3	50	50	100	BS
20CHT11	Chemical Process Industries	3	0	0	3	50	50	100	PC
20MEC11	Engineering Drawing	2	0	2	3	50	50	100	ES
Practical / Employability Enhancement									
20MEL11	Engineering Practices Laboratory	0	0	2	1	50	50	100	ES
20PHL11	Physical Sciences Laboratory I	0	0	2	1	50	50	100	BS
20VEC11	Yoga and Values for Holistic Development	1	0	1	1	100	0	100	HS
20MNT11	Student Induction Program #	-	-	-	0	100	0	100	MC
						Total credits to be earned	**22**		

*Alternate weeks

SEMESTER – II

Course Code	Course Title	Hours/ Week L	T	P	Credit	Maximum Marks CA	ESE	Total	CBS
Theory/Theory with Practical									
20EGT21	Advanced Communication Skills	3	0	0	3	50	50	100	HS
20MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	50	50	100	BS
20PHT25	Physics for Chemical Engineering	3	0	0	3	50	50	100	BS
20CYT24	Industrial Chemistry	3	0	0	3	50	50	100	BS
20CHT21	Chemical Process Utilities	3	1	0	4	50	50	100	PC
20CHT22	Electrical Drives and Industrial Electronics	3	0	0	3	50	50	100	ES
Practical / Employability Enhancement									
20CHL21	Electrical Drives and Industrial Electronics Laboratory	0	0	2	1	50	50	100	ES
20PHL29	Physical Sciences Laboratory II	0	0	2	1	50	50	100	BS
						Total credits to be earned	**22**		

*Alternate weeks

B.TECH. DEGREE IN CHEMICAL ENGINEERING
CURRICULUM UNDER REGULATIONS 2020
(For the candidates admitted in the academic year 2020-21)

SEMESTER – III									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20MAT31	Probability and Partial Differential Equations	3	1	0	4	50	50	100	BS
20CSC31	Programming in C	3	0	2	4	50	50	100	ES
20CHT31	Chemical Engineering Thermodynamics	3	1	0	4	50	50	100	ES
20CHT32	Applied Organic Chemistry	3	0	0	3	50	50	100	PC
20CHT33	Fluid Mechanics	3	0	0	3	50	50	100	PC
20CHT34	Chemical Process Calculations	3	1	0	4	50	50	100	PC
Practical / Employability Enhancement									
20CHL31	Applied Organic Chemistry Laboratory	0	0	2	1	50	50	100	ES
20CHL32	Fluid Mechanics Laboratory	0	0	2	1	50	50	100	PC
20MNT31	Environmental Science	2	0	0	0	100	0	100	MC
Total Credits to be earned					**24**				

SEMESTER – IV									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20MAT41	Statistics and Numerical Methods	3	1	0	4	50	50	100	BS
20CSC41	Python Programming	3	0	2	4	50	50	100	ES
20CHT41	Mechanical Operations	3	0	0	3	50	50	100	PC
20CHT42	Process Heat Transfer	3	0	0	3	50	50	100	PC
	Open Elective I	3	1	0	4	50	50	100	OE
Practical / Employability Enhancement									
20CHL41	Mechanical Operations Laboratory	0	0	2	1	50	50	100	PC
20CHL42	Process Heat Transfer Laboratory	0	0	2	1	50	50	100	PC
20EGL31	English for Workplace Communication Laboratory	0	0	2	1	50	50	100	HS
20GET31	Universal Human Values	2	0	0	2	100	0	100	HS
Total Credits to be earned					**23**				

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(For the candidates admitted in the academic year 2020-21)

SEMESTER – V									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20CHT51	Mass Transfer I	3	1	0	4	50	50	100	PC
20CHT52	Chemical Reaction Engineering I	3	0	0	3	50	50	100	PC
20CHT53	Chemical Equipment Design and Drawing	3	1	0	4	50	50	100	PC
	Professional Elective I	3	0	0	3	50	50	100	PE
	Open Elective II	3	1	0	4	50	50	100	OE
Practical / Employability Enhancement									
20CHL51	Chemical Reaction Engineering Laboratory	0	0	2	1	50	50	100	PC
20CHL52	Process Computation Laboratory	0	0	2	1	50	50	100	PC
20GEL51/ 20GEI51	Professional Skills Training I / Industrial Training I $	--	--	--	2	100	0	100	EC
Total Credits to be earned					**22**				

$ 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									
20CHT61	Mass Transfer-II	3	0	0	3	50	50	100	PC
20CHT62	Process Modeling and Simulation	3	0	0	3	50	50	100	PC
20CHT63	Process Instrumentation Dynamics and Control	3	0	0	3	50	50	100	PC
	Open Elective III	3	1/0	0/2	3	50	50	100	OE
Practical / Employability Enhancement									
20CHL61	Mass Transfer Laboratory	0	0	2	1	50	50	100	PC
20CHL62	Process Modeling and Simulation Laboratory	0	0	2	1	50	50	100	PC
20CHL63	Process Instrumentation Dynamics and Control Laboratory	0	0	2	1	50	50	100	PC
20CHP61	Project Work I	0	0	4	2	100	0	100	EC
20GEL61/ 20GEI61	Professional Skills Training II / Industrial Training II @	---	---	---	2	100	0	100	EC
20GEP61	Comprehensive Test and Viva	---	---	---	2	100	0	100	EC
Total Credits to be earned					**21**				

@ 80 hours of training

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(For the candidates admitted in the academic year 2020-21)

SEMESTER – VII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20CHT71	Process Engineering and Economics	3	0	0	3	50	50	100	HS
20CHT72	Transport Phenomena	3	1	0	4	50	50	100	PC
	Professional Elective II	3	0	0	3	50	50	100	PE
	Professional Elective III	3	0	0	3	50	50	100	PE
	Professional Elective IV	3	0	0	3	50	50	100	PE
	Professional Elective V	3	0	0	3	50	50	100	PE
Practical / Employability Enhancement									
20CHP71	Project Work II Phase I	0	0	12	6	50	50	100	EC
Total Credits to be earned					**25**				

SEMESTER – VIII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
	Open Elective IV	3	0	0	3	50	50	100	OE
	Professional Elective VI	3	0	0	3	50	50	100	PE
Practical / Employability Enhancement									
20CHP81	Project Work II Phase II	---	---	8	4	50	50	100	EC
Total Credits to be earned					**10**				

Total Credits: 169

B.TECH. DEGREE IN CHEMICAL ENGINEERING
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(with the inclusion of Amendment No.2022.18.07)
(For the candidates admitted in the academic year 2021-22)

SEMESTER – I										
Course Code	Course Title	Hours/ Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20EGT11	English Language Skills	3	0	0	3	40	60	100	HS
20MAC11	Matrices and Differential Equations	3	1*	2*	4	50	50	100	BS
20PHT11	Applied Physics	3	0	0	3	40	60	100	BS
20CYT11	Applied Chemistry	3	0	0	3	40	60	100	BS
20CHT11	Chemical Process Industries	3	0	0	3	40	60	100	PC
20MEC11	Engineering Drawing	2	0	2	3	50	50	100	ES
Practical / Employability Enhancement									
20MEL11	Engineering Practices Laboratory	0	0	2	1	60	40	100	ES
20PHL11	Physical Sciences Laboratory I	0	0	2	1	60	40	100	BS
20VEC11	Yoga and Values for Holistic Development	1	0	1	1	100	0	100	HS
20MNT11	Student Induction Program #	-	-	-	0	100	0	100	MC
Total credits to be earned							**22**		

*Alternate weeks

SEMESTER – II										
Course Code	Course Title	Hours/ Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20EGT21	Advanced Communication Skills	3	0	0	3	40	60	100	HS
20MAC21	Multivariable Calculus and Complex Analysis	3	1*	2*	4	50	50	100	BS
20PHT25	Physics for Chemical Engineering	3	0	0	3	40	60	100	BS
20CYT24	Industrial Chemistry	3	0	0	3	40	60	100	BS
20CSC31	Programming in C	3	0	2	4	50	50	100	ES
20CHT22	Electrical Drives and Industrial Electronics	3	0	0	3	40	60	100	ES
Practical / Employability Enhancement									
20CHL21	Electrical Drives and Industrial Electronics Laboratory	0	0	2	1	60	40	100	ES
20PHL29	Physical Sciences Laboratory II	0	0	2	1	60	40	100	BS
Total credits to be earned							**22**		

*Alternate weeks

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CURRICULUM UNDER REGULATIONS 2020
(For the candidates admitted in the academic year 2021-22)

SEMESTER – III									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20MAT31	Probability and Partial Differential Equations	3	1	0	4	40	60	100	BS
20CSC33	Fundamentals of Data Structures	3	0	2	4	50	50	100	ES
20CHT31	Chemical Engineering Thermodynamics	3	1	0	4	40	60	100	ES
20CHT32	Applied Organic Chemistry	3	0	0	3	40	60	100	PC
20CHT33	Fluid Mechanics	3	0	0	3	40	60	100	PC
20CHT34	Chemical Process Calculations	3	1	0	4	40	60	100	PC
Practical / Employability Enhancement									
20CHL31	Applied Organic Chemistry Laboratory	0	0	2	1	60	40	100	ES
20CHL32	Fluid Mechanics Laboratory	0	0	2	1	60	40	100	PC
20MNT31	Environmental Science	2	0	0	0	100	0	100	MC
Total Credits to be earned					**24**				

SEMESTER – IV									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20MAT41	Statistics and Numerical Methods	3	1	0	4	40	60	100	BS
20CHT21	Chemical Process Utilities	3	1	0	4	40	60	100	PC
20CHT41	Mechanical Operations	3	0	0	3	40	60	100	PC
20CHT42	Process Heat Transfer	3	0	0	3	40	60	100	PC
	Open Elective I	3	1/0	0/2	4	40/ 50	60/ 50	100	OE
Practical / Employability Enhancement									
20CHL41	Mechanical Operations Laboratory	0	0	2	1	60	40	100	PC
20CHL42	Process Heat Transfer Laboratory	0	0	2	1	60	40	100	PC
20EGL31	English for Workplace Communication Laboratory	0	0	2	1	60	40	100	HS
20GEL51/ 20GEI51	Professional Skills Training I / Industrial Training I $	--	--	--	2	100	0	100	EC
Total Credits to be earned					**23**				

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CURRICULUM UNDER REGULATIONS 2020
(For the candidates admitted in the academic year 2021-22)

SEMESTER – V									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20CHT51	Mass Transfer I	3	1	0	4	40	60	100	PC
20CHT52	Chemical Reaction Engineering I	3	0	0	3	40	60	100	PC
20CHT53	Chemical Equipment Design and Drawing	3	1	0	4	40	60	100	PC
	Professional Elective I	3	0	0	3	40	60	100	PE
	Open Elective II	3	1/0	0/2	4	40/ 50	60/ 50	100	OE
Practical / Employability Enhancement									
20CHL51	Chemical Reaction Engineering Laboratory	0	0	2	1	60	40	100	PC
20CHL52	Process Computation Laboratory	0	0	2	1	60	40	100	PC
20GEL61/ 20GEI61	Professional Skills Training II / Industrial Training II @	---	---	---	2	100	0	100	EC
Total Credits to be earned					**22**				

$ 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									
20CHT61	Mass Transfer-II	3	0	0	3	40	60	100	PC
20CHT62	Process Modeling and Simulation	3	0	0	3	40	60	100	PC
20CHT63	Process Instrumentation Dynamics and Control	3	0	0	3	40	60	100	PC
	Open Elective III	3	1/0	0/2	3	40	60	100	OE
Practical / Employability Enhancement									
20CHL61	Mass Transfer Laboratory	0	0	2	1	60	40	100	PC
20CHL62	Process Modeling and Simulation Laboratory	0	0	2	1	60	40	100	PC
20CHL63	Process Instrumentation Dynamics and Control Laboratory	0	0	2	1	60	40	100	PC
20CHP61	Project Work I	0	0	4	2	100	0	100	EC
20GET31	Universal Human Values	2	0	0	2	100	0	100	HS
20GEP61	Comprehensive Test and Viva	---	---	---	2	100	0	100	EC
Total Credits to be earned					**21**				

@ 80 hours of training

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(For the candidates admitted in the academic year 2021-22)

SEMESTER – VII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20CHT71	Process Engineering and Economics	3	0	0	3	40	60	100	HS
20CHT72	Transport Phenomena	3	1	0	4	40	60	100	PC
	Professional Elective II	3	0	0	3	40	60	100	PE
	Professional Elective III	3	0	0	3	40	60	100	PE
	Professional Elective IV	3	0	0	3	40	60	100	PE
	Professional Elective V	3	0	0	3	40	60	100	PE
Practical / Employability Enhancement									
20CHP71	Project Work II Phase I	0	0	12	6	50	50	100	EC
Total Credits to be earned					**25**				

SEMESTER – VIII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
	Open Elective IV	3	0	0	3	40	60	100	OE
	Professional Elective VI	3	0	0	3	40	60	100	PE
Practical / Employability Enhancement									
20CHP81	Project Work II Phase II	---	---	8	4	50	50	100	EC
Total Credits to be earned					**10**				

Total Credits: 169

LIST OF PROFESSIONAL ELECTIVES (PE)

S. No.	Course Code	Course Name	L	T	P	C	Domain Stream
		Semester-V					
		Elective I					
1.	20CHE01	Chemical Process Plant Safety	3	0	0	3	PPO
2.	20CHE02	Organic Synthesis	3	0	0	3	AC&RE
3.	20CHE03	Instrumental Methods of Analysis	3	0	0	3	AC&RE
4.	20CHE04	Chemical Analysis	3	0	0	3	AC&RE
5.	20CHE05	Bio Chemical Engineering	3	0	0	3	CT
		Semester-VII					
		Elective II					
6.	20CHE06	Pulp and Paper Technology	3	0	0	3	CT
7.	20CHE07	Chemical Reaction Engineering -II	3	0	0	3	AC&RE
8.	20CHE08	Surface Coating Technology	3	0	0	3	CT
9.	20CHE09	Energy Technology	3	0	0	3	E&E
10.	20CHE10	Modern Separation Processes	3	0	0	3	PPO
		Elective III					
11.	20CHE11	Air Pollution Control	3	0	0	3	E&E
13.	20CHE12	Process Instrumentation	3	0	0	3	CSMS&C
14.	20CHE13	Fertilizer Technology	3	0	0	3	CT
15.	20CHE14	Corrosion Technology	3	0	0	3	CT
16.	20GEE01	Fundamentals of Research	3	0	0	3	GE
		Elective IV					
17.	20CHE15	Natural Gas Engineering	3	0	0	3	CT
18.	20CHE16	Nano Materials and Composite Materials for Chemical Engineers	3	0	0	3	AC&RE
19.	20CHE17	Fundamentals of Computational Fluid Dynamics	3	0	0	3	CSMS&C
20.	20CHE18	Pharmaceutical Process Technology	3	0	0	3	CT
21.	20CHE19	Process optimization	3	0	0	3	CSMS&C
22.	20CHE20	Total Quality Management	3	0	0	3	GE
		Elective V					
23.	20CHE21	Nuclear Engineering for Chemical Engineers	3	0	0	3	CT
24.	20CHE22	Numerical Techniques in Chemical Engineering	3	0	0	3	CSMS&C
25.	20CHE23	Petroleum Refinery Engineering	3	0	0	3	CT
26.	20CHE24	Industrial Waste Water Treatment	3	0	0	3	E&E
27.	20CHE25	Piping Engineering	3	0	0	3	T&TO
		Semester-VIII					

		Elective VI					
28.	20CHE26	Battery and Fuel Cell Technology	3	0	0	3	E&E
29.	20CHE27	Fluid Movers	3	0	0	3	T&TO
30.	20CHE28	Advanced Process Control	3	0	0	3	CSMS&C
31.	20CHE29	Ores and Mineral Processing	3	0	0	3	PPO
32.	20CHE30	Polymer Technology	3	0	0	3	CT

***** Domain/Stream Abbreviations: T&TO-Thermodynamics & Transport Operations, CSM&S-Chemical Systems Modeling & Simulation & Control, AC&RE –Applied Chemistry & Reaction Engineering, PPO-Process Plant Operation, CT-Chemical Technology, E&E-Energy & Environment

LIST OF OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)
(Common to all departments except offering department)

S.No.	Course Code	Course Title	Hours/Week			Credit	Sem
			L	T	P		
1.	20CHO01	Drugs and Pharmaceuticals Technology	3	1	0	4	IV
2.	20CHO02	Process Automation	3	1	0	4	IV
3.	20CHO03	Renewable Bioenergy Resources	3	1	0	4	V
4.	20CHO04	Intelligent Controllers	3	1	0	4	V
5.	20CHO09	Industrial Enzymology	3	1	0	4	V
6.	20CHO10	Waste to Energy Conversion	3	1	0	4	V
7.	20CHO11	Applied Nanotechnology	3	1	0	4	V
8.	20CHO05	Food as Medicine	3	0	0	3	VI
9.	20CHO06	Organic Farming	3	0	0	3	VI
10.	20CHO12	Air Pollution Monitoring and Control	3	0	0	3	VI
11.	20CHO13	Paints and Coatings	3	0	0	3	VI
12.	20CHO14	Powder Technology	3	0	0	3	VI
13.	20CHO07	Cosmetics and Personal health Care Products	3	0	0	3	VIII
14.	20CHO08	Brewing and Alcohol Technology	3	0	0	3	VIII
15.	20CHO15	Hydrogen Energy	3	0	0	3	VIII
16.	20CHO16	Industrial Accident Prevention and Management	3	0	0	3	VIII
17.	20CHO17	Electrochemical Engineering	3	0	0	3	VIII
18.	20CHO18	Smart and Functional Materials	3	0	0	3	VIII

20EGT11 - ENGLISH LANGUAGE SKILLS

(Common to all Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**1**	**HS**	**3**	**0**	**0**	**3**

Preamble	This course is designed to impart required levels of fluency in using the English Language at A2/B1 Level in the Common European Framework (CEFR).	
Unit - I	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – I:**	**9**
Listening - Talking about past experiences - listening to descriptions - Speaking - Exchanging personal information - Talking about cities and transportation - Reading - Life and achievements of a famous personality - Global transport systems - Writing - Childhood experiences - Process Description – Grammar & Vocabulary – Past tense – Expressions of quantity – Indirect questions.		
Unit - II	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – II:**	**9**
Listening - Information about hotels and accommodation - Recipes and food items - Speaking - Life style changes and making comparisons - Talking about food - Reading - Habit formation and changing habits - International cuisine - Writing - Personal email - emails about food and recipes – Grammar & Vocabulary – Evaluations and Comparisons with adjectives – Simple past and present perfect tenses.		
Unit - III	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – III:**	**9**
Listening - Information about travel - descriptions / conversations about family life - Speaking - Vacations and Holidays - Requests, complaints and offering explanations - Reading - Tourist places and travel experiences - Group behaviour and politeness - Writing - Personal letter about travelling - Writing guidelines and checklists – Grammar & Vocabulary – Future tense – Modals – Two-part verbs.		
Unit - IV	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – IV:**	**9**
Listening - Descriptions about festivals - Presentations on technology - Speaking - About technology - festivals, special events and traditions - Reading - Sports, hobbies and past time - About different cultures - Writing - Product Description - Writing web content – Grammar & Vocabulary – Infinitives and Gerunds for uses and purposes – Imperatives for giving suggestions – Relative clauses of time.		
Unit - V	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – V:**	**9**
Listening - Talking about changes - Job preferences - Speaking - Comparing different periods or phases in life – Changes that happen - Skills and abilities, Personality Development - Employability Skills – Reading - Reading about life experiences - Emotions and feelings – Job preferences – Jobs and Personality – Writing - Writing about one's past, present and future – Researching job options – Choosing the right job – Grammar & Vocabulary – Time contrasts – Conditional sentences with "if clauses" – Gerunds – short responses.		

Total: 45

TEXT BOOK:

1.	Jack C. Richards, Jonathan Hull, and Susan Proctor, "Interchange - Student's Book 2", 4th Edition, Cambridge University Press, New York, 2017.

REFERENCES:

1.	Sanjay Kumar and Pushp Lata, "Communication Skills", 2nd Edition, Oxford University Press, New Delhi, 2015.
2.	Pamela Hartmann and Brenda Wegmann, "New Interactions English Language Learning and Assessment Platform (Level Intro - Level IV)", McGraw Hill India, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	use language effectively and accurately acquiring vocabulary from real-life context	Applying (K3)
CO2	listen/view and comprehend different spoken discourses / excerpts in different accents	Applying (K3)
CO3	read different genres of texts adopting various reading strategies	Analyzing (K4)
CO4	write cohesively, coherently and flawlessly avoiding grammatical errors, using a wide range of vocabulary, organizing their ideas logically on a topic	Creating (K6)
CO5	speak clearly, confidently, comprehensibly and communicate with others using appropriate communicative strategies	Creating (K6)

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	2	2		
CO2									2	3		1		
CO3						1				3	1	1		
CO4										3		1		
CO5									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		16	30	37		17	100
CAT2		17	30	37		16	100
CAT3		13	33	37		17	100
ESE		7	21	37		35	100

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

20MAC11 - MATRICES AND 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 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.		
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.		
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^nsinax and x^ncosax – 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** & **Inverse 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) – Solution of linear ODE of second order with constant coefficients.		

List of Exercises / Experiments:

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

***Alternate week**

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

TEXT BOOK:

1.	Ravish R. Singh, Mukul Bhatt "Engineering Mathematics", 1st Edition, McGraw Hill Education, New Delhi, 2016.

REFERENCES:

1.	Kreyszig E., "Advanced Engineering Mathematics", 10th Edition, John Wiley Sons, 2011.
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.	MATLAB 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	know the basics of MATLAB and computing eigen values and eigen vectors of real matrix by MATLAB.	Understanding (K2), Manipulation (S2)
CO7	solve ordinary differential equations with constant and variable coefficients and simultaneous first order ordinary differential equations using MATLAB.	Applying (K3), Manipulation (S2)
CO8	compute Laplace and inverse Laplace Transform of basic functions and solve Second Order ODE by using Laplace Transform with 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	1										
CO2	3	3	2	1										
CO3	3	3	2	1										
CO4	3	3	2											
CO5	3	3	2	1										
CO6					3									
CO7					3									
CO8					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)**

20PHT11 - APPLIED PHYSICS

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	BS	3	0	0	3

Preamble	This course aims to impart the essential concepts of propagation of elastic waves, acoustics, ultrasonics, laser and fiber optics, quantum physics, crystal structure and crystal defects. It also describes the physical phenomena related to the aforementioned concepts and their applications in engineering and provides motivation towards innovations	
Unit - I	**Propagation of Elastic Waves:**	**9**
Oscillatory Motion: Introduction to simple harmonic motion - Damping velocity - Damping coefficient - Differential equation of simple harmonic motion - Velocity and acceleration - Restoring force - Vibration of a spring and mass system - Frequency response - Phase response - Resonance - Wave motion: Definition of a plane progressive wave - Attenuation of waves - Differential equation of a plane progressive wave - Phase velocity - Phase and phase difference - Solution of the differential equation of a plane progressive wave.		
Unit - II	**Acoustics and Ultrasonics:**	**9**
Acoustics: Introduction - Reverberation and reverberation time - Growth and decay of sound - Sabine's formula for reverberation time – Determination of sound absorption coefficient – Design of an auditorium: Factors affecting acoustics of buildings and the remedies. Ultrasonics: Introduction – Properties of ultrasonic waves – Generation of ultrasonic waves: Magnetostrictive generator and Piezoelectric generator - Determination of velocity of ultrasonics in a liquid: Acoustic grating – Industrial application: Non-destructive testing - Other applications of ultrasonic waves (qualitative).		
Unit - III	**Laser and Fiber Optics:**	**9**
Laser and Applications: Introduction – Interaction of light with matter - Three quantum process: Stimulated absorption, spontaneous emission and stimulated emission - Population inversion - Einstein's coefficients and their relations - Pumping methods - Nd:YAG laser - CO_2 laser - Holography. Fiber Optics and Applications: Introduction - Numerical aperture and acceptance angle - Classification of optical fibers based on refractive index, modes and materials - Fiber optics communication system (qualitative) - Fiber optic sensors: Temperature and displacement sensors.		
Unit - IV	**Quantum Physics:**	**9**
Introduction - Blackbody radiation - Planck's quantum hypothesis - Compton scattering (qualitative) - de Broglie's hypothesis - Properties of matter waves - Application of Heisenberg uncertainty principle - Schrodinger's time independent and time dependent wave equations - Physical significance of wave function - The free particle - Potential energy step - Infinite potential well (one - dimensional).		
Unit - V	**Crystal Physics:**	**9**
Introduction - Classification of solids - Space lattice - Crystal structure - Unit cell - Bravais lattice - Single and polycrystalline materials - Lattice planes - Miller indices - Indices of crystal direction - Interplanar spacing in cubic system - Hexagonal close packed crystal structure and c/a ratio - Symmetry -Symmetry elements in cubic crystal - Crystal imperfections: line, surface and volume imperfections - Features of crystal imperfections (qualitative).		

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.

REFERENCES:

1.	Purnima Khare and Swarup A.,"Engineering Physics: Fundamentals and Modern Applications", 1st Edition, Jones and Bartlett Publishers, Sudbury, Massachusetts, 2009.
2.	Gaur R.K. and Gupta S.L., "Engineering Physics", 8th Edition, Dhanpat Rai and Sons, New Delhi, 2009.
3.	Tamilarasan K. and Prabu K., "Engineering Physics – I", 3rd Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	make use of the concepts of oscillatory and wave motion to comprehend the phenomena related to the propagation of elastic waves.	Applying (K3)
CO2	apply the concepts of growth and decay of sound energy in a hall to compute Sabine's formula to recognize the requirements of acoustically good buildings, and to describe the production of ultrasonic wave, working of acoustic grating & non-destructive testing using ultrasonic waves.	Applying (K3)
CO3	apply the concepts of stimulated emission to explain the working and the applications of laser in engineering and technology, and to apply the principle of propagation of light through optical fiber to compute acceptance angle and numerical aperture to comprehend the loss in optical fiber, fiber optic communication system and working of fiber optic sensors.	Applying (K3)
CO4	use the concepts of quantum mechanics to describe the behavior of electrons in a metal by solving Schrodinger's wave equation for particle motion in infinite potential well.	Applying (K3)
CO5	utilize the concepts of the seven crystal systems to obtain interplanar spacing in cubic lattice and c/a ratio of HCP crystal structure, and to comprehend symmetry elements, reciprocal lattice and the types of crystal imperfections and their impacts.	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	20	40	40				100
CAT2	20	35	45				100
CAT3	25	35	40				100
ESE	20	40	40				100

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

20CYT11 - APPLIED CHEMISTRY

(Common to All Engineering and Technology Branches)

Programme & Branch	**All BE/BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**BS**	**3**	**0**	**0**	**3**

Preamble	Applied Chemistry course explores the basic principles and advancements of chemistry in the field of engineering and technology. It aims to impart the fundamentals of chemistry towards innovations in science and technology and also for societal applications.	
Unit - I	**Water Technology:**	**9**
Introduction - sources of water - impurities in water - 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 – electrochemical cells - applications of electrochemical series - reference electrode - standard calomel electrode - ion selective electrode - glass electrode - concentration cells - electrode and electrolyte concentration cells (simple problems) -applications- potentiometric titrations - acid-base, redox, precipitation titrations - advantages- conductometric titrations - strong acid vs strong base, weak acid vs strong base, mixture of weak and strong acid vs strong base- advantages of conductometric titrations.		
Unit - III	**Corrosion and its Control:**	**9**
Introduction – causes and effects of corrosion - types of corrosion - chemical corrosion – Pilling Bed-worth rule - electrochemical corrosion –types - galvanic corrosion, concentration cell corrosion – other types of corrosion -stress, intergranular and microbiological corrosion- galvanic series - factors influencing rate of corrosion – corrosion control methods - design and material selection, anodic protection, corrosion inhibitors, protective coatings - i) metallic coatings : hot dipping (tinning and galvanizing) ii) non-metallic coating : anodizing iii) organic coating : paints – constituents and their functions.		
Unit - IV	**Fuels and Combustion:**	**9**
Introduction – classification of fuels - characteristics of a good fuel - combustion - calorific values – gross and net calorific values - Dulong‘s formula (simple problems) - Flue gas analysis by Orsat‘s method - ignition temperature - spontaneous ignition temperature - explosive range - solid fuels - coal and its varieties – proximate and ultimate analysis – significance – metallurgical coke - Otto-Hoffman byproduct method - liquid fuel - refining of petroleum – manufacture of synthetic petrol - hydrogenation of coal - Bergius process - knocking - octane number – cetane number - gaseous fuel - water gas.		
Unit - V	**Polymers:**	**9**
Introduction – terminology - classification - polymerization - types of polymerization (definition only)- polymerisation techniques- bulk, solution, suspension and emulsion polymerisation - 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.	Palanisamy P.N., Manikandan P., Geetha A.& Manjula Rani K., “Applied Chemistry”, 6th Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2019.
2.	Payal B. Joshi, Shashank Deep, “Engineering Chemistry”, Oxford University Press, New Delhi, 2019.
3.	Palanna O., “Engineering Chemistry”, McGraw Hill Education, New Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the suitable water softening methods to avoid boiler troubles.	Applying (K3)
CO2	apply the principle of electrochemistry for various applications.	Applying (K3)
CO3	make use of corrosion control methods to solve corrosion related problems.	Applying (K3)
CO4	illustrate the quality of fuels from its characteristics.	Understanding (K2)
CO5	explain the types of polymers, plastics and fabrication methods.	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										
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)**

20MEC11 – ENGINEERING DRAWING

(Common to Civil, Mechanical, Mechatronics, Automobile Engineering, Chemical & Food Technology Branches)

Programme & Branch	BE(Civil, Mech, MTS, Auto) &BTech(Chem, FT)	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	ES	2	0	2	3

Preamble	To impart knowledge on orthographic, isometric projections, sectional views and development of surfaces by solving different application oriented problems.	
Unit - I	**General Principles of Orthographic Projection:**	**9**
Importance of graphics in engineering applications - Use of drafting instruments - BIS conventions and specifications - Size, layout and folding of drawing sheets - Lettering and dimensioning - Projections of Points, Lines and Planes - General principles of orthographic projection - First angle projection - Layout of views - Projection of points located in all quadrant and straight lines located in the first quadrant - Determination of true lengths and true inclinations and location of traces - Projection of polygonal surface and circular lamina inclined to both reference planes.		
Unit - II	**Projections of Solid:**	**9**
Projections of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method.		
Unit - III	**Sectioning of Solids:**	**9**
Sectioning of solids - prisms, pyramids, cylinder and cone in simple vertical position by cutting planes inclined to one reference plane and perpendicular to the other - Obtaining true shape of section.		
Unit - IV	**Development of Surfaces:**	**9**
Development of lateral surfaces of simple solids like prisms, pyramids, cylinders and cones – development of simple truncated solids involving prisms, pyramids, cylinders and cones.		
Unit - V	**Isometric Projection and Introduction to AutoCAD:**	**9**
Principles of isometric projection - Isometric scale - Isometric projections of simple and truncated solids like prisms, pyramids, cylinders and cones - Conversion of isometric projection into orthographic projection - Introduction to AutoCAD.		

Lecture:30, Practical:30, Total:60

TEXT BOOK:

1.	Venugopal K. and Prabhu Raja V., “Engineering Graphics”, 15th Edition, New Age International Pvt. Ltd., New Delhi, 2018.

REFERENCES:

1.	Basant Agrawal, Agrawal C.M., “Engineering Drawing”, 2nd Edition, McGraw Hill Education, 2019.
2.	Gopalakrishnana K.R. “Engineering Drawing”, Volume. I & II, Subhas Publications, Bengaluru, 2014.
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 standards of drawings and sketch the projections of points, lines and planes.	Understanding (K2)
CO2	draw the projections of 3D primitive objects like prisms, pyramids, cylinders and cones.	Applying (K3)
CO3	construct the various sectional views of solids like prisms, pyramids, cylinders and cones.	Applying (K3)
CO4	develop the lateral surfaces of simple and truncated solids.	Applying (K3)
CO5	sketch the isometric projections of simple and truncated solids and convert isometric drawing in to orthographic projection.	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	2	2	2	3
CO2	3	2	1	1						3	2	3	2	3
CO3	3	2	1	1						3	2	3	2	3
CO4	3	2	1	1						3	2	3	2	3
CO5	3	2	1	1						3	2	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	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	25	35	40				100

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

20CHT11 - CHEMICAL PROCESS INDUSTRIES

Programme & Branch	BTech – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	3	0	0	3

Preamble	This course will educate students about manufacture process of various chemical products	
Unit - I	**Introduction to Chemical Industry:**	**9**
Introduction to Chemical Engineering and chemical industries, role of Chemical Engineers, Basic concepts: units and dimensions, systems of units, conversion and conversion factors of units; Classification of unit operations and unit processes - Construction of block diagrams and process flow diagram		
Unit - II	**Inorganic Alkalis and Acids Industries:**	**9**
Manufacture of sodium chloride, soda ash, sodium bicarbonate, caustic soda and chlorine, hydrochloric acid, sulfuric acid, phosphoric acid, nitric acid		
Unit - III	**Fertilizer Industries:**	**9**
Manufacture of ammonia, urea, ammonium phosphate, ammonium sulphate, single and triple super phosphate, potassium nitrate, potassium sulphate and potassium chloride- compound fertilizers		
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:**	**9**
Agro based industries - Sugar industries, Pulp and Paper industries, Manufacture of cement - Manufacture of glass - Paint industries- Constituents, Manufacture of white gloss enamels, red oxide primer and exterior emulsion paint		

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 the role of chemical engineers and develop the process flow diagram	Applying (K3)
CO2	sketch and explain the production of alkali-based products and mineral acids	Applying (K3)
CO3	illustrate the manufacturing process of chemical fertilizers using flow diagram	Applying (K3)
CO4	describe the manufacturing process of polymer and allied product with the help of process flow sheet	Applying (K3)
CO5	draw a process flow diagram and elaborate production of sugar, paper and pulp, cement, glass and paint	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	1	1		1	1	1	1				1	3	1
CO2	2	1	1		1	1	1	1				1	3	1
CO3	2	1	1		1	1	1	1				1	3	1
CO4	2	1	1		1	1	1	1				1	3	1
CO5	2	1	1		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	60	20				100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	70	10				100

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

20VEC11 – YOGA AND VALUES FOR HOLISTIC DEVELOPMENT

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	HS	1	0	1	1

Preamble	Providing Value Education to improve the Students' character - understanding yogic life and physical health - maintaining youthfulness - Measure and method in five aspects of life	
Unit - I	**Physical Health:**	**2**
Manavalakalai (SKY) Yoga: Introduction - Education as a means for youth empowerment - Greatness of Education - Yoga for youth Empowerment. **Simplified Physical Exercises:** Need and Objectives of Simplified Physical Exercise - Hand, Leg, Breathing, Eye exercises - Kapalabathi, Makarasana Part I, Makarasana Part II, Body Massage, Acu pressure, Relaxation exercises - Benefits. **Yogasanas:** Pranamasana - Hastha Uttanasana - Pada Hasthasana - Aswa Sanjalana Asana - Thuvipatha asva Sanjalana asana - Astanga Namaskara - Bhujangasana - Atha Muktha Savasana - Aswa Sanjalana Asana - Pada Hasthasana - Hastha Uttanasana - Pranamasana. **Pranayama:** Naddi suddi - Clearance Practice - Benefits.		
Unit - II	**Life Force:**	**2**
Reasons for Diseases: Body Function - Reason for Diseases and Prevention - Natural reasons (Genetic / imprints, Planetary Position, Natural calamities and climatic changes) - Unnatural reasons (Food habits, Thoughts, Deeds). **Philosophy of Kaya kalpa:** Enriching Bio-Magnetism - Physical body - Sexual vital fluid - Life force - Bio-Magnetism - Mind. **Maintaining youthfulness:** Postponing old age - Transformation of food into seven components - Importance of sexual vital fluid - Measure and method in five aspects of life - Controlling undue Passion. **Kayakalpa practice:** Aswini Mudra - Ojas breath - Benefits of Kaya Kalpa.		
Unit - III	**Mental Health:**	**2**
Mental Frequencies: Beta, Apha, Theta and Delta wave - Agna Meditation explanation - benefits. **Shanti meditation:** Shanthi Meditation explanation – benefits. **Thuriya Meditation:** Thuriya Meditation explanation – benefits. **Benefits of Blessing:** Self blessing (Auto suggestion) - Family blessing - Blessing the others - World blessing - Divine protection.		
Unit - IV	**Values:**	**2**
Human Values: Self control - Self confidence - Honesty Contentment - Humility – Modesty - Tolerance - Adjustment - Sacrifice – Forgiveness - Purity (Body, Dress, Environment) - Physical purity - Mental purity - Spiritual purity. **Social Values:** Non violence – Service. Patriotism – Equality. Respect for parents and elders - care and protection - Respect for teacher. Punctuality - Time Management.		
Unit - V	**Morality (Virtues):**	**2**
Importance of Introspection: I - Mine (Ego, Possessiveness). Six Evil Temperaments - Greed - Anger - Miserliness - Immoral sexual passion - Inferiority and superiority Complex – Vengeance. Maneuvering of Six Temperaments: Contentment - Tolerance - Charity - Chastity - Equality - Pardon (Forgiveness). Five essential Qualities acquired through Meditation: Perspicacity - Magnanimity - Receptivity - Adaptability - Creativity (Improved Memory Power).		

Lecture:10, Practical:10, Total:20

TEXT BOOK:

1. Thathuvagnani Vethathiri Maharishi, "Yoga for Youth Empowerment", Vethathiri Publications, 2019.

REFERENCES:

1. Thathuvagnani Vethathiri Maharishi, "Yoga for Modern Age", Vethathiri Publications, 2019.
2. Thathuvagnani Vethathiri Maharishi, "Simplified Physical Exercises", Vethathiri Publications, 2019.
3. Neelam Sharma, "Holistic Education and Yoga", Shipra Publications, 2017.
4. Dr. Joseph Murphy, "The Power of Your Subconscious Mind", Pushpak Publication, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the importance of physical health and practice simplified physical yoga exercise.	Applying (K3)
CO2	understand the importance of Kayakalpa exercise to enrich Bio-Magnetism and practice it.	Applying (K3)
CO3	understand the significance of meditation and do meditation to get sound mind.	Applying (K3)
CO4	understand the human and social values to provide service to society.	Applying (K3)
CO5	understand the evil temperaments and five essential qualities acquired through meditation	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		
CO3						3		3				1		
CO4						3		2	1			1		
CO5						3		3				1		

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

ASSESSMENT PATTERN

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

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

20PHL11 – PHYSICAL SCIENCES LABORATORY I

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech Branches	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, frequency of vibration, velocity of ultrasonic waves, compressibility of water, wavelength of laser, acceptance angle and the numerical aperture of an optical fiber, and to develop the skills in handling different basic instruments and also aims to impart the basic concepts of volumetric, conductometric and pH meter experiments and thereby, to improve the analytical capability.

List of Exercises / Experiments:

1.	Determination of the Young's modulus of the material of a given beam using uniform bending method.
2.	Determination of the rigidity modulus of the material of a given wire using torsional pendulum.
3.	Determination of frequency of electrically vibrating rod by forming standing waves using Melde's apparatus.
4.	Determination of the velocity of ultrasonic waves in a liquid and the compressibility of a liquid using ultrasonic interferometer.
5.	Determination of (i) the wavelength of a semiconductor laser and (ii) the acceptance angle and the numerical aperture of a given optical fiber.
6.	Estimation of total, temporary and permanent hardness of water by EDTA method.
7.	Estimation of $Ca^{2+}$and Mg^{2+}hardness separately by EDTA method.
8.	Estimation of alkalinity of the given water sample.
9.	Conductometric titration -Mixture of acids.
10.	Estimation of hydrochloric acid using pH meter.

Total: 30

REFERENCES:

1.	Tamilarasan K. and Prabu K.,"Physics Laboratory Manual', 1st Edition, SCM Publishers, Erode, 2020.
2.	Palanisamy P.N., Manikandan P., Geetha A. and Manjula Rani K., "Chemistry Laboratory Manual", 1st Edition, Rajaganapathy Publishers, Erode, 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 wire using the concepts of twisting couple and to compute the frequency of electrically vibrating rod using the concept of standing waves formed in fixed vibrating string.	Applying (K3), Precision (S3)
CO2	determine the wavelength of a semiconductor laser beam using the concept of diffraction of light, and to compute the acceptance angle and the numerical aperture of an optical fiber using the concepts of total internal reflection and divergence of light in air and estimate the amount of hardness for the given water sample by EDTA method, and the amount of alkalinity for the given water sample.	Applying (K3), Precision (S3)
CO3	demonstrate the conductivity meter and pH meter to estimate the amount of the given solution.	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										
CO2				3										
CO3				3										

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

20MEL11 – ENGINEERING PRACTICES LABORATORY

(Common to Civil, Mechanical, Mechatronics, Automobile Engineering, Chemical & Food Technology Branches)

Programme & Branch	**BE (Civil, Mech, MTS, Auto) & BTech (Chem, FT)**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**ES**	**0**	**0**	**2**	**1**

Preamble	This course is designed to provide a hands-on experience in basic of mechanical and electrical engineering practices.

List of Exercises / Experiments:

	PART A – MECHANICAL ENGINEERING
1.	To prepare square or rectangular shaped MS plates using power tools for cutting, polishing and shaping to the required dimensions.
2.	To carryout drilling, tapping and assembly on the given MS plates.
3.	To carryout thread forming on a GI/PVC pipes and prepare water leak proof water line from overhead tank.
4.	To prepare a wood or plywood box/tray/any innovative models using modern power tools like cutting machine, router, jigsaw, power screw driver etc.
5.	Welding practice through arc welding / simulator
	PART B – ELECTRICAL AND ELECTRONICS ENGINEERING
1.	Safety Aspects of Electrical Engineering, Electrical Symbols, Components Identification, Fuse selection and installation, Circuit Breakers selection
2.	Wiring circuit for fluorescent lamp and Stair case wiring
3.	Measurement of Earth resistance
4.	Soldering of Simple Circuits and trouble shooting
5.	Implementation of half wave and full wave Rectifier using diodes

Total: 30

REFERENCES /MANUAL / SOFTWARE:

1.	Engineering Practices Laboratory Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	plan the sequence of operations for effective completion of the planned models/ innovative articles	Creating (K6), Precision (S3)
CO2	identify and use appropriate modern power tools and complete the exercises/models accurately	Applying (K3), Precision (S3)
CO3	select fuses and Circuit breakers	Understanding (K2), Manipulation (S2)
CO4	perform house wiring and realize the importance of earthing	Applying (K3), Manipulation (S2)
CO5	trouble shoot the electrical and electronic circuits	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	2		3	3	2	1			3	3		3		
CO2	2		3	3	2				3	3		3		
CO3	3		3	3	1				2	2		3		
CO4	3		3	3	1				2	3		3		
CO5	3		3	3	1				2	2		3		

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

20EGT21 ADVANCED COMMUNICATION SKILLS
(Common to all Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	20EGT11 – English Language Skills	2	HS	3	0	0	3

Preamble	This course is designed to impart required levels of fluency in using the English Language at B1Level in the Common European Framework (CEFR).	
Unit - I	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase –VI:**	**9**
Listening – Job and career related descriptions and conversations – requests of different kinds and the responses – **Speaking -** Career choices and professional skills – making requests and responding to requests – **Reading** – Using texts about jobs and careers – about different societies and cultural differences – **Writing** – Resumes, CVs and job oriented advertisements – business and career related emails – **Grammar &Vocabulary** – Gerunds and elements of comparison – requests and indirect requests.		
Unit - II	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – VII:**	**9**
Listening – Expository and narrative descriptions – information about different cultures, nations and societies. **Speaking** – Narrating and describing – talking about other countries and other cultures – **Reading** – Using texts about media and information technology – living abroad and experiencing different cultures – **Writing** – Blog writing – brochures and tourist pamphlets – **Grammar & Vocabulary** – The past tense forms - noun phrases and relative clauses.		
Unit - III	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – VIII:**	**9**
Listening – Consumerism – product description – complaints and redressal – environmental issues – ecology – saving the planet – **Speaking** – Talking about problems, issues, complaints – solutions and redressal – talking about environmental issues – **Reading** – Using texts on segregating wastes – recycling and reusing – texts on environmental issues – **Writing** – Online reviews, articles and writing web content – **Grammar & Vocabulary** – Phrases and sentences used for describing problems – passives – prepositions and infinitives.		
Unit - IV	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – IX:**	**9**
Listening – Education, learning and the choice of courses – various services needed in daily life – self-improvement for success in life – **Speaking** - Discussions about educational and career oriented issues – talking about everyday services – giving advice and self improvement – **Reading** – Reading about learning strategies and learning styles – using texts about personality development – **Writing** – Writing about hobbies – pastime and individual skills – writing short articles on everyday life and personality development – **Grammar & Vocabulary** – Using of "would" and certain gerund forms – use of modals, verbs, gerunds, negative questions and infinitives.		
Unit - V	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – X:**	**9**
Listening – Historical narratives – biographies and learning about the future – important life events, milestones and happenings of the past – **Speaking** – Talking about the past, present and the future – talking about important events in life – **Reading** – Texts about new technologies and future science – using texts about social organization, culture and social practices – **Writing** – Biographical sketches – historical events – famous personalities, stages of life and getting along with people – **Grammar & Vocabulary** – Future tense forms – time clauses and certain "if clauses".		

Total: 45

TEXT BOOK:

1.	Jack C. Richards, Jonathan Hull, and Susan Proctor, "Interchange - Student's Book 3", 4th Edition, Cambridge University Press, New York, 2017.

REFERENCES:

1.	Sanjay Kumar and Pushp Lata, "Communication Skills: A Workbook based on AICTE Syllabus", Oxford University Press, 2018.
2.	Board of Editors, "Skills Annexe: Functional English for Success", Orient BlackSwan, Hyderabad, 2013.

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 spoken excerpts critically and infer Unspoken and implied meanings.	Applying (K3)
CO3	read different genres of texts, infer implied meanings and critically analyze and evaluate them for ideas as well as for method of presentation.	Analyzing (K4)
CO4	write effectively and persuasively and produce different types of writing such as narration, description, exposition and argument as well as creative, critical, analytical and evaluative writing.	Creating (K6)
CO5	speak effectively, to express opinions clearly, initiate and sustain a discussion and also negotiate using appropriate communicative strategies.	Creating (K6)

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	1	1		
CO2									2	3		1		
CO3						1				3	1	1		
CO4										3		2		
CO5									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		13	30	33	-	17	100
CAT2		13	33	37	-	17	100
CAT3		20	30	33	-	17	100
ESE		6	40	36	-	18	100

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

20MAC21 - MULTIVARIABLE CALCULUS AND COMPLEX ANALYSIS

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**2**	**BS**	**3**	**1***	**2***	**4**

Preamble	To impart the knowledge of partial derivatives, evaluation of real and complex integrals, vector calculus and analytic functions to the students for solving the problems related to various engineering disciplines.	
Unit - I	**Functions of Several Variables:**	**9**
Functions of two or more variables – Partial derivatives – Total differential – Taylor's series for functions of two variables – Maxima and minima – Constrained maxima and minima – Lagrange's multiplier method		
Unit - II	**Multiple Integrals:**	**9**
Double integration in cartesian coordinates – Change of order of integration – Application: Area between two curves – Triple integration in cartesian coordinates –Volume as triple integrals		
Unit - III	**Vector Calculus:**	**9**
Directional derivative – Gradient of a scalar point function – Divergence of a vector point function – Curl of a vector – Solenoidal and Irrotational vectors – Green's, Stoke's and Gauss divergence theorems (without proof) – Verification of the above theorems and evaluation of integrals using them.		
Unit - IV	**Analytic Functions:**	**9**
Functions of a complex variable – Analytic functions – Necessary and sufficient conditions (excluding proof) – Cauchy–Riemann equations (Statement only) – Properties of analytic function (Statement only) – Harmonic function – Construction of analytic function – Conformal mapping: w = z + a, az, 1/z – Bilinear transformation.		
Unit - V	**Complex Integration:**	**9**
Introduction – Cauchy's theorem (without proof) – Cauchy's integral formula – Taylor's and Laurent series – Singularities – Classification – Cauchy's residue theorem (without proof) – Applications: Evaluation of definite integrals involving sine and cosine functions over the circular contour.		

List of Exercises / Experiments:

1.	Finding ordinary and partial derivatives
2.	Computing extremes of a single variable function
3.	Evaluating double and triple integrals
4.	Finding the area between two curves
5.	Computing gradient, divergence and curl of point functions
6.	Applying Milne-Thomson method for constructing analytic function
7.	Determination of Mobius transformation for the given set of points
8.	Finding poles and residues of an analytic function

***Alternate week**

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

TEXT BOOK:

1.	Ravish R. Singh, Mukul Bhatt "Engineering Mathematics", 1st Edition, McGraw Hill Education, New Delhi, 2016.

REFERENCES:

1.	Kreyszig E., "Advanced Engineering Mathematics", 10th Edition, John Wiley Sons, 2011.
2.	Dass H K, "Higher Engineering Mathematics", 3rd Revised Edition, S.Chand and Co., New Delhi, 2014.
3.	Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics – I", 2nd Edition, Pearson India Education, New Delhi, 2018.
4.	MATLAB Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	compute extremal values which arise in function of several variables.	Applying (K3)
CO2	solve Problems involving Double and Triple integrals.	Understanding (K2)
CO3	apply the concept of vectors in engineering problems.	Applying (K3)
CO4	identify, construct and apply analytic functions in electrostatics and fluid flow problems.	Applying (K3)
CO5	evaluate complex integrals which are extensively applied in engineering.	Applying (K3)
CO6	compute maxima and minima of a single variable function, gradient, curl and divergence of a vector function using MATLAB.	Understanding (K2), Manipulation (S2)
CO7	evaluate Double, Triple integrals and determine area between two curves using MATLAB	Applying (K3), Manipulation (S2)
CO8	construct analytic function, find bilinear transformation and compute poles and residues 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												
CO2	3	3	2											
CO3	3	3												
CO4	3	3												
CO5	3	3	2											
CO6					3									
CO7					3									
CO8					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)**

20PHT25 - PHYSICS FOR CHEMICAL ENGINEERING

Programme & Branch	**BTech – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Applied Physics**	**2**	**BS**	**3**	**0**	**0**	**3**

Preamble	This course aims to impart the knowledge on the physics of ferrous metals and alloys, non-ferrous metals and alloys, ceramics, composites and advanced functional materials. It also describes the select characterization techniques and the applications of aforementioned materials in Chemical Engineering and provides motivation towards innovations.	
Unit - I	**Ferrous Metals and Alloys:**	**9**
Introduction – Iron ore - Composition and classification of pig iron and cast iron–Manufacture of pig iron and cast iron – Solid solution alloys – Vegards law – Lever rule - Mechanical mixtures -Iron-Carbon equilibrium diagram - Effect of impurities on Cast iron - Types of cast iron: Grey cast iron – White cast iron – Chilled cast iron - Mottled cast iron - Malleable cast iron - Ductile cast iron – Alloy cast iron – Wrought iron – Steel: carbon steel - Alloy steels –Tool and Die Steel - Special steels: High speed steel – Stainless steel - Heat resisting steels - Shock resisting steels.		
Unit - II	**Non-Ferrous Metals and Alloys:**	**9**
Introduction - Aluminum and Aluminum alloys: Duralumin, Magnalumin - Copper and Copper Alloys: Brass, Bronze, Gun Metal, German Silver - Nickel and Nickel alloys: Monel, Inconel, Nichrome, Nimonic - Chromium and Chromium alloys: Chrome moly, Stellite - Lead and Lead alloys: Solder lead, Antimonial lead.		
Unit - III	**Ceramics and Composites:**	**9**
Ceramics: Introduction – Classification of ceramics: Glasses – Clay products – Refractories – Abrasives – Cements – Advanced Ceramics - General properties and applications. Composites: Introduction – Fibre Phase - Matrix Phase - Classification of composites based on matrix materials: Polymer-matrix composites, Metal-matrix composites, Ceramic-matrix composites.		
Unit - IV	**Advanced Functional Materials:**	**9**
Metallic glasses: Preparation, properties and applications – Shape memory alloy: Characteristics and applications – Superconductors: Properties and applications – Carbon fibers – Biomaterials: Basic requirements of biomaterials – Biocompatibility – Classification of biomaterials – Metallic and alloy biomaterials (qualitative): Cobalt–chromium alloys and Titanium and titanium alloys.		
Unit - V	**Materials Characterization:**	**9**
Importance of materials characterization - X-ray diffraction - Scanning electron microscope and Energy dispersive spectroscopy: principle, construction and working - Transmission electron microscope: principle, construction and working - Spectroscopy: IR and UV-visible spectroscopy - Raman spectroscopy (qualitative) - Thermal analysis: Thermo gravimetric analysis – Differential scanning calorimetry.		

Total:45

TEXT BOOK:

1. 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.

REFERENCES:

1. Donald K. Askeland, Pradeep P. Fulay and Wendelin J. Wright, "The Science and Engineering of Materials", 6th Edition, Centage Learning, Singapore, 2011.
2. Sam Zhang, Lin Li and Ashok Kumar, "Materials Characterization Techniques", 1st Edition, CRC Press, Boca Raton, 2008.
3. Tamilarasan K. and Prabu K., "Materials Science", 1st Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the basic concepts of phase rule, cooling curve and binary phase diagram (Fe-C) to explain the composition, properties and applications of the select ferrous metals and their alloys (iron and steel).	Applying (K3)
CO2	apply the basic concepts of phase rule, cooling curve and binary phase diagram (Cu-Ni) to explain the composition, properties and applications of the select non-ferrous metals and their alloys (Aluminum, Copper, Nickel, Chromium, Lead and their alloys).	Applying (K3)
CO3	utilize suitable physical concepts to comprehend the properties and applications of select ceramics and composites with different composition.	Applying (K3)
CO4	utilize appropriate methods to prepare select advanced functional materials (metallic glasses, shape memory alloys, superconductors, carbon fibers and bio-materials) and to comprehend their properties and applications.	Applying (K3)
CO5	apply the concepts of X ray diffraction, matter wave, absorption of light, Raman effect and thermogram to describe the principle and working of the 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	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	40	40				100
CAT2	30	30	40				100
CAT3	25	35	40				100
ESE	20	40	40				100

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

20CYT24 - INDUSTRIAL CHEMISTRY

Programme & Branch	B.Tech - Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Chemistry	2	BS	3	0	0	3

Preamble	Industrial chemistry aims to equip the chemical engineering students to have a sound knowledge of chemistry in order to meet the industrial needs.	
Unit - I	**Modern Analytical Techniques:**	**9**
Introduction - Beer Lambert's law –UV-vis spectroscopy – chromophore – auxochrome – electronic transition – instrumentation and applications of UV-vis spectroscopy - Infra Red spectroscopy – interaction between infrared radiation and molecular vibrations – mode of vibration – FTIR – instrumentation and applications of FTIR spectroscopy, Flame Photometry – principle – instrumentation – estimation of sodium, Atomic Absorption Spectroscopy – principle – instrumentation – estimation of nickel.		
Unit - II	**Phase Rule:**	**9**
Introduction - Statement and explanation of terms involved – one component system – water system – Polymorphism – experimental determination of transition point – sulphur system - condensed phase rule – construction of phase diagram by thermal analysis – two component system – simple eutectic system – Silver-Lead System–Potassium Iodide-Water System – congruent and incongruent melting point.		
Unit - III	**Chemical Kinetics :**	**9**
Introduction–order – determination of order of the reaction by i) integrated rate equations ii) graphical method iii) half-life period iv) differential method and v) Ostwald isolation method - Lindeman's equation for unimolecular collision - transition state theory - kinetics of simultaneous reactions - opposing, consecutive, parallel reactions (first order examples) – kinetics of photochemical reactions - Hydrogen-Chlorine reaction and Hydrogen-bromide reaction, steady state approximation.		
Unit - IV	**Catalysis :**	**9**
Introduction – types–catalytic poisoning – autocatalysis –kinetics of surface catalyzed reactions – Reaction between two adsorbed molecules (Langmuir-Hinshelwood mechanism) –hydrogenation of ethene in presence of nickel –acid-base catalysis –mechanism of acid catalysis –enzyme catalysis–mechanism of enzyme catalysis –characteristics of enzyme catalysis –Industrial applications of catalyst.		
Unit - V	**Surface Chemistry :**	**9**
Introduction - mechanism of adsorption - types of adsorption - Langmuir adsorption isotherm - derivation of Langmuir isotherm - adsorption of solutes from solutions – important adsorbents used in industries –applications of adsorption – chromatography, Role of adsorbent in catalysis and ion exchange adsorption and pollution abatement.		

Total: 45

TEXT BOOK:

1.	Arun Bahl, Bahl B.S. & Tuli G.D.,"Essentials of Physical Chemistry". S.Chand Publishing,New Delhi, 2019 for Units II, III, IV, V.
2.	Wiley Editorial Board ."Wiley Engineering Chemistry". 2nd Edition, Wiley India Pvt. Ltd, New Delhi, Reprint 2019 for Units I, II, III, IV, V.

REFERENCES:

1.	Payal B. Joshi & Shashank Deep, "Engineering Chemistry", Oxford University Press, New Delhi, 2019.
2.	Puri B.R., Sharma L.R. & Pathania M.S., "Principles of Physical Chemistry", Vishal Publishing Company, Jalandhar, 2019.
3.	Dara S.S. and Umare S.S., "A Textbook of Engineering Chemistry", 12th Edition, S. Chand & Company Ltd. New Delhi, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the principle of various spectro-analytical techniques for real time analysis.	Applying (K3)
CO2	draw the phase diagram and phase equilibria for different eutectic systems.	Applying (K3)
CO3	make use of the principle of kinetics for designing the reactor .	Applying (K3)
CO4	apply the knowledge of catalysis in industry.	Understanding (K2)
CO5	experiment with different reaction mechanisms of surface chemistry.	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	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)**

20CHT21 - CHEMICAL PROCESS UTILITIES

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

Preamble	This course highlights the working of various utilities used in chemical process industries.	
Unit – I	**Steam and Water**	**9+3**
Steam: Properties of steam, Mollier chart, determination of dryness fraction of steam- Different types of calorimeters ; Efficient use of steam in process plants, Insulation of Steam Mains. Water: Source and characteristics of water- soft and Demineralised water - Treatment of water for boiler and cooling towers.		
Unit - II	**Compressed Air and Inert Gas:**	**9+3**
Compressed Air – Introduction, Plant Air Systems, Instrument Air Systems, Operation and Maintenance. Inert Gases – Properties, Uses of inert gases, Sources and Methods of Generation		
Unit - III	**Boilers:**	**9+3**
Types and classification of boilers: water tube, fire tube, coal, oil and gas fired boilers; Stoker fired, pulverized and fluidized bed boilers. Mountings and accessories. Performance and efficiency calculation of boilers		
Unit - IV	**Refrigeration:**	**9+3**
Principles - compression and absorption refrigeration systems, calculation of efficiency and capacity of refrigeration - Types and properties of refrigerants - eco- friendly refrigerants.		
Unit - V	**Vacuum System:**	**9+3**
Introduction, Classification of Vacuum, Vacuum Generation equipment – Liquid Ring Vacuum Pump, Steam Jet Ejector, Mechanical Vacuum Pump, Vacuum Measurement using McLeod Gauge, Vacuum Conveying of powders, Vacuum Filtration and Drying		

Lecture:45, Tutorial:15,Total:60

TEXT BOOK:

1.	Jack Broughton, "Process Utility System - Introduction to Design Operation and Maintenance", 1st Edition, Institution of Chemical Engineers, United Kingdom, 1994 for units I, II, III & IV.
2.	Wolfgang Jorisch, “Vacuum Technology in the Chemical Industry”, 1st Edition, Wiley VCH, 2014 for unit V.

REFERENCES:

1.	Lyle O, "Efficient use of Steam", 1st Edition, H M S O Publishers, United Kingdom, 2000.
2.	Eskel Nordell, "Water treatment for industrial and other uses", 1st Edition, Reinhold Publishing Corporation, New York, 1961.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the water treatment and steam utilization practices in process industries	Applying (K3)
CO2	discuss the fundamentals and applications of compressed air and inert gases in process industries	Understanding (K2)
CO3	describe different types of boiler and calculate the performance efficiency	Applying (K3)
CO4	describe the principles of refrigeration processes and analyze their performance	Applying (K3)
CO5	explain the working of different vacuum generation equipment and their 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	2	2			2						1	2	1
CO2	3	1				1						1	2	1
CO3	3	2	2			2						1	2	1
CO4	3	2	2			2						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	20	60	20				100
CAT2	20	70	10				100
CAT3	20	60	20				100
ESE	20	60	20				100

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

20CHT22 - ELECTRICAL DRIVES AND INDUSTRIAL ELECTRONICS

Programme & Branch	B.Tech – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	2	ES	3	0	0	3

Preamble	This course forms the basis for understanding various types of dynamic machines and their starting, braking and speed control methods. It provides the fundamental concepts of power electronic converters and its applications.	
Unit - I	**Electrical Drives and Motor Characteristics:**	**9**
Basic Elements of Drive – Types of Electric Drives – Factors Influence the Choice of Electrical Drives – Classification of Load Torques and Classes of Duty – Selection of Power Rating for Drive Motors – Torque Equation of DC Machine – Speed-Torque Characteristics of DC Motors: Series, Shunt Motor – Torque Equation and Speed-Torque Characteristics of Three Phase Induction Motor – Application: Submersible pump.		
Unit - II	**Motor Starting and Braking Methods:**	**9**
Types of Starters: Two Point Starter, Three Point Starter, Four Point Starter, DOL Starter, Y-Δ Starter. Braking of Electrical Motors: Shunt Motor, Series Motor, Three Phase Induction Motor – Trouble Shooting of Electrical Motors.		
Unit - III	**Power Electronics:**	9
Introduction – Construction, Principle of Operation**,** Static Characteristics of SCR, IGBT-Phase Angle Control – Single Phase Full wave Controlled Rectifiers with R, RL and RLE Load – Three phase Voltage Source Inverters (120° and 180° Mode) – Chopper Operation (Step-Up and Step-Down).		
Unit - IV	**Conventional and Solid State Speed Control of DC Drives:**	9
Speed Control of DC Series and Shunt Motors – Armature and Field Control, Ward-Leonard Control System – Controlled Rectifiers Fed DC Drive and Chopper Based DC Drive (Four Quadrant Operation) – Selection of DC Drives for Cranes and Paper Mill.		
Unit - V	**Conventional and Solid State Speed Control of AC Drives:**	9
Speed Control of Three Phase Induction Motor – Voltage Control, Voltage / Frequency Control – Slip Power Recovery Scheme (Static Kramer and Scheribus drive) – Inverter and AC Voltage Controller Based Induction Drives – Selection of AC Drives for Textile Mill and Air Compressors.		

Total:45

TEXT BOOK:

1	Dubey G.K., “Fundamentals of Electrical Drives”, 2nd Edition, Narosa Publishing House, New Delhi, 2019.

REFERENCES:

1	Muhammad H. Rashid, “Power Electronics: Devices, Circuits and Applications”, 4th Edition, Pearson Educati New Delhi, 2018.
2	Vedam Subrahmaniam, “Electric Drives: Concepts and Applications”, 2nd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	infer the fundamentals of electrical drives and the characteristics of electric motors	Understanding (K2)
CO2	classify and interpret the operation of starting and braking methods of AC and DC machines	Understanding (K2)
CO3	sketch the characteristics of various power electronic converters	Applying (K3)
CO4	apply the appropriate speed control techniques for DC drives and their applications	Applying (K3)
CO5	implement the speed control techniques for AC drives and their 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	2	1												
CO2	2	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)**

20PHL29 - PHYSICAL SCIENCES LABORATORY II

Prog. & Branch	BTech - Chemical Engineering	Sem.	Category	L	T	P	Credit
Pre requisite	Nil	2	BS	0	0	2	1

Preamble	This course aims to impart hands on training in the determination of physical parameters such as Young's modulus, specific resistance, thermal conductivity, thickness of a thin film and particle size, wavelength of Hg spectrum and to develop the skills in handling different basic instruments. This course also aims to impart the fundamentals of chemical analysis and thereby, to improve the analytical capability.

List of Exercises / Experiments:

1.	Determination of the Young's modulus of a stainless steel using non-uniform bending method.
2.	Determination of the specific resistance of a non-ferrous material using Carey Foster's Bridge.
3.	Determination of the thermal conductivity of a ceramic/composite material using Lee's disc arrangement.
4.	Determination of the thickness of a metallic glass thin film using air-wedge arrangement.
5.	Determination of wavelength of Hg spectrum using spectrometer grating.
6.	Estimation of iron by colorimetry.
7.	Determination of transition temperature of a hydrated salt.
8.	Construction of phase diagram – simple eutectic system.
9.	Determination of rate constant of acid – catalyzed hydrolysis of an ester.
10.	Verification of Freundlich isotherm –adsorption of oxalic acid on charcoal.

Total: 30

REFERENCES:

1.	Tamilarasan K. and Prabu K., "Physics Laboratory Manual", 1st Edition, SCM Publishers, Erode, 2020.
2.	Palanisamy P.N., Manikandan P., Geetha A. and Manjula Rani K., "Chemistry Laboratory Manual", 1st Edition, Kalaikathir Publishers, Coimbatore, 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 stainless steel using the concepts of elasticity and bending moment of a beam and to determine the specific resistance of non-ferrous materials using the concept of electrical conductivity, and to determine the thermal conductivity of ceramics/composite materials using concept of heat conduction through materials	Applying (K3), Precision (S3)
CO2	determine the thickness of metallic glass thin films using the concept of interference of light, and to determine the wavelength of electromagnetic waves (visible part of Hg spectrum) using the concept of diffraction of light. Determine the amount of iron using colorimeter and to demonstrate the simple eutectic system for the determination of eutectic temperature & composition and thermometric method for determination of transition temperature	Applying (K3), Precision (S3)
CO3	determine the rate constant of hydrolysis of an ester and verify the Freundlich isotherm for an adsorption process.	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											
CO2			3											
CO3			3											

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

20CHL21- ELECTRICAL DRIVES AND INDUSTRIAL ELECTRONICS LABORATORY

Programme & Branch	CHEMICAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	ES	0	0	2	1

List of Exercises / Experiments :

1.	Load Test on DC Shunt Motor
2.	Speed Control of DC Shunt Motor (Armature control and Field control)
3.	Load Test on Three Phase Squirrel Cage Induction Motor
4.	Speed Control of Three Phase Squirrel Cage Induction Motor
5.	Identification of AC and DC Machines Parts
6.	Steady State Characteristics of SCR
7.	R and RC firing circuits for SCR
8.	Single Phase Fully Controlled Rectifier
9.	Three Phase Inverter (120◦ & 180◦ Mode Operation)
10.	Operational Analysis of Choppers (Step Up and Step Down)

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	execute the method of speed control in electrical machines	Applying (K3), Manipulation (S2)
CO2	sketch the characteristics of power electronic devices	Applying (K3), Manipulation (S2)
CO3	analyze the various power electronics converters	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	2
CO2	3	2	1	1									2	3
CO3	3	2	1	1									2	3

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

20MAT31 - PROBABILITY AND PARTIAL DIFFERENTIAL EQUATIONS

(Common to Civil, Mechanical, Mechatronics, Automobile, Chemical & Food Technology branches)

Programme & Branch	BE & Civil, Mechanical, Mechatronics, Automobile Engineering & BTech Chemical, Food Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	BS	3	1	0	4

Preamble	To provide the skills for solving the real time engineering problems involving partial differential equations and impart knowledge in applying probability concepts in their respective fields and express functions in terms of Fourier series.	
Unit - I	**Random Variables:**	**9+3**
Introduction to Probability – Definition of random variable – Discrete and Continuous random variables – Probability Mass and Probability density functions – Mathematical expectation and Variance – Moments – Moment generating functions.		
Unit - II	**Standard Probability Distributions:**	**9+3**
Discrete Distributions: Binomial distribution – Poisson distribution – Geometric distribution – Continuous Distributions: Uniform distribution – Exponential distribution – Normal distribution.		
Unit - III	**Fourier Series:**	**9+3**
Dirichlet's conditions – General Fourier series – Change of interval – Odd and even functions – Half range Sine series – Half range Cosine series – Harmonic analysis.		
Unit - IV	**Partial Differential Equations:**	**9+3**
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.		
Unit - V	**Applications of Partial Differential Equations:**	**9+3**
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).		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1. Ravish R. Singh, Mukul Bhatt, "Engineering Mathematics", 1st Edition, McGraw Hill Education, New Delhi, 2016.

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons Limited, 2019.
2. Veerarajan T., "Transforms and Partial Differential Equations", 3rd Reprint, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2013.
3. Jay L. Devore., "Probability and Statistics for Engineering and the Sciences", 9th Edition, Cengage Learning, USA, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the concept of random variables.	Applying (K3)
CO2	implement the exact distribution for solving engineering problems.	Applying (K3)
CO3	express the given function or data in terms of Fourier series.	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)

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											
CO2	3	3	2											
CO3	3	2												
CO4	3	3	1											
CO5	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	10	10	80	-	-	-	100
CAT2	10	10	80	-	-	-	100
CAT3	10	10	80	-	-	-	100
ESE	10	20	70	-	-	-	100

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

20CSC31 - PROGRAMMING IN C
(Common to all BE/BTech Engineering & Technology branches except CSE, IT)

Programme & Branch	All BE/BTech Engineering & Technology branches except CSE, IT	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	ES	3	0	2	4

Preamble	The course is designed for use by freshmen students taking their first course in programming. It deals with the techniques needed to practice computational thinking, the art of using computers to solve problems and the ways the computers can be used to solve problems. This course also focuses on developing programming skills using C language.	
Unit - I	**Introduction to Computer and Problem Solving:**	**9**
Overview of computers : Types, Generations, Characteristics, Basic computer Organization – Problem solving techniques: Algorithms - Flowcharts – Pseudo codes – Structuring the logic: Sequential, selection and repetitive structure		
Unit - II	**Introduction to C and Control Statements:**	**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 - decision making and looping statements		
Unit - III	**Arrays and Functions:**	**9**
Declaring, initializing and accessing arrays – operations on arrays – Two dimensional arrays and their operations. 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, passing arguments to function using pointers -pointers and 1D arrays –arrays vs pointers , 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 Exercises:

1.	Writing algorithms and drawing flowcharts using Raptor Tool for problems involving sequential, Selection and repetition structures
2.	Programs for demonstrating the use of different types of operators like arithmetic, logical, relational and ternary operators
3.	Programs using decision making and repetitive statements
4.	Programs for demonstrating one-dimensional and two-dimensional numeric array
5.	Programs to demonstrate modular programming concepts using functions and strings (Using built-in and user-defined functions)
6.	Programs to illustrate the use of structures and pointers
7.	Programs to implement file operations

Lecture:45, Practical : 30, Total:75

TEXT BOOK:

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

REFERENCES:

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.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	outline the basics of computers and apply problem solving techniques to express the solution for the given problem	Applying (K3)
CO2:	identify the appropriate looping and control statements in C and develop applications using these statements	Applying (K3)
CO3:	develop simple C programs using the concepts of arrays and modular programming	Applying (K3)
CO4:	apply the concepts of pointers and develop C programs using strings and pointers	Applying (K3)
CO5:	make use of user defined data types and file concept to solve given problems	Applying (K3)
CO6:	demonstrate the execution of flowcharts for the given problem using Raptor	Applying (K3), Precision (S3)
CO7:	demonstrate the application of sequential, selective and repetitive control structures	Applying (K3), Precision (S3)
CO8:	develop solutions to the given problem using derived /user defined data types and functions and also using file concepts	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	PSO 1	PSO 2
CO1	3	2	1						1	1		1		
CO2	3	2	2						1	1		1		
CO3	3	2	2						1	1		1		
CO4	3	2	2						1	1		1		
CO5	3	2	2						1	1		1		
CO6	3	2	2	2	1				1	1		1		
CO7	3	2	2	2	1				1	1		1		
CO8	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	20	30	50				100
CAT2	10	30	60				100
CAT3	10	30	60				100
ESE	20	30	50				100

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

20CSC41 PYTHON PROGRAMMING

Common to all BE/BTech Engineering and Technology branches except CSE,IT)

Programme& Branch	All branches except CSE,IT	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3/4	ES	3	0	2	4

Preamble	This course introduces the core python programming. It emphasizes on developing python programs with all data types, functions, classes, objects and numpy	
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 and Modules: 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, NumPy, Matplotlib:**	**9**
Object Orientation: 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.		

ListofExercises/Experiments:

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

TEXTBOOK:

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

REFERENCES:

1	NageswaraRao, "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.

COURSEOUTCOMES: Oncompletionof thecourse, the studentswillbe ableto		**BT Mapped (HighestLevel)**
CO1	understand the basics of python programming using nested and control statements	Understanding (K2)
CO2	apply list, tuple and dictionary to handle variety of data	Applying(K3)
CO3	apply strings and regular expression for searching in a string.	Applying(K3)
CO4	solve the problems using functions and modules	Applying(K3)
CO5	understand the object oriented concepts and perform data science operations for applications	Applying(K3)
CO6	implement the basic data types and control statements	Applying (K3), Precision(S3)
CO7	demonstrate functions, regular expressions and object oriented concepts	Applying(K3), Precision(S3)
CO8	perform numpy operations and analyse results using matplotlib	Applying(K3), Precision(S3)

MappingofCOswith POsandPSOs

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		2			2	2		2		
CO5	3	2	1	1		2			2	2		2		
CO6	3	2	1	2	2	2			2	2		2		
CO7	3	2	1	2	2	2			2	2		2		
CO8	3	2	1	2	2	2			2	2		2		

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	25	50				100
CAT2	20	20	60				100
CAT3	20	20	60				100

ESE	25	25	50				100

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

20CSC33– 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**	**3**	**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) Precision (S3)
CO2	make use of arrays and linked lists to create Stack and Queue ADTs.	Applying (K3) Precision (S3)
CO3	utilize Tree ADT to develop simple application	Applying (K3) Precision (S3)
CO4	make use of Graph ADT for standard problems	Applying (K3) Precision (S3)
CO5	illustrate the use of standard sorting and Hashing Techniques	Applying (K3) Precision (S3)

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
ESE	5	35	60				100
* ±3% may be varied (CAT 1 & 2 – 60 marks & ESE – 100 marks)							

20CHT31 - CHEMICAL ENGINEERING THERMODYNAMICS

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

Preamble	This course introduces the laws and concepts of thermodynamics which can be applied for analyzing and evaluating the performance of various systems and processes in the field of chemical engineering	
Unit - I	**Laws of Thermodynamics:**	**9+3**
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+3**
PVT behaviour of fluids: compressibility factor - two-and three-parameter theorems of corresponding states. Equation of states: Virial - van der Waals – Redlich & Kwong – Peng &Robinson equations. Basic energy relations. Maxwell relations.		
Unit - III	**Properties of Solutions:**	**9+3**
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+3**
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+3**
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.		

Lecture:45, Tutorial:15, Total:60

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:

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)
CO2	determine the volumetric properties of pure fluids	Applying (K3)
CO3	analyze the molar and partial molar properties of solutions	Analyzing (K4)
CO4	apply phase equilibrium concepts to systems at VLE	Applying (K3)
CO5	analyze the homogeneous chemical reactions and evaluate the equilibrium composition	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	2	1								1	3	2
CO2	3	3	2	1								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	40	20			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)**

20CHT32 - 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 in writing organic reactions and understand the reaction mechanism for various applications.	
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, Riemer Tiemann 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. **Protein** Classification and Properties - Amino Acids – classification and properties.		
Unit – IV	**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.		
Unit – V	**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 detergent, biodegradability, purification of fatty acids, manufacture of glycerin and synthetic detergent.		

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	Remembering (K1)
CO2	Interpret the mechanism of the organic reactions	Understanding (K2)
CO3	classify the carbohydrates, amino acids with characteristics	Understanding (K2)
CO4	demonstrate the synthesis of dyes and drugs	understanding (K2)
CO5	Summarize the extraction and uses of oils and carry out the synthesis of soaps and detergents	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	1	1	1	1	1	1				1	2	1
CO2	3	2	1	1	1	1	1	1				1	3	1
CO3	3	2	1	1	1	1	1	1				1	3	1
CO4	2	1	1	1	1	1	1	1				1	3	1
CO5	2	1	1	1	1	1	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	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)**

20CHT33 - FLUID MECHANICS

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

Preamble	This course provides a brief knowledge about the fundamentals of momentum transfer, metering and transportation of fluids	
Unit - I	**Fluid Properties and Fluid Statics:**	**9**
Nature of fluids: Liquids and Gases - Properties of fluids - Fluid statics: Basic equations, Pressure-depth relationships- Pressure measurement: Manometer and its types - Units and Dimensions: Dimensional analysis and its methods- Principles of Similarity.		
Unit - II	**Flow of Incompressible fluids in Pipes:**	**9**
Types of fluid flow – Boundary layer - Basic equation of fluid flow: Mass balance equation- Bernoulli’s equation and its applications- Fluid friction in steady, one dimensional flow: Reynolds’s experiment- Laminar flow- Turbulent flow – Moody’s chart – Enlargement and Contractions - Fitting losses- Flow of compressible fluids.		
Unit - III	**Flow Past Immersed Bodies:**	**9**
Flow around submerged objects: Drag and drag coefficients- Flow through porous media: Determination of pressure drop using Ergun equation. Fluidization: Types- Determination of minimum fluidization velocity and pressure drop – Motion of particles through fluids.		
Unit - IV	**Fluid Flow Measurements:**	**9**
Classification and selection of flow meters- Pitot tube, Venturi, Orifice and Rotameters - Determination of discharge coefficient - Principle and applications of Anemometers, Turbine, Coriolis, Vortex flow and Magnetic flow meters - Introduction to notches and weirs.		
Unit - V	**Transportation of Fluids:**	**9**
Classification and selection of pumps and compressors: Positive displacement pumps and compressors- Centrifugal pumps and compressors- Rotary pumps and compressors- Elementary principles of gear, air lift, diaphragm and submersible pumps - Introduction to pipe, fittings and valves.		

Total:45

TEXT BOOK:

1.	Noel de Nevers, “Fluid Mechanics for Chemical Engineers”, 3rd Edition, Mc Graw-Hill Chemical Engineering Series, 2004.

REFERENCES:

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
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	determine pressure drop and power based on properties of fluids	Applying (K3)
CO2	apply the principles of flow behavior for incompressible fluids	Applying (K3)
CO3	analyze the hydrodynamic behavior of packed and fluidized bed	Analyzing (K4)
CO4	analyze the choice of flow meters for the given fluid flow application	Analyzing (K4)
CO5	inspect the selection of pumps, compressors and valves in process industries	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	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	20	30	40	10			100
CAT2	10	30	30	30			100
CAT3	10	20	35	35			100
ESE	10	20	40	30			100

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

20CHT34 - 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 – molality, molarity, normality, mole fraction, mass fraction; Application of Dalton's law and Amagat's law for gas mixture calculation; Calculations of pressure, volume and temperature using ideal gas law.		
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 bypass, recycle and purging.		
Unit - IV	**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 pressure and temperature on heat of reaction; Adiabatic flame temperature..		
Unit - V	**Fuels and Combustion:**	**9+3**
Classification and analysis of fuels; Calculation of calorific value and composition of fuels; theoretical and excess air for combustion of solid, liquid and gaseous fuels; Composition of flue gases by Orsat analyzer.		

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 Sheriffa Begam 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	compute the composition of mixture and solution; apply ideal gas law	Applying (K3)
CO2	calculate the mass/ molar flow rate and composition of streams for diverse unit operation	Applying (K3)
CO3	apply stoichiometric principles to various unit process, bypass, purge and recycle operation	Applying (K3)
CO4	analyze the enthalpy change and adiabatic flame temperature for given system	Analyzing (K4)
CO5	examine the calorific value of fuel, composition of fuel and flue gas and percentage excess air	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	10	10	80				100
CAT2	10	10	80				100
CAT3	10	10	20	60			100
ESE	10	10	40	40			100

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

20CHL31 APPLIED ORGANIC CHEMISTRY LABORATORY

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

List of Exercises / Experiments :

1.	Determination of carbohydrates from unknown organic compounds
2.	Determination of acids from unknown organic compounds-ester
3.	Determination of esters from unknown organic compounds-thiourea
4.	Determination of amine from unknown organic compounds-nitro compound
5.	Determination of amide from unknown organic compounds
6.	Determine the yield of m-dinitro benzene from nitro benzene
7.	Determine the yield of benzoic acid from ethyl benzoate
8.	Determine the yield of benzoic acid from benzaldehyde
9.	Estimation of phenol/aniline using Winkler's method
10.	Determination of qualitative separation of acid from hydrocarbon mixture
11.	Estimation of acid value and iodine value of the given oil sample
12.	Determination of the alkali content and fatty acid content in the given sample soap

Total:30

REFERENCES/MANUAL/SOFTWARE:
Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	determine the functional group of Carbohydrate, Ester, Amide, Amine and Acid	Applying (K3), Precision (S3)
CO2	synthesis of the organic compounds and calculate its yield	Applying (K3), Precision (S3)
CO3	estimation of phenol and/or aniline by Winklers methods/ 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	1	1	3	2		1	3	1
CO2	3	2				1	1	1	3	2		1	3	1
CO3	2	1				1	1	1	3	2		1	3	1

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

20CHL32 FLUID MECHANICS LABORATORY

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

List of Exercises / Experiments :

1.	Estimate the discharge coefficient of variable head flow meters
2.	Investigate of flow characteristics of Rotameter
3.	Estimate the discharge coefficient of V- notch and open drum
4.	Measure the air velocity using 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 for flow through fluidized bed
11.	Estimate the characteristics of centrifugal and reciprocating pump
12.	Estimate the characteristics of vacuum and gear pump

Total:30

REFERENCES/MANUAL/SOFTWARE: Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Estimate coefficient of discharge for flow through open and closed channels, show the relationship between Reynolds number and friction factor for flow through closed conduits	Applying (K3), Precision (S3)
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 pump	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			2		1	3	2		2	3	2
CO2	3	2	1			2		1	3	2		2	3	2
CO3	3	2	1			2		1	3	2		2	3	2

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

20MAT41 - STATISTICS AND NUMERICAL METHODS

(Common to all Engineering and Technology Branches except ECE, CSE and IT)

Programme & Branch	All BE/BTech branches except ECE, CSE and IT branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	BS	3	1	0	4

Preamble	To impart knowledge in testing of samples, ANOVA and interpolation. Also develop 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 proportion and difference of two sample proportions – 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 classification: 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 and Integration: 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, Tata McGraw Hill Publishing Company, New Delhi, 2018.

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.	Ravish R. Singh, Mukul Bhatt, "Engineering Mathematics", 1st Edition, McGraw Hill Education, New Delhi, 2016.

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	handle experimental data with the knowledge of ANOVA.	Applying (K3)
CO3	apply various numerical techniques to solve algebraic and transcendental equations	Applying (K3)
CO4	compute intermediate values of given data, numerical derivatives and integral values	Applying (K3)
CO5	obtain 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	3	2	3										
CO2	3	2	1	3										
CO3	3	3	2											
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	10	20	70				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	30	60				100

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

20CHT41 - MECHANICAL OPERATIONS

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

Preamble	This course enables the students to understand the handling and operation of solids	
Unit - I	**Properties and Handling of Particulate Solids:**	**9**
Particle characterization, agglomeration and segregation; Methods of handling, transportation and storage of bulk solids		
Unit - II	**Size Reduction:**	**9**
Laws and mechanism of size reduction; types of crushing equipment; industrial screens and screen effectiveness.		
Unit - III	**Separation of Particulate Solids:**	**9**
Gravity separation: classifier, clarifier, settler; sedimentation and centrifugal separation; flotation, magnetic separators and electrostatic precipitator.		
Unit - IV	**Filtration:**	**9**
Filtration theory, classification of filtration process, Selection of filters; Industrial filtration equipment.		
Unit - V	**Agitation and Mixing:**	**9**
Significance of agitation and mixing, equipment for agitation, types of impellers, power requirement for mixing of Newtonian liquids; Mixers for powders and pastes, mixing index.		

Total:45

TEXT BOOK:

1.	Swain A.K, Patra H. and Roy G.K, "Mechanical Operations", 1st Edition, Tata McGraw Hill Education Pvt. Ltd, New Delhi, 2017.

REFERENCES:

1.	Coulson J.M. and Richardson J.F, "Chemical Engineering", 5th Edition, Butterworth-Heinemann Ltd, United States of America, 2002.
2.	Badger Walter L. and Banchero Julius T, "Introduction to Chemical Engineering", 1st Edition, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	determine the characteristics of solids, conduct size analysis, demonstrate the transportation and storage of solids	Applying (K3)
CO2	categorize the size reduction equipment and estimate the power consumption and effectiveness of the screen	Applying (K3)
CO3	examine the separation equipment for solid-solid, solid-liquid and solid-gas system and design of thickener	Applying (K3)
CO4	categorize various filters and determine the rate of filtration	Applying (K3)
CO5	analyze the working of various types of impellers, mixers and determine the 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		2	2				1	3	1
CO2	3	3	1				2	2				1	3	1
CO3	3	2	1				2	2				1	3	2
CO4	3	2	1				2	2				1	3	2
CO5	3	2	1				2	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	40	40				100
CAT2	20	40	40				100
CAT3	10	50	40				100
ESE	20	40	40				100

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

20CHT42 - PROCESS HEAT TRANSFER

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

Preamble	This course will help the students to apply the modes of heat transfer and its application in design of heat transfer equipment.	
Unit - I	**Conduction:**	**9**
Nature and 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. Relationship between Individual and overall heat transfer coefficients; critical thickness of insulation; fundamental concepts in extended surfaces heat transfer; Transient heat conduction.		
Unit - II	**Convection:**	**9**
Natural and forced convection –Application of dimensional analysis for convection and dimensionless numbers, Reynolds and Colburn analogy –jH factor, 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	**Heat Transfer with Phase Change:**	**9**
Boiling heat transfer-General aspects, boiling regimes, factors affecting boiling, boiling correlations, condensation heat transfer—film and dropwise condensation, Evaporator-Types and method of feed -steam economy and surface area calculations for single effect evaporator.		
Unit - IV	**Heat Exchangers:**	**9**
Types of heat exchangers; LMTD; use of correction factor charts; Fouling factors; surface area calculations for double pipe and shell and tube heat exchangers; effectiveness and number of transfer units –Wilson's plot.		
Unit - V	**Radiation**	**9**
Concept and nature of thermal radiations -Concept of Black and grey bodies; Stefan Boltzmann, Kirchhoff's, Planck's and Wien laws; Radiation between surfaces –configuration factor; radiation shield.		

Total:45

TEXT BOOK:

1.	Rajput R.K, “Heat and Mass Transfer”, 5th Edition, S.Chand, New Delhi, 2007

REFERENCES:

1.	Holman. J.P. and Souvik Battacharyya, “Heat Transfer”, 10th Edition, McGraw-Hill Education, Europe, 2011
2.	Binay K. Dutta, “Heat Transfer: Principles and Applications”, 7th Edition, PHI Learning Pvt. Ltd., 2000
3.	Kern D.Q, “Process Heat Transfer”, 2nd Edition, Tata McGraw Hill Europe, 1997.
4.	Necati 0zisik.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	calculate heat transfer rate for different geometries under steady state and transient heat conduction	Applying (K3)
CO2	apply the different flow conditions by convective heat transfer.	Analyzing (K4)
CO3	Inspect the fundamentals of boiling and condensation and determine the economy of evaporator	Applying (K3)
CO4	design and analyze the performance of heat exchangers.	Analyzing (K4)
CO5	apply the laws of radiation heat transfer for different configurations.	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	2	1								2	3	2
CO2	3	3	2	1								2	3	2
CO3	3	3	3	2								2	3	3
CO4	3	3	3	2								2	3	3
CO5	3	3	2	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	30	50				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)**

20CHL41 - MECHANICAL OPERATIONS LABORATORY

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

List of Exercises / Experiments :

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

Total:30

REFERENCES/MANUAL/SOFTWARE:
Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	determine crushing characteristics, power requirements and constants of crushing laws for different crushers	Applying (K3), Manipulation(S2)
CO2	calculate the screen effectiveness, average particle size and particle distribution using particle size analyzing techniques.	Applying (K3), Manipulation (S2)
CO3	estimate the separation efficiency, performance and power consumption of filters, conveyors, agitator 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	2
CO2	2	1				1	1	1	3	2		2	3	2
CO3	2	1				1	1	1	3	2		2	3	2

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

20CHL42 - PROCESS HEAT TRANSFER LABORATORY

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

List of Exercises / Experiments :

1.	Calculate the thermal conductivity of a material.
2.	Estimate transient heat conduction- constant flux and constant temperature
3.	Evaluate the overall heat transfer coefficient and heat transfer rate in a Column.
4.	Calculate the heat transfer coefficient and fin efficiency in an extended surface
5.	Investigate 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: Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the heat transfer concepts to solve steady state and unsteady state heat transfer	Applying (K3), Manipulation (S2)
CO2	appraise boiling and condensation mechanism to evaluate steam economy in evaporator and heat transfer coefficient in condenser	Applying (K3), Manipulation (S2)
CO3	evaluate the heat transfer coefficient for jacketed vessel, double pipe and shell and tube heat exchanger	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

20EGL31 - ENGLISH FOR WORKPLACE COMMUNICATION
(Common to all Engineering and Technology branches)

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Cred
Prerequisites	Nil	5	HS	0	0	2	1
Preamble							

Language Practice Domains:	
1. Listening:	**6**
Techniques for effective listening - Listening and note taking - Listening activities using listening texts - Listening to discourse samples of native English speakers – Focussed listening for improving pronunciaition - understanding different accents.	
2. Reading:	**6**
Developing reading skills - Reading aloud - Group reading activities - Reading with correct word stress and intonation.	
3. Soft Skills:	**6**
Attitude - Goal setting - Time Management - Team Work - Telephonic conversation skills.	
4. Writing:	**6**
Making preparatory notes, drafts and PPT's for laboratory activities - Word editing features - editing and proof reading.	
5. Speaking:	**6**
Verbal and non-verbal communication - Introducing oneself - Introducing others – Mock Interviews - Making presentations on chosen topics - Group Discussion.	

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Sanjay Kumar & Pushp Lata, "Communication Skills", 2nd Edition, Oxford University Press, New Delhi, 2017.
2.	Laboratory Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	acquire effective listening and reading skills	Understanding (K2), Imitation (S1)
CO2	acquire and demonstrate appropriate professional skills for the workplace	Applying (K3), Naturalization (S5)
CO3	speak fluently and write meaningfully in English in the given context	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	PSO1	PSO2
CO1									2	3		3		
CO2									2	2		2		
CO3									2	2		2		

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

20GET51 - UNIVERSAL HUMAN VALUES
(Common to all BE/BTech branches)

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	MC	2	0	0	2

Preamble	To make the student to know what they 'really want to be' in their life and profession, understand the meaning of happiness and prosperity for a human being. Also to facilitate the students to understanding of harmony at all the levels of human living, and live accordingly	
Unit - I	**Introduction:**	**9**
Need and Basic Guidelines of Value Education – Content and Process of Value Education – Self Exploration – purpose of self-Exploration – Content and Process of Self exploration – Natural Acceptance – Realization and Understanding – Basic Human Aspirations – Continuous Happiness and Prosperity – Exploring Happiness and Prosperity – Basic Requirement for Fulfillment of Human Aspirations – Relationships – Physical Facilities – Right Understanding.		
Unit - II	**Harmony in the Self and Body:**	**9**
Human Begin and Body – Understanding Myself as Co–existence of Self ('I') and Body, Needs of the Self and Body, Activities in the Self and Body, Self ('I') as the Conscious Entity, the Body as the Material Entity – Exercise – Body as an Instrument– Harmony in the Self ('I) – Understanding Myself – Harmony with Body.		
Unit - III	**Harmony in the Family and Society:**	**9**
Harmony in the Family – Justice – Feelings (Values) in Human Relationships – Relationship from Family to Society – Identification of Human Goal – Five dimensions of Human Endeavour.		
Unit - IV	**Harmony in Nature and Existence:**	**9**
Order of Nature – Interconnectedness – Understanding the Four order – Innateness – Natural Characteristic – Basic Activity – Conformance – Introduction to Space – Co–existence of units of Space – Limited and unlimited – Active and No–activity – Existence is Co–existence.		
Unit - V	**Implications of the above Holistic Understanding of Harmony on Professional Ethics:**	**9**
Values in different dimensions of Human Living – Definitiveness of Ethical Human Conduct –Implications of Value based Living – Identification of Comprehensive Human Goal – Humanistic Education – Universal Human Order – Competence and Issues in Professional Ethics.		

Total: 45

TEXT BOOK:

1. Gaur R.R., Sangal R., Bagaria G.P., "A Foundation Course in Human Values and Professional Ethics", 1st Edition, Excell Books Pvt. Ltd., New Delhi, 2016.

REFERENCES:

1. Ivan Illich, "Energy & Equity", The Trinity Press, USA, 1974.
2. Schumacher E.F., "Small is Beautiful: a study of economics as if people mattered", Britain, 1973.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the significance of value inputs in a classroom, distinguish between values and skills, understand the need, basic guidelines, content and process of value education, explore the meaning of happiness and prosperity and do a correct appraisal of the current scenario in the society.	Understanding (K2)
CO2	distinguish between the Self and the Body, understand the meaning of Harmony in the Self the Co–existence of Self and Body.	Understanding (K2)
CO3	understand the value of harmonious relationship based on trust, respect and other naturally acceptable feelings in human–human relationships and explore their role in ensuring a harmonious society.	Understanding (K2)
CO4	understand the harmony in nature and existence, and work out their mutually fulfilling participation in the nature.	Understanding (K2)
CO5	distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.	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		3						
CO2								2						
CO3						1		3						
CO4								2						
CO5								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	75					100
CAT2	25	75					100
CAT3	NA						
ESE	NA						

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

20CHT51 MASS TRANSFER- I

Programme & Branch	**B.Tech. & Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Chemical Process Calculations**	**5**	**PC**	**3**	**1**	**0**	**4**

Preamble	The subject focuses on the diffusion, mass transfer co-efficient, theories of mass transfer, the process aspects and equipment used in the operations like Absorption, Adsorption, Ion Exchange and Humidification.	
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	**Turbulent Transfer of Mass and Interface Mass Transfer:**	**9+3**
Mass transfer in turbulent flow, eddy diffusion, mass transfer coefficients, estimation of mass transfer coefficient in wetted wall column, correlations for the calculation of mass transfer coefficients. Theory of interface mass transfer, Individual and overall mass transfer coefficients, steady state co-current and counter current mass transfer processes, stages and stage efficiencies, cross flow and counter current cascades of stages, Kremser equations for the calculation of number of theoretical stages. Equipments for gas-liquid contact operations.		
Unit - III	**Absorption:**	**9+3**
Gas Absorption - Tray tower absorber, absorption factor, calculation number of theoretical stages, Murphree efficiency - point efficiency, tray efficiency and overall tray efficiency, calculation of actual number of trays.Packed tower absorber - HETP, HTU and NTU calculations Non-isothermal absorber, absorption with chemical reaction.		
Unit - IV	**Adsorption and Ion Exchange:**	**9+3**
Adsorption – Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Freundlich equation. Adsorption operation – stage wise operations, steady state moving bed absorbers, unsteady state fixed bed adsorbers, break through curves, rate of adsorption in fixed beds, design of fixed bed adsorbers. Ion Exchange – Selectivity, univalent, divalent-univalent, ion diffusion – particle and film control, Equipment – Fixed bed, Fluidized bed, Higgins moving packed bed, Industrial applications.		
Unit - V	**Humidification:**	**9+3**
Humidification - Humidity chart, adiabatic saturation curves, wet bulb temperature and measurement of humidity, Lewis relation, equipments for humidification operations, water cooling towers and spray chambers. Theory and calculation of humidification processes - gas liquid interaction, conditions in the top and bottom of cooling towers, design of cooling towers and dehumidifiers.		

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., Meera Sheriffa 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.
4.	Coulson J.M. and Richardson J.F., "Chemical Engineering", 5th Edition, Butterworth Heinemann, United State of America, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	measure and determine diffusion coefficients of gas, liquid systems	Applying (K3)
CO2	determine mass transfer coefficients and appreciate stage concept	Applying (K3)
CO3	perform process design calculations related to absorption and stripping operations	Applying (K3)
CO4	perform process design calculations related to adsorption operation and describe ion exchange concepts	Applying (K3)
CO5	perform process design calculations related to humidification operation	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	30	50	20				100
CAT2	10	30	60				100
CAT3	10	30	60				100
ESE	20	20	60				100

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

20CHT52 CHEMICAL REACTION ENGINEERING- I

Programme & Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Applied Chemistry & Chemical Process Calculations	**5**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course enables the student to learn about basic concepts of kinetics and design of various ideal reactors.	
Unit - I	**Elements of Reaction Kinetics:**	**9**
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:**	**9**
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:**	**9**
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:**	**9**
Parallel reactions: Product distribution and reactor size Series reactions: Irreversible reactions. Yield: Fractional yield and Selectivity. Recycle reactor, Autocatalytic reactions.		
Unit - V	**Reaction Equilibrium:**	**9**
Equilibrium in chemically reactive systems, evaluation of reaction equilibrium constant, effect of temperature on equilibrium conversion. Optimum temperature progression, reactor sizing.		

Total:45

TEXT BOOK:

1.	Levenspiel O, "Chemical Reaction Engineering", 4th 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.
2.	Mark E. Davis , Robert J. Davis, "Fundamentals of Chemical Reaction Engineering", 1st Edition, Tata McGraw Hill Publishing Company Ltd, New York, 2014.

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 ideal reactor concepts to develop the performance equation to workout conversion and space time	Analyzing (K4)
CO3	analyze the experimental kinetic data to select a suitable reactor combination for a particular application	Analyzing (K4)
CO4	determine selectivity and yield for series, parallel and mixed reactions	Applying (K3)
CO5	calculate reaction equilibrium constant, 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	1	2	1	1	1	1	1				2	2	1
CO2	3	3	2	1	1	1	1	1				2	3	3
CO3	3	3	2	1	1	1	1	1				2	3	3
CO4	3	3	2	1	1	1	1	1				2	3	3
CO5	3	2	2	1	1	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	30	30	40				100
CAT2	20	20	30	30			100
CAT3	20	30	50				100
ESE	20	20	30	30			100

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

20CHT53 - CHEMICAL EQUIPMENT DESIGN AND DRAWING

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Chemical Process Calculations & Process Heat Transfer	5	PC	3	1	0	4

Preamble	To acquire knowledge on process and mechanical design of various process equipment used in process industries with suitable codes and standards like ASME, ASTM and BIS.	
Unit - I	**Vessels:**	**9+3**
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:**	**9+3**
Design of Shell and tube and double pipe heat exchangers		
Unit - III	**Heat Transfer Equipment with Phase change:**	**9+3**
Design of condensers. Design of vertical thermosyphon reboiler. Design of single effect evaporator.		
Unit - IV	**Mass Transfer Equipment:**	**9+3**
Design of distillation column for binary systems – estimation of height and diameter. Design of plate and packed absorption column.		
Unit - V	**Reactors:**	**9+3**
Mechanical and process design of conventional mixed flow reactor, packed/tubular reactor and fluid reactor		

Lecture:45, Tutorial:15, Total:60

TEXT BOOKS:

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.	BI, Thakore SB, "Introduction to Process Engineering and Design", 2nd Edition, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2015 for unit V

REFERENCES:

1.	Bh Luyben, William Lat, “Chemical Reactor Design and Control”, 1st Edition, John Wiley & Sons, New Jersey, 2007.
2.	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, storage vessel under different pressure conditions	Analyzing (K4)
CO2	estimate the suitable design parameters of shell and tube and double pipe heat exchangers for the given process conditions	Analyzing (K4)
CO3	calculate the required design dimensions of a condenser, reboiler and single effect evaporator for the given duty	Analyzing (K4)
CO4	compute the height and diameter of the distillation and absorption columns for the given systems	Analyzing (K4)
CO5	perform the mechanical and process design of reactors for the given operating conditions	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	2	1	1	2				1		1	2	3	3
CO2	3	2	1	1	2				1		1	2	3	3
CO3	3	2	1	1	2				1		1	2	3	3
CO4	3	2	1	1	2				1		1	2	3	3
CO5	3	2	1	1	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		5	30	65			100
CAT2		5	30	65			100
CAT3		5	30	65			100
ESE		5	30	65			100

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

20CHL51 - CHEMICAL REACTION ENGINEERING LABORATORY

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	PC	0	0	2	1

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 of 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.	Calculate the residence time distribution in a plug flow and mixed flow reactors
9.	Evaluate the non-ideal reactors using dispersion and tank in series models
10.	Estimate the residence time distribution studies in fixed bed/ fluidized bed reactors
11.	Determine the surface area using BET isotherm
12.	Compare the catalytic and non catalytic systems in batch reactor

Total:30

REFERENCES/MANUAL/SOFTWARE:

Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the fundamentals of reaction engineering for batch and continuous systems and analyze the reactor performance	Applying(K3)/ Manipulating(S2)
CO2	perform experiments to develop models for non ideal reactors	Applying(K3)/ Manipulating(S2)
CO3	apply the principles of catalytic reactions and determine the surface area of a catalyst	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	2			1			1	3	2		2	3	1
CO2	3	2		1	1			1	3	2		2	3	1
CO3	3	2		1	1			1	3	2		2	3	1

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

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

20CHL52 - PROCESS COMPUTATION LABORATORY

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	PC	0	0	2	1

List of Exercises / Experiments :

1.	Perform basic Thermodynamic calculations using spreadsheet
2.	Linearization and Error Analysis of graphical data using spreadsheet
3.	Solving Material and Energy Balance for Non-Reactive systems using 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.	(a) Determine the average heat transfer coefficient for forced and natural convection using MATLAB (b) Determine the friction factor for laminar and turbulent flows using MATLAB
9.	Design of Shell and Tube heat exchanger using MATLAB / C Programming
10.	Calculation of Transfer Function of I, II and higher order processes using MATLAB
11.	Design of Double pipe heat exchanger using PYTHON Programming
12.	Design of Single / Multiple effect evaporator using PYTHON Programming
13.	Design of Plug Flow / Mixed Flow Reactor for a given reaction using PYTHON Programming

Total:30

REFERENCES/MANUAL/SOFTWARE:
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	1	1	1	1	2	2		1	3	1
CO2	3	2	3	3	1	1	1	1	2	2		1	3	1
CO3	3	2	3	3	1	1	1	1	2	2		1	3	1

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

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

20GEL51 - PROFESSIONAL SKILLS TRAINING I
(Common to all BE/ BTech / MSc /MCA /BSc Branches)

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	EC	0	0	80	2

Preamble	This subject is to enhance the employability skills and to develop career competency	
Unit - I	**Soft Skills – I:**	**20**
Soft skills and its importance: Pleasure and pains of transition from an academic environment to work environment-Need for change- Fear, stress and competition in the professional world-Importance of positive attitude- Self motivation and continuous knowledge upgradation-Self-confidence. Professional grooming and practices: Basics of corporate culture-Key pillars of business etiquette- Basics of etiquette-Introductions and greetings-Rules of the handshake, earning respect, business manners-Telephone etiquette- Body Language.		
Unit - II	**Quantitative Aptitude & 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	**Written Communication & Verbal Aptitude:**	**30**
Writing Skills: Writing strategies and formats – Importance of Résumés – Writing a Cover letter – Writing a fresher's CV / Résumés – Responding to Job Advertisements – Professional e-mail Writing – Responding to e-mails and business letters – Technical Report writing – Interpretation of Technical Data (Transcoding) – Writing One-page Essays. Verbal Aptitude – Synonyms – Antonyms – Homonyms – One word substitution – Idioms and Phrases – Paired words – Analogies – Spelling test – Cloze test – using suitable verb forms – using appropriate articles and prepositions; Spotting Errors – Sentence Correction and Formation – Grammar Based questions (Transformation : Active-Passive & Direct-Indirect); Rearranging Jumbled Sentences & Jumbled paragraphs, Identifying Facts, Inferences and Judgements statements.		

Total: 80

TEXT BOOK:

1	Thorpe, Showick and Edgar Thorpe, "Objective English For Competitive Examination", 6th Edition, Pearson India Education Services Pvt Ltd, 2017.

REFERENCES:

1	Bailey Stephen, "Academic Writing: A practical guide for students", Routledge, New York, 2011.
2	Raman, Meenakshi and Sharma, Sangeeta, "Technical Communication - Principles and Practice", 3rd Edition, Oxford University Press, New Delhi, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	develop the soft skills of learners to support them work efficiently in an organization as an individual and as a team	Applying (K3), Precision (S3)
CO2	solve real time problems using numerical ability and logical reasoning	Applying (K3), Precision (S3)
CO3	apply communication skills effectively to understand and deliver information in various written discourses grammatically with accuracy	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
ESE	**NA**						

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

20CHT61 - MASS TRANSFER- II

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Mass Transfer I	6	PC	3	0	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:**	**9**
Vapour liquid equilibria - 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 Ponchan - Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio.		
Unit - II	**Stage Calculations:**	**9**
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:**	**9**
Liquid - liquid extraction, ternary liquid- liquid equilibrium, solvent characteristics, equipments 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), equipments for leaching operation, multi stage continuous cross current and counter current leaching, stage calculations, stage efficiency.		
Unit - IV	**Drying:**	**9**
Theory and mechanism of drying-drying characteristics of materials-batch and continuous drying-calculation for continuous drying-various drying equipments and their applications.		
Unit - V	**Crystallization:**	**9**
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, equipments for crystallization.		

Total: 45

TEXT BOOK:

1.	Treybal R.E., "Mass Transfer Operations", 3rd Edition, McGraw Hill Book Co., New York, 1981.

REFERENCES:

1.	Binay K Dutta, Principles of Mass Transfer and Separation Process, PHI learning private limited, 2007.
2.	Anantharaman N., Meera Sheriffa 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.
4.	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 distillation operations through stage concept	Analyzing(K4)
CO3	analyze extraction and leaching operations through ternary diagrams	Analyzing(K4)
CO4	determine drying time requirements for various devices and design industrial driers	Applying(K3)
CO5	estimate crystal yields for batch and continuous equipments	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	3	3
CO2	3	3	3	2								2	3	3
CO3	3	3	3	2								2	3	3
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	10	30	60				100
CAT2	10	20	50	20			100
CAT3	10	30	60				100
ESE	10	20	60	10			100

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

20CHT62 - PROCESS MODELING AND SIMULATION

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	PC	3	0	0	3

Preamble	To make the students knowledgeable in different aspects of modeling chemical process systems & familiarize with the numerical simulation of models in fluid flow operations, separation processes and reactors. They will also acquire knowledge on the fundamental concepts of recent techniques in process 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 flowsheet, major blocks used and basic steps involved in solving and convergence hints		

Total:45

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:

1.	Luyben W.L, "Process Modeling, Simulation and Control for Chemical Engineers", 2nd Edition, Tata McGraw Hill Publishing Company Ltd, New York, 1990.
2.	Babu B.V, "Process Plant Simulation", 1st Edition, Oxford University Press, New Delhi, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the fundamental principles, types and applications of modeling and simulation	Understanding (K2)
CO2	develop mathematical models for various reactors used in process industries	Applying (K3)
CO3	develop mathematical models for industrial separation processes–distillation, absorption and extraction units	Applying (K3)
CO4	apply appropriate numerical techniques for modeling and simulating reactors and absorber	Applying (K3)
CO5	explain process simulation, illustrate the simulation of unit operations and processes using Aspen plus software package	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	2	3	2
CO2	3	3	2		2						1	2	3	2
CO3	3	3	2		2						1	2	3	2
CO4	3	3	2		2						1	2	3	2
CO5	3	3	2		3						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	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)**

20CHT63 - PROCESS INSTRUMENTATION DYNAMICS AND CONTROL

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

Preamble	This course will enable the students to compute the response of various control system strategies for different process dynamics	
Unit – I	**Principles of Measurement:**	**9**
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:**	**9**
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:**	**9**
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:**	**9**
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:**	**9**
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		

Total:45

TEXT BOOKS:

1.	Alan S Morris, "Measurement and Instrumentation: Theory and Application", 3rd Edition, Butterworth-Heinemann, New Delhi, 2001 for 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 for 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 various measuring instruments and transmitters used in process industries	Understanding (K2)
CO2	examine the response of first and second order systems	Applying (K3)
CO3	explain the principle and types of controllers and control elements for different applications	Applying (K3)
CO4	analyze the closed loop control systems to determine the transient response, offset and their stability	Analyzing (K4)
CO5	assess the frequency response of closed loop systems and describe the advanced control strategies	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	1
CO2	3	3	1									2	3	1
CO3	3	3	2									2	3	1
CO4	3	3	2									2	3	1
CO5	3	3	1									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	50	40				100
CAT2	10	30	60				100
CAT3		20	40	40			100
ESE	10	20	30	40			100

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

20CHL61 - MASS TRANSFER LABORATORY

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	PC	0	0	2	1

Total:30

List of Exercises / Experiments:

1.	Determine the diffusivity of a fluid – fluid and fluid - solid system
2.	Estimate the mass transfer co-efficient using Wetted wall column
3.	Estimate the mass transfer coefficient of a air-water system in a cooling tower
4.	Conduct the batch drying study and estimate the mass transfer coefficient and psychometric ratio
5.	Conduct the drying experiment using Vacuum dryer
6.	Determine the activity coefficients & Van Laar constant for the given system by performing VLE experiments
7.	Verify Raleigh's equation for the given system using simple distillation setup
8.	Estimate the height equivalent to a theoretical plate (HETP) and find out percentage recovery of the overhead and bottom products of given system under total reflux conditions
9.	Determine the vaporization efficiency (Ev) and thermal efficiency (Et) of the given system using steam distillation apparatus
10	Conduct simple Leaching studies using given system
11.	Conduct the liquid - liquid extraction studies and plot binodal curve for the given ternary system
12.	Verify adsorption isotherms by Batch Adsorption
13.	Determine the exchange rate and saturation point by deionising water using Ion-Exchange experiment

REFERENCES/MANUAL/SOFTWARE:
Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	determine diffusivity and mass transfer co-efficient of a given system using mass transfer operations	Applying (K3), Manipulating(S2)
CO2	evaluate the performance and design parameters for various distillation operations	Applying (K3), Manipulating (S2)
CO3	estimate the separation efficiency of various mass transfer equipment	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	2			1			1	3	2		2	3	1
CO2	3	2		1	1			1	3	2		2	3	1
CO3	3	2		1	1			1	3	2		2	3	1

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

20CHL62 - PROCESS MODELING AND SIMULATION LABORATORY

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	PC	0	0	2	1

List of Exercises / Experiments :

1.	Analyse of physical properties and thermodynamic equilibrium diagram construction
2.	Estimate the physical property for a non- data bank component
3.	Design pump, valves and pipes for fluid transport
4.	Simulate the heat exchanger using Aspen Plus by short cut and detailed method
5.	Simulate the mixer and flash separator
6.	Simulate the distillation column
7.	Perform the sensitivity analysis and influence of flow rate of single component on absorption and its optimization
8.	Simulate the steady state plug flow reactor
9.	Simulate the steady state mixed flow reactor
10.	Generate a simple process flow diagram and perform simulation study

Total:30

REFERENCES/MANUAL/SOFTWARE: Laboratory Manual

1. Aspen Plus

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	construct T-x-y / P-x-y diagrams, estimate the physical properties of non-data bank component and perform fluid flow problems	Applying (K3), Manipulating (S2)
CO2	simulate heat and mass transfer equipments	Analyzing (K4), Manipulating(S2)
CO3	perform simulation of reactors and simple process flow diagram	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		2	3				3		2	2	3	1
CO2	3	2		2	3				3		2	2	3	1
CO3	3	2		2	3				3		2	2	3	1

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

20CHL63 - PROCESS INSTRUMENTATION DYNAMICS AND CONTROL LABORATORY

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	PC	0	0	2	1

List of Exercises / Experiments :

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

Total:30

REFERENCES/MANUAL/SOFTWARE:

Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	estimate time constant and transient response of various dynamic systems	Applying (K3), Manipulation (S2)
CO2	analyze 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			1			1	3	2		2	3	1
CO2	3	2		1	1			1	3	2		2	3	1
CO3	3	2		1	1			1	3	2		2	3	1

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

20CHP61 - PROJECT WORK-I

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	**6**	**EC**	**0**	**0**	**4**	**2**

Total:60

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify and define the problems that need to be solved	Applying (K3)
CO2	select appropriate literature and frame the objectives	Applying (K3)
CO3	develop/ design value added products equipment using research tools and methods	Creating(K6)
CO4	analyze the experimental data and device the valid conclusion	Analyzing(K4)
CO5	elaborate the project in the form of oral presentation, report and technical paper publication	Creating(K6)

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	2	2	3	2	3	3	3	3	3	3
CO2	3	2	2	2	3	2	2	2	3	3	3	3	2	2
CO3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	2	3	3	2	2	2	3	3	3	3	2	2
CO5	3	2	2	2	2	2	2	2	3	3	3	3	2	2

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

20GEL61 - PROFESSIONAL SKILLS TRAINING II
(Common to all BE/ BTech / MSc /MCA /BSc Branches)

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	EC	0	0	80	2

Preamble	This subject is to enhance the employability skills and to develop career competency	
Unit - I	**Soft Skills – II:**	**20**
Group discussions: Advantages of group discussions-Structured GD- Team work: Value of team work in organizations- Definition of a team, why team-Elements of leadership, disadvantages of a team, stages of team formation- Group development activities. Facing an interview: Foundation in core subject- industry orientation / knowledge about the company- professional personality-Communication skills-Activities before Interview, upon entering interview room, during the interview and at the end Mock interviews.		
Unit - II	**Quantitative Aptitude & Logical Reasoning – II:**	**30**
Problem solving level II: Money related problems-Mixtures-Symbol base problem-Clocks and calendars-Simple-linear-quadratic and polynomial equations-Special, equations-Inequalities-Sequence and series-Set theory-Permutations and combinations-Probability-Statistics-Data sufficiency-Geometry-Trigonometry-Heights and distances-Co-ordinate geometry-Mensuration. Logical reasoning: Conditionality and grouping-Sequencing and scheduling- Selections-Networks:-Codes; Cubes-Venn diagram in logical reasoning- Quant based reasoning-Flaw detection- Puzzles-Cryptarithms.		
Unit - III	**Reading & Speaking Skills:**	**30**
Reading: Reading comprehension– Effective Reading strategies – Descriptive, Inferential, & Argumentative reading passages – Identifying and locating factual information within a text – global reading/skimming for general understanding – selective comprehension / scanning for specific information – detailed comprehension / intensive reading – understanding the development of an argument – identifying the writer's attitude and opinions – Reading news articles in business magazines, newspapers – Reading notices and book reviews –Interpreting graphic data & Advertisements. Speaking: Mock Interviews –Self-Introduction – Sharing of Real Time Experience; Conversational Practices –Role Play – Short Talks / TED Talks –Extempore; Giving a Presentation on Various Topics – Technical / Non-Technical Topics – Project Review Presentation – Oratory and Effective Public Speaking; Pair Discussion – Group Discussion – The process of Group Discussion – Strategies to be adopted – Skills Assessed – Telephonic Conversations & Skills – Negotiating Skills.		

Total: 80

TEXT BOOK:

1	Thorpe, Showick and Edgar Thorpe, "Objective English For Competitive Examination", 6th Edition, Pearson India Education Services Pvt Ltd, 2017.

REFERENCES:

1	Aruna Koneru, "Professional Speaking Skills," Oxford University Press India, 2015.
2	Thorpe, Showick and Edgar Thorpe, "Winning at Interviews," 5th edition, Pearson Education, India, 2013.
3	Rizvi, Ashraf M, "Effective Technical Communication," 2nd Edition, McGraw Hill Education India, 2017.

COURSE OUTCOMES:	BT Mapped

On completion of the course, the students will be able to		(Highest Level)
CO1	develop the soft skills of learners to support them work efficiently in an organization as an individual and as a team	Applying (K3), Precision (S3)
CO2	solve real time problems using numerical ability and logical reasoning	Applying (K3), Precision (S3)
CO3	apply reading and speaking skills effectively 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	40	40				100
CAT2		50	50				100
CAT3		50	50				100
ESE	NA						

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

20GEP61 - COMPREHENSIVE TEST AND VIVA

(Common to all BE/BTech branches)

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	EC	0	0	0	2

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	demonstrate knowledge in their respective programme domain.	Applying (K3)
CO2	defend any type of interviews, viva-voce, and aptitude tests conducted for career progression	Applying (K3)
CO3	exhibit professional etiquette and solve related 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	2					1	2	2	3	3	2
CO2	3	3	2	2					1	2	2	3	3	2
CO3	3	3	2	2					1	2	2	3	3	2

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

20CHT71 - PROCESS ENGINEERING AND ECONOMICS

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

Preamble	This course enables students to learn the process design development, plant location and layout, cost accounting and estimation, capital investments, taxes and depreciation	
Unit – I	**Process Design Development:**	**9**
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**
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**
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**
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**
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.		

Total:45

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.	Applying (K3)
CO2	explain the factors affecting plant location and layout	Understanding (K2)
CO3	estimate the cost for industrial operations	Applying (K3)
CO4	determine taxes and depreciation for industrial operations	Applying (K3)
CO5	calculate the capital cost investment for process industries	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			
CO2		1	2				1				3		2	
CO3	1	2	1								3		2	
CO4	1	2	1								3		1	
CO5	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	60	20				100
CAT2	20	50	30				100
CAT3	15	60	25				100
ESE	15	65	20				100

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

20CHT72 - 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	1	0	4

Preamble	To enable students to relate the concepts of heat, mass and momentum transfer.	
Unit - I	**Fundamentals of Transport Phenomena:**	**9+3**
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+3**
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 equations of change:**	**9+3**
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+3**
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+3**
Development and applications of analogies between momentum, heat and mass transfer- Reynolds, Prandtl, Von Karman and Chilton-Colburn analogies.		

Lecture:45, Tutorial:15, Total:60

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	comprehend the analogous nature of Transport processes; Gain insight about different rheological models and transport properties of fluids	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	use equations of change to solve heat transfer problems; Develop 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	30	50				100

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

20CHP71 - PROJECT WORK -II PHASE- I

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	EC	0	0	6	3

Total:90

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify and define the problems that need to be solved	Applying (K3)
CO2	select appropriate literature and frame the objectives	Applying (K3)
CO3	develop/ design value added products equipment using research tools and methods	Creating(K6)
CO4	analyze the experimental data and device the valid conclusion	Analyzing(K4)
CO5	elaborate the project in the form of oral presentation, report and technical paper publication	Creating(K6)

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	2	2	3	2	3	3	3	3	3	3
CO2	3	2	2	2	3	2	2	2	3	3	3	3	2	2
CO3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	2	3	3	2	2	2	3	3	3	3	2	2
CO5	3	2	2	2	2	2	2	2	3	3	3	3	2	2

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

20CHP81 – PROJECT WORK- II Phase -II

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	EC	0	0	14	7

Total:210

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify and define the problems that need to be solved	Applying (K3)
CO2	select appropriate literature and frame the objectives	Applying (K3)
CO3	develop/ design value added products equipment using research tools and methods	Creating(K6)
CO4	analyze the experimental data and device the valid conclusion	Analyzing(K4)
CO5	elaborate the project in the form of oral presentation, report and technical paper publication	Creating(K6)

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	2	2	3	2	3	3	3	3	3	3
CO2	3	2	2	2	3	2	2	2	3	3	3	3	2	2
CO3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	2	3	3	2	2	2	3	3	3	3	2	2
CO5	3	2	2	2	2	2	2	2	3	3	3	3	2	2

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

20CHE01 - CHEMICAL PROCESS PLANT SAFETY

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Chemistry, Industrial Chemistry & Chemical Process Industries	5	PC	3	0	0	3

Preamble	The course outlines the workplace safety and associated terms applicable to the Process Industries	
Unit - I	**Industrial Safety and Standards:**	**9**
Industrial Safety programs - Training and Education; Personal protective Equipments; Safety codes & Standards: NFPA, API, IS and OSHA standards, Colour codes for pipe lines; Materials Safety Data sheets.		
Unit - II	**Hazards and Occupational Health:**	**9**
Occupational health hazards and their control - Types of Hazards & Exposure Controls; Safety in storage and handling of hazards; Designs to prevent fire and explosion hazards; Relief valves; Occupational diseases –Types, Causes, effects and Control measures.		
Unit - III	**Process Safety and Safety Studies:**	**9**
Safety in processes and plant operations, Process Safety Information (Key Terminologies & Definitions), Plant Layout spacing (Safety Distance), Inherently Safer plant Design Principles, Chemical Reactivity (Runaway reactions)- Handling of unstable products, Safety Critical Elements, Classification of Electrical Equipment's in Hazardous area, Fire and Gas Detection Systems, Fire Protection Systems, Emergency Planning and Response. Hazard Identification Safety Reviews – HAZID, HAZOP & SIL. Hazard Evaluation Safety Studies – Risk Assessment (QRA, FERA), Toxic Release & Dispersion Models, Layer of Protection Analysis, Fault tree, Event tree Methods for Risk analysis, ALARP, Risk Management Approach.		
Unit - IV	**Industrial Accidents and Case Studies:**	**9**
Accidents - Causes, Effects, Costs, and Prevention; Accident Investigation; Accident proneness; Major Accident Case Histories and Loss statistics - 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 associated safety procedures to ensure occupational health	Applying (K3)
CO3	describe the process safety in plant operations and analyze the safety failures through safety studies	Applying (K3)
CO4	examine major industrial accidents, their consequences and describe the preventive methods	Applying (K3)
CO5	summarize the safety law and regulations and recognize the roles played by different bodies in promoting 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
CAT3	20	40	40				100
ESE	20	40	40				100

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

20CHE02 - 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	describe the nitration and amination in various unit processes	Applying (K3)
CO2	explain the halogenation and sulfonation processes	Applying (K3)
CO3	sketch process flow diagrams for ammonolysis and oxidation processes	Applying (K3)
CO4	employ various methods for production of hydrogen and hydrocarbon	Applying (K3)
CO5	demonstrate 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	2	1			1	1	1				1	3	1
CO2	3	1	1			1	1	1				1	3	1
CO3	3	2	1			1	1	1				1	3	1
CO4	3	2	1			1	1	1				1	3	1
CO5	3	1	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	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)**

20CHE03 - INSTRUMENTAL METHODS OF ANALYSIS

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	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	describe UV-Visible, IR instrument for chemical analysis	Applying (K3)
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	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		3	2	1	1	1				1	2	1
CO2	3	3		2	2	1	1	1				1	2	1
CO3	3	3		3	2	1	1	1				1	2	1
CO4	3	3		2	2	1	1	1				1	2	1
CO5	3	3		3	2	1	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	60	10				100
CAT2	40	60					100
CAT3	40	60					100
ESE	30	60	10				100

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

20CHE04 - CHEMICAL ANALYSIS

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

Preamble	This course helps the student to understand the basic principles in chemical analysis, chemical equilibria, and different types of acid base titrations.	
Unit - I	**Chemical Measurements**	**9**
SI units, Chemical concentration, preparing solution, stoichiometry calculations for gravimetric analysis, Introduction to titration and its calculation, Experimental error.		
Unit – II	**Chemical equilibrium in chemical analysis**	**9**
Equilibrium constants, solubility products, complex formation, protic acids and bases. Strength of acid and bases. Effect of ionic strength on solubility of salt, systematic treatment of equilibrium. Activity coefficients.		
Unit – III	**Acid-Base equilibria and its titrations**	**9**
Monoprotic and polyprotic equilibria, types of acid-base titration, buffers, indicators. Metal ion indicators and EDTA titrations with techniques.		
Unit – IV	**Electrodes and potentiometry**	**9**
Reference electrodes, indicator electrodes, junction potential, pH measurement and ion selective electrodes, solid state chemical sensors.		
Unit - V	**Redox titrations and Electro analytical techniques**	**9**
Redox titrations, finding end points, oxidation state analysis – oxidation with $KMnO_4$ and $K_2Cr_2O_7$. Fundamentals of electrolysis, Electrogravimetric analysis, Coulometry, Amperometry and Voltammetry		

Total:45

TEXT BOOK:

1. Daniel C. Harris, “Quantitative Chemical Analysis”, 8th Edition, W. H. Freeman and Company, New York, 2010.

REFERENCES:

1. Skoog D.A. and West D.M, "Fundamentals of Analytical Chemistry", 7th Edition, Saunders College Publishing, New York, 1996.
2. 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	understand the concepts in calculation for gravimetric analysis and titrations	Understanding (K2)
CO2	explain about equilibria for the solubility of ionic compounds, complex formation and acid base reactions	Understanding (K2)
CO3	describe the acid base equilibria, different types of titrations and buffers.	Understanding (K2)
CO4	Illustrate the different types of electrodes and the role of chemical sensors	Understanding (K2)
CO5	outline the basics of redox titrations and the fundamentals of coulometry, amperometry and voltammetry	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	1	1	1	1				1	3	1
CO2	3	1	2	1	1	1	1	1				1	3	1
CO3	3	1	2	1	1	1	1	1				1	3	1
CO4	3	1	2	1	1	1	1	1				1	3	1
CO5	3	1	2	1	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	40	60					100
CAT2	40	60					100
CAT3	30	70					100
ESE	40	60					100

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

20CHE05 - BIO CHEMICAL ENGINEERING

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	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.		
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	classify microbes and describe microbial growth kinetics	Understanding (K2)
CO2	explain Michaelis Menten Kinetics and various immobilization techniques	Applying (K3)
CO3	describe the sterilization and fermentation process	Understanding (K2)
CO4	explain theories of mass transfer to microbial systems	Understanding (K2)
CO5	classify bioreactors and explain 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	20	60	20				100
CAT3	40	60					100
ESE	20	60	20				100

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

20CHE06 - PULP AND PAPER TECHNOLOGY

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 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 various paper manufacturing operations	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	1
CO2	2	1					2						3	1
CO3	3	3					2						3	1
CO4	3	2					2						3	1
CO5	2	1					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	30	70					100
CAT2	20	80					100
CAT3	30	70					100
ESE	30	70					100

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

20CHE07 - CHEMICAL REACTION ENGINEERING -II

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

Preamble	This course offers an insight into the non ideal flow, adsorption and catalytic reaction, diffusion and reaction in porous catalysts, catalytic reactors and fluid-solid non catalytic reactions	
Unit - I	**Non Ideal Flow:**	**9**
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:**	**9**
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:**	**9**
Diffusion within catalyst particle, effective thermal conductivity, mass and heat transfer within catalyst pellets; effectiveness factor		
Unit – IV	**Catalytic Reactors:**	**9**
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:**	**9**
Models for explaining the kinetics; shrinking core model; controlling resistances and rate controlling steps; time for complete conversion for single and mixed sizes particle.		

Total:45

TEXT BOOK:

1.	Smith, J. M., "Chemical Engineering Kinetics", 3rd Edition, Tata McGraw Hill Publishing Company Ltd, New York, 1981.

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	discuss the types of catalysts, their preparation techniques and analyze the mechanism of adsorption	Analyzing (K4)
CO3	deduce the mechanism of catalysis for porous catalysts and determine the effectiveness factor	Analyzing (K4)
CO4	discuss the multiphase reactors used in industries	Applying (K3)
CO5	explain the principles of non-catalytic fluid-solid reactions and understand their mechanisms	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	1				2	3	1
CO2	3	3	2	2	2	1	1	1				2	3	1
CO3	3	3	2	2	2	1	1	1				2	3	1
CO4	3	3	1	2	2	1	1	1				2	3	1
CO5	3	3	1	2	2	1	1	1				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	20	30	50				100
CAT2	10	20	50	20			100
CAT3	20	30	50				100
ESE	10	30	50	10			100

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

20CHE08 - 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	describe 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	1	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	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	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)**

20CHE09 - 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 BOOKS:

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 renewable energy sources like biomass, hydro, wind and solar systems	Understanding (K2)
CO4	Explain the contributions of renewable resources like 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				3					1	2	
CO2	2	2	2	1			3					1	2	2
CO3	2	2	2	1			3					1	2	2
CO4	2	2	2	1			3					1	2	2
CO5	2	2	2			2	3	2	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	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)**

20CHE10 - MODERN SEPARATION PROCESSES

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	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 separation processes for selecting optimal process for new and innovative applications and the novel techniques of filtration	Understanding (K2)
CO2	apply the types of membranes and membrane materials and exhibit the understanding of various membrane separation processes	Applying (K3)
CO3	explain the basic principles of common membrane separation processes and its application in process industries	Applying (K3)
CO4	apply the latest concepts like Ion Exchange, Electrophoresis, Dielectrophoresis, Chromatography in chemical process industries	Applying (K3)
CO5	discuss the advancement of recent separation 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	3	2		1	2					3	3	2
CO2	3	3	2	2		1	2					3	3	2
CO3	3	3	3	2		1	2					3	2	2
CO4	3	3	3	3		1	2					3	2	2
CO5	3	2	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	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)**

20CHE11 - AIR POLLUTION CONTROL

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	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 BOOKS:

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.

REFERENCE:

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 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 operations and applications of air pollution control equipment	Understanding (K2)
CO4	Execute the operations, applications and design 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	1	1			3	3				2		2	2
CO2	3	2	2			3	3				2		2	2
CO3	3	2	2			3	3						2	2
CO4	3	2	3		2	3	3				2		3	2
CO5	3	2	2	2	2	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	35	65					100
CAT3	10	60	30				100
ESE	20	60	20				100

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

20CHE12 - PROCESS INSTRUMENTATION

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

Preamble	This course will help the students to be aware of various measurement system used in chemical industries to measure process variables.	
Unit - I	**Principles of Measurement:**	**9**
Measuring Instrument: Introduction and its types- Elements and its function. Transducer: Importance and its classification - Measuring errors: Sources - reduction - quantification of systematic and Random errors. Performance characteristics: Static and Dynamic characteristics		
Unit - II	**Temperature Measurement:**	**9**
Principles of temperature measurement: Thermoelectric effect sensors - Varying resistance devices - Radiation thermometers - Thermography - Thermal expansion methods - Fibre-optic temperature sensors - Selection of temperature transducers.		
Unit - III	**Pressure Measurement:**	**9**
Principles of Pressure Measurement: Manometers - Bourdon tube - Bellows - Diaphragms - Capacitive pressure sensor - Fibre-optic pressure sensors - Resonant-wire devices - Dead-weight gauge - Special measurement devices for low pressures measurement -Selection of pressure sensors.		
Unit – IV	**Flow and Viscosity measurement:**	**9**
Principles of Flow Measurement : Mass flow rate measurement and Volume flow rate measurement - Choice between flow meters for particular applications. Viscosity measurement: Capillary and tube viscometers - Falling body viscometer - Rotational viscometers.		
Unit – V	**Level Measurement:**	**9**
Principles of Level Measurement: Float systems - Pressure measuring devices - Capacitive devices - Ultrasonic level gauge - Radar (microwave) methods - Radiation methods - Vibrating level sensor and Laser methods - Choice between different level sensors.		

Total:45

TEXT BOOK:

1.	Alan S Morris, Reza Langari, "Measurement and Instrumentation: Theory and Application", 3rd Edition, Academic Press, USA, 2001.

REFERENCES:

1.	William C Dunn , "Fundamentals of Industrial Instrumentation and Process Control", 1st Edition, McGraw Hill International Edition, New Delhi, 2005.
2.	Singh S.K, "Industrial Instrumentation and Control", 2nd Edition, McGraw Hill International Edition, New Delhi, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the type, performance characteristics and error generation of measurement	Understanding (K2)
CO2	explain temperature measurement device applied in chemical industries	Understanding (K2)
CO3	describe various range of pressure measuring system used in process industries	Understanding (K2)
CO4	illustrate flow and viscosity measurement techniques related to production industries	Understanding (K2)
CO5	elaborate level measurement tool adopted in 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										2	2	
CO2	3	1										2	2	
CO3	3	1										2	2	
CO4	3	1										2	2	
CO5	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	20	80					100
CAT3	20	80					100
ESE	20	80					100

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

20CHE13 - FERTILIZER TECHNOLOGY

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 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	describe the physical, chemical properties, manufacturing and applications of nitrogen based fertilizers	Understanding (K2)
CO3	explain the physical, chemical properties, manufacturing and applications of ammonia and urea	Understanding (K2)
CO4	summarize the physical, chemical properties and production of potassium fertilizers	Understanding (K2)
CO5	describe 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	2					1	1	2
CO2	3					2	2					1	1	2
CO3	3					2	2					1	1	2
CO4	3					2	2					1	1	2
CO5	3					2	2					1	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	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)**

20CHE14 CORROSION 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 the principles of corrosion, its testing methods, control measures in specific environments.	
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, Electrophoteric 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 BOOKS:

1.	Fontana M.G., "Corrosion Engineering", 1st edition, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2005 for units I, II, III & IV.
2.	Pierre R. Roberge, "Corrosion Inspection and Monitoring", 1st edition, John Wiley and Sons Inc, Canada, 2008 for unit V

REFERENCES:

1.	Jones D.A, "Principle and Protection of Corrosion", 1st Edition, Prentice Hall of India Pvt. Ltd, India, 1996.
2.	Sastri V.S., Ghali E., Elboujdaini M., "Corrosion Prevention and Protection: Practical Solutions", 1st 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	describe the different types of corrosion and their testing methods	Understanding (K2)
CO2	explain the corrosion protection methods for applications in chemical process industries	Applying (K3)
CO3	describe the corrosion in specific environments and its control	Understanding (K2)
CO4	explain the corrosion control methods in industrial applications and case studies	Applying (K3)
CO5	demonstrate corrosion inspection and 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	3	2			1	2	2						2	1
CO2	3	2			1	2	2						2	1
CO3	3	2			1	2	2						2	1
CO4	3	2			1	2	2						2	1
CO5	3	2			1	2	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	60	20				100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	20	60	20				100

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

20GEE01 - FUNDAMENTALS OF RESEARCH
(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 familiarize 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 - Outcome 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 - Measurement 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**

Reports and Presentations: 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”. Routledge, 2017.

REFERENCES:

1. Melville S, Goddard W. “Research Methodology: An Introduction For Science and Engineering Students”. Kenwyn: Juta & Co Ltd., 1996.
2. Kumar, Ranjit. “Research Methodology: A step-by-step guide for beginners”. SAGE Publications Limited, 2019.

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.	Analyzing (K4)
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	1	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	1	1		3	3	3	2	2	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	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		40	35	25			100
CAT2		30	40	30			100
CAT3				50	50		100
ESE		25	25	25	25		100

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

20CHE15 - 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", 1st Edition(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	describe the purification, compression and liquefaction of oil and natural gas for storage and transportation	Understanding (K2)
CO3	exemplify the deliverability and flow behaviour in a reservoir	Understanding (K2)
CO4	demonstrate the techniques involved in natural gas treatment	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	1			2	2	2						2	1
CO2	3	1			2	2	2						2	1
CO3	3	2			2	2	2						3	1
CO4	3	1			2	2	2						2	1
CO5	3	1			2	2	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	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)**

20CHE16 - 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 BOOKS:

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.

REFERENCE:

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)**

20CHE17 - FUNDAMENTALS OF COMPUTATIONAL FLUID DYNAMICS

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	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	explain governing equations for fluid flow and heat transfer.	Applying (K3)
CO2	explain the different types of models for turbulence.	Applying (K3)
CO3	apply finite volume method for developing solution of steady state diffusion and convection diffusion problems.	Analyzing (K4)
CO4	describe the solution 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.	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	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	20	50	20			100
CAT3	10	20	50	20			100
ESE	10	20	50	20			100

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

20CHE18 - PHARMACEUTICAL PROCESS 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 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 BOOKS:

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.

REFERENCE:

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	describe the manufacturing processes of different types of pharmaceutical products	Understanding (K2)
CO5	elaborate 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	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)**

20CHE19 - PROCESS OPTIMIZATION

Programme & Branch	B.Tech. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Mathematics	7	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	Develop and interpret the objective functions of optimization.	Applying (K3)
CO3	Apply unidirectional search methods in solving unconstrained functions.	Applying (K3)
CO4	Solve optimization problems using unconstrained multivariable optimization.	Applying (K3)
CO5	Describe the methods of linear programming and 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		
CO2	3	3	3	3	1							2		
CO3	3	3	3	2	1							2		
CO4	3	3	3	3	1							2		
CO5	3	3	3	3	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	25	65				100
CAT2	10	25	65				100
CAT3	10	30	60				100
ESE	10	30	60				100

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

20CHE20 - TOTAL QUALITY MANAGEMENT

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 quality concepts and Total Quality Management (TQM) principles focusing on process quality to assure product quality to the customers. It also deals with the basic and modern quality management tools including ISO standards	
Unit - I	**Quality Concepts and Principles**	**9**
Definition of Quality, Dimensions of Quality, Quality Planning, Quality Assurance and Control, Quality Costs With Case Studies, Elements/Principles of TQM - Historical Review, Leadership-Qualities/Habits, Quality Council, Quality Statements, Strategic Planning – Importance - Case Studies, Deming Philosophy, Barriers to TQM Implementation.		
Unit - II	**TQM-Principles and Strategies**	**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's Trilogy - PDSA Cycle - 5S – Kaizen, Supplier Partnership – Partnering - Sourcing - Supplier Selection - Supplier Rating - RelationshipDevelopment, Performance Measures-Purpose- Methods-Cases.		
Unit - III	**Control Charts for Process Control**	**9**
Basic Seven Tools of Quality and its Role in Quality Control, Statistical Fundamentals –Measures of Central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for Variables and Attributes - Process Capability- Case Study- Introduction to Six Sigma.		
Unit - IV	**TQM-Modern Tools:**	**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), Total Productive Maintenance (TPM)-Uptime Enhancement, Failure Mode and Effect Analysis(FMEA)-Risk Priority Number (RPN) - Process - Case Studies.		
Unit - V	**Quality Systems**	**9**
Need For ISO 9000 and Other Quality Systems - ISO 9000 : 2015 Quality System –Elements - Implementation of Quality System - Documentation - Quality Auditing, Introduction to ISO 14000- IATF 16949 - TL 9000-IEC 17025 - ISO 18000 - ISO 20000 - ISO 22000. Process of Implementing ISO - Barriers in TQM Implementation.		

Total: 45

TEXT BOOK:

	Besterfield Dale H., Besterfield Carol, Besterfield Glen H., Besterfield Mary, Urdhwareshe Hemant, UrdhwaresheRashmi. "Total Quality Management", 5th Edition, Pearson Education, Noida, 2018.

REFERENCES:

1.	Subburaj Ramasamy, "Total Quality Management", McGraw Hill Education, New Delhi, 2017.
2.	James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, Cengage Learning, 2012.
3	David Goetsch & Stanley Davis, "Quality Management for Organizational Excellence: Introduction to Total Quality", 8th Edition, Pearson, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the evolution of TQM principles.	Applying (K3)
CO2	illustrate the principles and strategies of TQM	Applying (K3)
CO3	make use of various tools and techniques of quality management	Applying (K3)
CO4	apply various quality tools and techniques in both manufacturing and service industry	Applying (K3)
CO5	explain the concepts of quality management system and ISO.	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	2	3	2	2	1	1		3
CO2	1	1				3	2	3	3	3	1	1	2	3
CO3	3	2	2	2	2	2		1	2	2	1	1	1	3
CO4	2	2	2	2	2	2		1	2	2	1	1	2	3
CO5						3	3	2	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	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)**

20CHE21 - NUCLEAR ENGINEERING 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 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)**

20CHE22 - NUMERICAL TECHNIQUES IN CHEMICAL ENGINEERING

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

Preamble	This course will enable the students to understand and apply various numerical techniques for solving chemical engineering problems	
Unit - I	**Solutions to Transcendental equations and Eigen value problems:**	**9**
Solution of equations – iteration method – Newton-Raphson Method – solution of linear system by Gaussian elimination and Gauss-Jordan method – iterative methods – Gauss-Jacobi and Gauss-Seidel methods – inverse of a matrix by Gauss-Jordon method –finding the Eigenvalue of a matrix by power method.		
Unit – II	**Interpolation:**	**9**
Lagrange's interpolating polynomials – interpolation with equal intervals – Newton's forward and backward difference formulae – central difference formulae – interpolation with unequal intervals – divided differences – Newton's divided difference formula.		
Unit - III	**Numerical Differentiation and Integration:**	**9**
Differentiation using interpolation formulae – numerical integration by trapezoidal and Simpson's 1/3 and 3/8 rules – Romberg's method – two and three point Gaussian quadrature formulae – double integrals using Trapezoidal and Simpson's rules.		
Unit - IV	**Numerical solutions of Ordinary Differential Equations:**	**9**
Single-step methods – Taylor series method – Euler method for first order equation – Fourth order Runge-Kutta method for solving first and second order equations – multi-step methods – Milne's and Adam's predictor-corrector methods.		
Unit - V	**Numerical Solutions of Partial Differential Equations:**	**9**
Classification of second order PDE - finite-difference approximations to partial derivatives – solution of Laplace and Poisson equations – solution of one-dimensional heat equation – solution of two-dimensional heat equation - solution of wave equation.		

Total: 45

TEXT BOOK:

1.	S.S. Sastry, Introductory Methods of Numerical Analysis, 4th Edition, PHI Learning Private Limited, New Delhi, 2007.

REFERENCES:

1.	Kenneth J Beers, "Numerical Methods for Chemical Engineering–Applications in MATLAB" Cambridge University Press, New York, USA, 2007.
2.	John H. Mathews and Kurtis D. Fink, "Numerical Methods using MATLAB", 4th Edition, PHI Learning Private Limited, New Delhi, 2007.
3.	B.S. Grewal, "Numerical methods in Engineering and Science – C,C++, and MATLAB, 2018, Mercury Learning and Information LLC, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply various numerical methods to solve transcendental equations and Eigenvalue problems	Applying(K3)
CO2	utilize interpolation method for solving problems involved in chemical systems	Applying(K3)
CO3	apply the differentiation and integration equations using numerical methods	Applying(K3)
CO4	solve ordinary differential equations using numerical techniques	Applying(K3)
CO5	Develop solutions for partial differential equations used in chemical engineering systems	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							2		
CO2	3	3	2	2	1							2		
CO3	3	3	2	3	1							2		
CO4	3	3	3	3	1							2		
CO5	3	3	3	3	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		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**

20CHE23 - 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 – ASTM distillation, Reid vapor pressure, Octane number, Oxidation stability, Sulfur, Carbon content, Pour point, Smoke point, Fire point, Flash point, Aniline point		
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 braking, 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	elucidate the formation, classification and properties of petroleum	Applying (K3)
CO2	explain the crude properties and test methods for petroleum	Applying (K3)
CO3	describe the various production and treatment techniques	Understanding (K2)
CO4	exemplify the various upgradation processes like cracking	Understanding (K2)
CO5	describe the process of asphalt technology and oil spill 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	1					1						2	2
CO2	3	1					1						2	2
CO3	3	1					1						2	2
CO4	3	1					1						2	2
CO5	3	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	20	70	10				100
CAT2	20	70	10				100
CAT3	30	70					100
ESE	20	70	10				100

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

20CHE24 - INDUSTRIAL WASTEWATER TREATMENT

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

Preamble	To promote understanding of basic and advanced concepts in Industrial wastewater treatment technologies	
Unit – I	**Sources and types of Industrial Wastewater:**	**9**
Sources and types of industrial wastewater – Characterization: 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, Mixing and flocculation, Equalization, Gravity separation, Grit removal, Sedimentation, Neutralization, Clarification, Flotation. Role of Chemical unit operations in wastewater treatment, Chemical unit Process: Chemical Coagulation, Chemical Precipitation- Heavy metal Removal, Phosphorus removal, Chemical oxidation, Chemical Neutralization and stabilization		
Unit – III	**Biological Treatment:**	**9**
Composition and Classification, Bacterial growth, Microbial growth, Aerobic biological oxidation, biological Nitrification, 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 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 effluent discharge systems -Wastewater reuse – Disposal of effluent on land – Quantification, characteristics and disposal of Sludge. Industrial process description, 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", 1st Edition, McGraw Hill Book Co, 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 and types of Industrial Wastewater	Understanding (K2)
CO2	apply 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	2					3						3	2
CO2	3	2	2				3				1		3	2
CO3	3	1	2				3						3	2
CO4	3	2	2		2		3					2	3	3
CO5	3	2	2				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	30	70					100
CAT2	30	70					100
CAT3	30	50	20				100
ESE	30	60	10				100

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

20CHE25 - PIPING ENGINEERING

Programme & Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fluid Mechanics**	**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 BOOKS:

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.

REFERENCE:

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	3	1		1							1	3	1
CO2	3	3	1		2							1	3	1
CO3	3	3	1		1							1	3	2
CO4	3	3	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	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)**

20CHE26 - BATTERY AND FUEL CELL TECHNOLOGY

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	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.

REFERENCE:

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	describe 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	describe 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	2	1
CO2	3	2										2	2	1
CO3	3	2										2	2	1
CO4	3	2										2	2	1
CO5	3	2										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)**

20CHE27 - FLUID MOVERS

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	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 BOOKS:

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	1										1	3	2
CO2	3	1										1	3	2
CO3	3	1										1	3	2
CO4	3	1										1	3	2
CO5	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	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)**

20CHE28 - ADVANCED PROCESS CONTROL

Programme & Branch	**B.TECH. – Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**8**	**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	3	1									2	3	1
CO2	3	3	1									2	3	1
CO3	3	3	2									2	3	1
CO4	3	3	2									2	3	1
CO5	3	3	1		1							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	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)**

20CHE29 - ORES AND MINERAL PROCESSING

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Mechanical Operations	8	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	describe the various comminution and solid screening techniques	Understanding (K2)
CO3	explain the aspects of gravity concentration techniques	Understanding (K2)
CO4	illustrate the importance of froth flotation in ore processing	Understanding (K2)
CO5	describe the various electro and magnetic separation 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		1			2	2					1	1
CO2	3	2		1			2	2					1	1
CO3	3	2		1			2	2					1	1
CO4	3	2		1			2	2					1	1
CO5	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	30	70					100
CAT3	30	70					100
ESE	30	70					100

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

20CHE30 - POLYMER TECHNOLOGY

Programme & Branch	B.TECH. – Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	PE	3	3	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 BOOKS:

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	describe the structure and properties of polymers	Understanding (K2)
CO3	explain the properties and manufacturing processes of polymers	Understanding (K2)
CO4	apply the characterization techniques for polymers using microscopic and spectroscopic instruments	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	2	1	3				2						1	2
CO2	2	1	3				2						1	2
CO3	2	1	3				2						1	2
CO4	3	2	3				2						3	2
CO5	2	1	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	30	70					100
CAT2	30	70					100
CAT3	20	60	20				100
ESE	20	70	10				100

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

20GEO011 ENTREPRENEURSHIP DEVELOPMENT

(Common to all Engineering and Technology Branches)

Programme& Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	Process Engineering and Economics	6	EC	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.		
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		1
CO2	1	2	2	2		2	2	1	1		3	2		2
CO3	2	2	2	2	2	2	2	2	2	2	3	2		1
CO4	1	1	2	1		2	1	1	1	2	3	2		1
CO5	1	1	2	1		2	1	1	1	2	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	40	40				100
CAT2	20	30	30	20			100
CAT3	30	30	40				100
ESE	20	30	40	10			100

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

20CHO01 - DRUGS AND PHARMACEUTICALS TECHNOLOGY
(Offered by Department of Chemical Engineering)

Programme & Branch	All BE\B.TECH. branches except Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	OE	3	1	0	4

Preamble	To gain knowledge in formulation and manufacturing of drugs and its quality analysis.	
Unit - I	**Principles and Kinetics:**	**9+3**
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+3**
Chemical Conversion process- alkylation, carboxylation, condensation and cyclisation, dehydration, esterification, halogenation, oxidation and sulfonation reactions.		
Unit - III	**Drug Delivery Systems:**	**9+3**
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+3**
Vitamins-Functions, laxatives-classification and uses, analgesics-Types and Mechanisms, antacids and antiseptics-classification, mechanism and applications.		
Unit - V	**Quality Control:**	**9+3**
Concept of quality control-IPQC tests for tablets, Quality analysis - raw materials, process and finished products. Good Manufacturing Practices-cGMP,FDA regulations.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1.	Brahmankar D.M. and Sunil B. Jaiswal, "Biopharmaceutics and Pharmacokinetics: A Treatise", 1st Edition, Vallabah Prakashan, India, 2017.

REFERENCES:

1.	Arthur Owen Bentley, "Text book of Pharmaceutics", 8th Edition Edition, All India Traveller Book Seller, New Delhi, 2002.
2.	Banker G.S. and Rhodes C.T, "Modern Pharmaceutics", 4th Edition Edition, Marcel Dekker Inc, New York, 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	describe the manufacturing processes of different types of pharmaceutical products	Understanding (K2)
CO5	elaborate 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	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)**

20CHO02 - PROCESS AUTOMATION
(Offered by Department of Chemical Engineering)

Programme & Branch	All BE\B.TECH. branches except Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	OE	3	1	0	4

Preamble	This course provides basic knowledge about the process automation techniques in process industries	
Unit - I	**Introduction to process instrumentation:**	**9+3**
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+3**
Basic concepts - terminology and techniques for process control - control modes - controller design - Tuning process controllers		
Unit - III	**Advanced Control Systems:**	**9+3**
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+3**
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+3**
z transforms - function ad Applications; discrete time response of dynamic systems, design of digital feedback controllers - Introduction to SCADA		

Lecture:45, Tutorial:15, Total:60

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	3	1									2		
CO2	3	3	1									2		
CO3	3	3	2									2		
CO4	3	3	2									2		
CO5	3	3	1		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	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)**

20CHO03 - RENEWABLE BIO ENERGY RESOURCES
(Offered by Department of Chemical Engineering)

Programme & Branch	**All BE\B.TECH. branches except Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course will help students to gain knowledge in the available bio energy and the present conversion techniques.	
Unit - I	**Bio Energy Resources**	**9+3**
Introduction: Sources of Biomass – Crop residue, fuel wood, aquatic biomass, sugar crops, oil crops, animal manure, municipal solid waste and energy forming. Properties of biomass resources		
Unit – II	**Types of bio fuel technologies**	**9+3**
Bio-diesel: Composition, Properties, Extraction, Refining and Trans-esterification. Bioethanol: Production from sugar and starchy crops, Cellulosic biomass, ethanol production systems. Biogas: Technology of hydrolysis, Aerobic and Anaerobic processes		
Unit - III	**Torrefaction and Pyrolysis**	**9+3**
Torrefaction: Introduction, Challenges, Products of Torrefaction, Biochar, Properties of Torrefaction products. Pyrolysis: Types of Pyrolysis, Processes, Bio oil and its properties		
Unit - IV	**Gasification and Liquefaction**	**9+3**
Gasification: Introduction, Types of gasifiers and its applications, Introduction to advanced gasifiers. Liquefaction: Introduction, Indirect, Direct and other biomass liquefaction processes.		
Unit - V	**Biomass Combustion technologies**	**9+3**
Introduction, Types of biomass combustion systems, Applications of biomass combustion systems, Sustainability issues and challenges.		

Lecture: 45, Tutorial:15, Total:60

TEXT BOOK:

1.	Sergio C Capareda, “Introduction to Biomass Energy Conversion”, 1st Edition, CRC Press, United Kingdom, 2013

REFERENCE BOOKS:

1.	Mukunda, H.S, "Understanding clean energy and Fuels from biomass", 1st Edition, Wiley India Pvt Ltd, New Delhi, 2012.
2.	Nijaguna, B.T, "Biogas Technology", 1st Edition, New age International, India, 2002.
3.	Lijun wang, "Sustainable bioenergy production", 1st Edition, CRC Press, United State of America, 2014.
4.	Sunggyu Lee, Y.T.Shah, "Bio fuels and bio energy; process and technologies", 1st Edition, CRC Press, United State of America, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the various sources of biomass and their properties	Applying (K3)
CO2	illustrate the different technologies for production of bio-energy	Applying (K3)
CO3	explain the technologies of torrefaction and pyrolysis of biomass	Applying (K3)
CO4	demonstrate the processes of gasification and liquefaction of biomass	Applying (K3)
CO5	describe the technologies of combustion of biomass	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					1		
CO2	3	2	2	2		2	2					1		
CO3	3	2	2	2		2	2					1		
CO4	3	2	2	2		2	2					1		
CO5	3	2	2	2		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)**

20CHO04 - INTELLIGENT CONTROLLERS
(Offered by Department of Chemical Engineering)

Programme & Branch	All BE\B.TECH. branches except Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	**5**	**OE**	**3**	**1**	**0**	**4**

Preamble	This course will help students to gain knowledge in the available bio energy and the present conversion techniques.	
Unit - I	**Fuzzy Logic Control**:	**9+3**
Need for FLC, Mamdani type FLC ,steps in the design of FLC, Fuzzification, Decision making Logic, Rule based logic and de-fuzzification interface. Simulation examples, FLC of a reactor, Development of Fuzzy Estimator, Multi level control using Fuzzy Logic. Fuzzy logic tuned PI controller.		
Unit – II	**T-S fuzzy model**:	**9+3**
Model structure, TS model from input output data, TS model from model using linearization method, TS model based control		
Unit - III	**Artificial Neural Network based Control**:	**9+3**
Architecture of ANN, supervised learning, Weights and Hidden Layers, Back Propagation algorithm, Control scheme based on ANN. Simulation examples.		
Unit - IV	**RBFN:**	**9+3**
Radial basis function, Learning in RBFN, Pseudo inverse technique, Gradient descent algorithm, examples, RBFN versus Multi stage network Controller Design for a T-S Fuzzy model ; Linear controllers using T-S fuzzy model.		
Unit - V	**Learning Automata**:	**9+3**
Principles of learning Automata, Steps in Learning Automata(LA) based control, Performance specification, Initial Probability assignment, Reward and penality. Probability modification, Simulation application on a reactor, LA tuned PI controllers.		

Lecture:45; Tutorial : 15; Total: 60

TEXT BOOKS:

1. Behera, L. and Indirani Kar, “Intelligent systems and control: principles and applications”, Oxford University Press, New Delhi, 2009 for units II, III & IV.
2. M.Chidambaram, “Applied Process Control”, Allied Publishers, New Delhi, 1998 for units I & V.

REFERENCES:

1. Cai,Z-X, “Intelligent Control: Principles, Techniques and Applications”, Word Scientific, Singapore 1997.
2. M.Chidambaram, Computer Control of Processes, Narosa Publications, New Delhi,2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Understand the concept of Fuzzy Logic Control	Understanding (K2)
CO2	Use of T-S model based control	Understanding (K2)
CO3	Develop ANN model and its use for controller	Understanding (K2)
CO4	Development of Radial basis function NN	Understanding (K2)
CO5	Design controllers using Learning automata	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		1						2		
CO2	1		2	3		1						2		
CO3	2		2	3		1						2		
CO4	2		2	3		1						2		
CO5	3		3	3		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	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)**

20CHO09 - INDUSTRIAL ENZYMOLOGY							
(Offered by Department of Chemical Engineering)							
Programme & Branch	**All BE/BTech Branches except Chemical Engg.**	**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. (Unit I, II, III)
2.	Robert J. Whitehurst & Maarten van Oort, "Enzymes in Food Technology", 2nd Edition, John Wiley & Sons, UK, 2009. (Unit IV, V)

REFERENCES:

1.	Ed Godfrey and West, Industrial Enzymology- Macmillan Press Ltd 2nd edition, 1996.
2.	Muthusamy Chandrasekaran, "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 fundamental concepts of economics and forecasting in food processing	Understanding (K2)
CO2	analyze the cost economics in food industry	Analyzing (K4)
CO3	make use of market equilibrium and interpret national income calculation and inflation issues	Applying (K3)
CO4	apply the management principles in food processing	Applying (K3)
CO5	outline the organizational structure and its types.	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	2		
CO2	3	2	2							2	2	2		
CO3	3	2	2							1	1	2		
CO4	3	2	1							2	2	2		
CO5	3	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) %	Tota l %
CAT1	20	40	20	20			100
CAT2	20	20	40	20			100
CAT3	20	40	40				100
ESE	20	40	30	10			100

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

20CHO10 - WASTE TO ENERGY CONVERSION								
(Offered by Department of Chemical Engineering)								
Programme & Branch	**All BE/BTech Branches except Chemical Engg.**	**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**
Overview of waste management and the importance of waste-to-energy conversion; Types of wastes and their characteristics; Overview of energy conversion technologies and their applications in waste-to-energy.		
Unit - II	**Waste Characterization and Analysis**	**9 + 3**
Methods for waste characterization and analysis; Techniques for determining waste composition and energy content; Principles of waste reduction, reuse, and recycling; Collection and transport systems for solid, liquid, and gaseous wastes; Waste storage, handling techniques and hazards associated.		
Unit - III	**Thermal and Biological Conversion Technologies**	**9 + 3**
Incineration and pyrolysis processes; Gasification and plasma arc gasification; Anaerobic digestion and biogas production; Composting and vermiculture - Operation, and optimization of thermal and biological conversion systems		
Unit - IV	**Chemical Conversion Technologies**	**9 + 3**
Hydrogen production from waste; Synthesis of fuels and chemicals from waste streams - Operation, and optimization of chemical conversion systems		
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	apply methods for waste characterization and analysis to determine waste composition and energy content	Applying (K3)
CO3	describe the basic principles of incineration, pyrolysis, gasification, plasma arc gasification, anaerobic digestion, biogas production, composting, and vermiculture processes	Understanding (K2)
CO4	summarize the principles of hydrogen production and synthesis of fuels and chemicals from waste streams	Understanding (K2)
CO5	express the 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	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	60	10				100
CAT2	30	60	10				100
CAT3	30	70					100
ESE	30	60	10				100

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

20CHO11 - APPLIED NANOTECHNOLOGY							
(Offered by Department of Chemical Engineering)							
Programme & Branch	**All BE/BTech Branches except Chemical Engg.**	**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, Applications of Nanocomposites		
		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	estimate the physicochemical characteristics of nanomaterials	Applying (K3)
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 nanocomposite 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		
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	30	60	10				100
CAT2	30	60	10				100
CAT3	20	80					100
ESE	30	60	10				100

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

20CHO05 - FOOD AS MEDICINE
(Offered by Department of Chemical Engineering)

Programme & Branch	All BE\B.TECH. branches except Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	0	0	3

Preamble	This course will deal about the importance of nutrients and its assimilation for different age groups to prevent diseases.	
Unit - I	**Food and Nutrition:**	**9**
Food groups, food guide pyramid and its importance, foods as a source of nutrients Relationship of nutrition to health, growth and human welfare; Definitions of terms used in nutrition -Recommended dietary allowances; balanced diet; health; functional food; phytochemicals; nutraceuticals; dietary supplements. Nutrition and Diabetes.		
Unit - II	**Energy and Body Composition:**	**9**
Energy -Units, sources and requirements, fuel value of foods, Methods of measuring energy value of food, Energy requirement of body, physical activity and thermogenic effect of food, BMR -methods of measurement, factors affecting BMR. Body composition – Five levels of body composition – body composition techniques. Obesity. Factors to be considered in meal/menu planning. Factors affecting food intake and nutrients use, nutrient needs, nutrition related		
Unit - III	**Nutrition deficiency:**	**9**
Digestion and absorption of carbohydrates, fats and proteins. Carbohydrates -Types, functions, sources, requirement, health conditions affected by carbohydrates, Significance of dietary fibre Lipids -Types, functions, sources, requirement, health problems associated with lipids 7 Proteins -types, functions, sources, requirement, quality evaluation, improvement, deficiency disorders and protein energy malnutrition.		
Unit - IV	**Nutraceuticals in Health care**	**9**
Sources, understanding benefits of nutraceuticals. Scope involved in industry, Indian and global scenario. Eye health ingredients – lutein, zeaxanthin, astaxanthin, beta-carotene, bilberry extracts; Heart health ingredients - omega-3, omega-6, omega-9, beta-glucan, soy protein, phytosterols; Digestive Health Ingredients – prebiotics, probiotics, synbiotics, digestive enzymes, zinc carnosine. Women health ingredients - Vitamin D, iron, calcium, soy isoflavones, folic acid, cranberry extract, lycopene, phytoestrogens.		
Unit - V	**Functional Foods in Health care:**	**9**
Introduction to dietary supplements, Dietary supplements – Need for dietary supplements, supplements forms- tablets, capsules, powders, soft gels, gel caps, liquids. Agnus castus, Aloe vera, Bee products, Chitosan, Echinacea, Garlic, Ginger, Ginkgo biloba, Ginseng, Guarana, Kelp, Milk thistle, Saw palmetto, Spirulina, Chlorella, Hypericum perforatum, Tea extracts, Super Foods.		

Total:45

TEXT BOOK:

1.	Mann Jim and Stewart Truswell (Eds), “Essentials of Human Nutrition”, 5th Edition, Oxford University Press, Oxford, 2017.

REFERENCES:

1.	Wildman, Robert E.C.,Robert Wildman, Taylor C. Wallace(Eds)., “Handbook of Nutraceuticals and Functional Foods”, 2nd Edition, CRC Press, New York, 2007.
2.	John Shi, Chi-Tang Ho and Fereidoon Shahidi., “Asian Functional Foods”, 1st Edition, CRC Press, 2005

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the physiological and metabolic functions of nutrients	Understanding(K2)
CO2	explain the energy value of foods and body composition	Understanding(K2)
CO3	examine the nutrition requirement based on different age groups	Applying(K3)
CO4	identify the suitable nutraceutical for different deficiencies	Applying (K3)
CO5	select appropriate functional foods based on their health effects	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						2		
CO2	3	3	2	2		3						2		
CO3	3	3	2	2		3						2		
CO4	3	3	2	2		3						2		
CO5	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	50	50					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)**

20CHO06 - ORGANIC FARMING
(Offered by Department of Chemical Engineering)

Programme & Branch	All BE\B.TECH. branches except Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	0	0	3

Preamble	This course introduces the foundations of organic farming and its considerations	
Unit - I	**Organic Farming:**	**9**
Concept and definition, Organic vs Natural farming, Essential Characteristics, Principles, Objectives, Options in organic farming, Management and advantages of organic farming, components of organic farming. Green Manuring: Introduction, definition, objectives, classification, characteristics, choice, forms and Agronomy of green manure crops.		
Unit – II	**Nutrient Management in Organic Farming:**	**9**
Introduction, Concept and definition, different types of manures, Vermicomposting, benefits of vermicompost, applications.		
Unit - III	**Management in organic farming:**	**9**
Pest management: Introduction, Cultural methods, mechanical methods, biological methods. Weed management: Introduction, preventive methods, cultural, mechanical, soil solarization, biological methods, allelopathy.		
Unit – IV	**National Standards:**	**9**
NPOP, National structure, operational structure, National Standards for organic farming. Certification: Introduction, Standards and Regulations, Accreditation Processing method,		
Unit - V	**Economic considerations:**	**9**
Viability of organic farming, marketing and export potential, transition period, major products produced in India by organic farming		

Total:45

TEXT BOOK:

1.	Palaniappan SP, Annadurai K, “Organic Farming: Theory and Practice”, 7th Edition, Scientific Publishers, Jodhpur, India, 2018

REFERENCES:

1.	Somasundaram E, Udhaya Nandhini D, Meyyappan M, “Principles of Organic Farming”, 1st Edition, CRC Press, London, 2021.
2.	Sarath Chandran, Unni MR, Sabu Thomas, “Organic Farming- Global Perspectives and Methods”, Woodhead Publishing, UK, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	deduce the importance of organic farming and green manure	Understanding(K2)
CO2	explain the process of vermi-composting and its benefits	Understanding(K2)
CO3	classify different methods applicable for pest and weed management	Understanding(K2)
CO4	enumerate the roll of national standards on organic farming	Understanding(K2)
CO5	describe the market and economic consideration of organic farming products	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			3	3	2	2		2	3		
CO2	2	2	2			3	3	2	2		2	3		
CO3	2	2	2			3	3	2	2		2	3		
CO4	2	2	2			3	3	2	2		2	3		
CO5	2	2	2			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	30	70					100
ESE	30	70					100

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

20CHO12 - AIR POLLUTION MONITORING AND CONTROL							
(Offered by Department of Chemical Engineering)							
Programme & Branch	**All BE/BTech Branches except Chemical Engg.**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**6**	**OE**	**3**	**0**	**0**	**3**

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**
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	**Ambient Air Quality Monitoring**	**9**
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**
Incinerators, Absorbers, Thermal oxidizers, Gravity settling chambers –classifications, operation, typical applications and suggestions for improvement		
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

TEXTBOOK:

1.	Karl B. Schnelle, Jr., Russell F. Dunn, Mary Ellen Ternes “Air Pollution Control Technology Handbook”, 2nd Edition, CRC Press, 2017. (Unit I, III)
2.	Louis Theodore, Anthony J. Buonicore, "Air Pollution Control Equipment Calculations”, 1st Edition, Wiley, USA, 2008. (Unit II, IV, V)

REFERENCES:

1.	Rao M.N. and Rao H.V.N, "Air Pollution", 1st Edition, 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	Understanding (K2)
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)

20CHO13 - PAINTS AND COATINGS							
(Offered by Department of Chemical Engineering)							
Programme & Branch	**All BE/BTech Branches except Chemical Engg.**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**6**	**OE**	**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

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	describe 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	1	1				1							
CO2	3	2	1				1							
CO3	3	2	1				1							
CO4	3	2	1				1							
CO5	3	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	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)

20CHO14 - POWDER TECHNOLOGY								
(Offered by Department of Chemical Engineering)								
Programme & Branch	**All BE/BTech Branches except Chemical Engg.**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**6**	**OE**	**3**	**0**	**0**	**3**

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**
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**
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**
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**
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**
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.		
		Total:45

TEXTBOOK:

1.	Hiroaki Masuda, Ko Higashitani, 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	describe various particle size characteristics and its measurement techniques	Understanding (K2)
CO2	explain different particle shape characteristics and its measurement methods	Understanding (K2)
CO3	summarize various fundamental properties of particles	Understanding (K2)
CO4	explain the fundamentals of techniques available for particle generation	Understanding (K2)
CO5	describe 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)

20CHO07 - COSMETICS AND PERSONAL HEALTH CARE PRODUCTS

(Offered by Department of Chemical Engineering)

Programme & Branch	**All BE\B.TECH. branches except Chemical Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**8**	**OE**	**3**	**0**	**0**	**3**

Preamble	This course is used to know about the preparation methods and uses of different cosmetics and personal health care products.	
Unit - I	. **Introduction to Cosmetics:**	**9**
Introduction, examples, uses, types. Lipsticks: Ideal Characteristics, Formulation, types of natural waxes, merits and demerits. Colouring Agents, Preparation of lipsticks, methods of preparation, evaluation of lipsticks, shampoo-types and formulation, preparation methods, evaluation of shampoos. Tooth paste: General requirements, formulation, preparation and evaluation of tooth pastes.		
Unit - II	**Types and preparation of powders, creams and hair dryers:**	**9**
Introduction, characteristics, formulation and classification of powders, Evaluation of powders, Creams: classification, preparation and evaluation of creams. Hair dryers: types, formulation and evaluation of hair colourant.		
Unit - III	**Introduction to Nail Care and herbal cosmetic products:**	**9**
Basics- Cleansing- Hand, Foot, and Nail Treatments-Hand and Nail Cream-Hand Lotion-Cuticle Conditioners and Moisturizers-Cuticle Removers; Professional Salon Products- preservice sanitization, manicure and pedicure procedure, Hand Soaks and Foot Soaks; protective colloids; Waterborne nail polish, herbal medicinal plants and their uses in different cosmetic products - Aloe, Neem, Tulsi,Turmeric, Cucumber, Lemon, Orange, Multani Mitti, Sandal, Rose, honey, Glycerine.		
Unit - IV	**Pigment Dispersions and Surfactants in Personal Care Products:**	**9**
A Brief Introduction to Pigment; properties; Dispersion process- Pigment Wetting, Particle De-aggregation and De-agglomeration; Dispersion Stabilization; Ways and Benefits of Using Pigments to Formulate Cosmetic Products; Hydrocarbons in Pigmented Products: Color Cosmetics, Petroleum Products, Pigments and Dyes, Mineral Oil, Petrolatum, and Mineral Waxes, Eye Makeup. Surfactants: Adverse Effects of Surfactants; Encapsulation; Nanoparticles in cosmetic industry.		
Unit - V	**Consumer Research and Ethics in the Development and Restaging of Personal Care Products:**	**9**
Broad Classes of Consumer Research: Primary and Secondary research- Competitive and Business Analysis; Outsourcing the Market Research Function. Ethical responsibilities in formulating, marketing, and using antimicrobial personal products; Ethics, aesthetics, and health; Responsibilities of individuals, organizations; other humans and ourselves; Legal liability, public health approach.		

Total: 45

TEXT BOOK:

1.	Gaurav Kumar Sharma, Jayesh Gadiya, Meenakshi Dhanawat , “A Textbook of Cosmetic Formulations (e-book)” , Pothi publishers, 2018.

REFERENCES:

1.	Martin J. Schick, Arthur T. Hubbard, “Surfactants in Personal Care Products and Decorative Cosmetics, 3rd Edition, Vol 135, CRC press, Taylor & Francis group, 2006.
2.	Nava Dayan and Philip W. Wertz, Innate Immune System of Skin and Oral Mucosa, Properties and Impact in Pharmaceutics, Cosmetics, and Personal Care Products, Edited by, John Wiley & sons publications, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Learn about various characteristics, preparation methods and evaluation of various cosmetics.	Understanding
CO2	Know about types and preparation of powders, creams and hair dryers and their selection.	Understanding
CO3	Study the treatment technologies for nail care and manufacturing methods of herbal	Understanding
CO4	Learn about pigment dispersion methods and surfactants in personal care products	Understanding
CO5	Describe Consumer Research and Ethics in the Development and Restaging of Personal Care Products	Applying

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		
CO2	3		1			2						1		
CO3	3		1			2						1		
CO4	3		1			2						1		
CO5	3		1			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	50	50					100
CAT2	50	50					100
CAT3	30	30	40				100
ESE	35	35	30				100

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

20CHO08 - BREWING AND ALCOHOL TECHNOLOGY
(Offered by Department of Chemical Engineering)

Programme & Branch	All BE\B.TECH. branches except Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	OE	3	0	0	3

Preamble	This course helps the students to understand the fermentation process for the production of Beer, Whisky Production and Distilled Beverages	
Unit - I	**Introduction to Fermentation and Distillation:**	**9**
History and development of Alcoholic Beverages. Fermentation, types of fermentations and role of microorganism and other condition on fermentation. Distillation fundamentals and it types.		
Unit - II	**Distillery Feed Stock:**	**9**
Distillery feed Stock. Feed stock selection, parameters influencing selection, fermentable sugars. Criteria for selection of molasses for production of ethanol. Alternative feedstock for the process and feedstock flexibility.		
Unit - III	**Whisky Production:**	**9**
Malt and Grain distilling- Raw Materials, Specification and Process Description. Malting, Beating and Mashing.		
Unit - IV	**Beer Production:**	**9**
Yeast Handling and Management, Post-Fermentation Treatment of Yeast, Milling of malt and adjuncts, Mashing, Lautering, Wort boiling, Wort aeration and wort colling.		
Unit - V	**Distilled Beverages:**	**9**
Rum, Gin, Tequila, Vodka and Brandy - Raw material, Composition and Production.		

Total: 45

TEXT BOOK:

1.	K.A. Jacques,T.P. Lyons and D.R. Kelsall, " The Alcohol Textbook ",4th Edition, Nottingham University Press, 2003.

REFERENCES:

1.	A.C. Chatterjee, B.M.Dutt, “Hand Book of Fermentation & Distillation” Poona Maharashtra Sugar Research Foundation”, 1977.
2.	A.J.Buglass, “Handbook of Alcoholic Beverages: Technical, Analytical and Nutritional Aspects”, 1st Edition, Wiley, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	familiarize in distillery fermentation and distillation process	Understanding (K2)
CO2	understand distillery feed stock processes	Understanding (K2)
CO3	examine the production of whisky	Applying (K3)
CO4	examine the production of beer	Applying (K3)
CO5	categorize the various types of distillery beverages	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												
CO2	3	2												
CO3	3	1												
CO4	3	2												
CO5	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	20	40	40				100
CAT2	10	45	45				100
CAT3	10	45	45				100
ESE	20	50	30				100

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

20CHO15 – HYDROGEN ENERGY							
(Offered by Department of Chemical Engineering)							
Programme& Branch	**All BE/BTech Branches except Chemical Engg.**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**8**	**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	describe the different production processes	Understanding (K2)
CO3	illustrate the chemical and physical properties which are required for storage of Hydrogen	Understanding (K2)
CO4	discuss major utilization of hydrogen energy in various sectors	Understanding (K2)
CO5	explain various risk analysis and safety protocols	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)

20CHO16 - INDUSTRIAL ACCIDENT PREVENTION AND MANAGEMENT								
(Offered by Department of Chemical Engineering)								
Programme & Branch	**All BE/BTech Branches except Chemical Engg.**	**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 of housekeeping. 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 Gas 5 welding 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, New York, 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 different issues in construction industries	Understanding (K2)
CO4	describe various hazards associated with different machines and mechanical material handling.	Understanding (K2)
CO5	utilize different hazard identification tools in different industries with the knowledge of different 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	2	1				3	3	3	2	1	1	3		
CO2	2	1	2			3	3	3	2	1	1	3		
CO3	2	2	2	2		3	3	3	2	1	1	3		
CO4	2	2		2		3	3	3	2	1	1	3		
CO5						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	70	10				100
CAT2	20	70	10				100
CAT3	20	70	10				100
ESE	20	70	10				100

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

20CHO17 - ELECTROCHEMICAL ENGINEERING								
(Offered by Department of Chemical Engineering)								
Programme & Branch	**All BE/BTech Branches except Chemical Engg.**	**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	describe 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	describe 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)

<table>
<tr><td colspan="8">20CHO18 - SMART AND FUNCTIONAL MATERIALS</td></tr>
<tr><td colspan="8">(Offered by Department of Chemical Engineering)</td></tr>
<tr><td>Programme& Branch</td><td>All BE/BTech Branches except Chemical Engg.</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>8</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">To acquire knowledge on smart and intelligent materials, their synthesis method and their applications in various fields</td></tr>
<tr><td>Unit – I</td><td colspan="6">Smart Materials and Structures</td><td>9</td></tr>
<tr><td colspan="8">Introduction, System intelligence- components and classification of smart structures, common smart materials and associated stimulus-response, Application areas of smart systems.</td></tr>
<tr><td>Unit - II</td><td colspan="6">Ferroelectric Materials</td><td>9</td></tr>
<tr><td colspan="8">Introduction, Piezoelectric materials- piezoelectric effect, Direct and converse, parameter definitions, Piezoceramics, Piezopolymers, Piezoelectric materials as sensors, Actuators and bimorphs.</td></tr>
<tr><td>Unit - III</td><td colspan="6">Shape Memory Materials</td><td>9</td></tr>
<tr><td colspan="8">Introduction, Shape memory effect, Martensitic transformation, One way and two-way SME, training of SMAs, binary and ternary alloy systems, Functional properties of SMAs.</td></tr>
<tr><td>Unit – IV</td><td colspan="6">Smart Hydrogels</td><td>9</td></tr>
<tr><td colspan="8">Introduction, Synthesis, Fast responsive hydrogels, Molecular recognition, Smart hydrogels as actuators, Controlled drug release, Artificial muscles, Hydrogels in microfluidics.</td></tr>
<tr><td>Unit – V</td><td colspan="6">Smart systems for space applications</td><td>9</td></tr>
<tr><td colspan="8">Introduction, Elastic memory composites, Smart corrosion protection coatings, Self-healing materials, Sensors, Actuators, Transducers, MEMS, Deployment devices, Molecular machines.</td></tr>
<tr><td colspan="8" align="right">Total:45</td></tr>
<tr><td colspan="8">TEXT BOOK:</td></tr>
<tr><td>1.</td><td colspan="7">Schwartz. M, “New Materials, Processes, and Methods Technology”, CRC Press, 2006. (Unit I, II, III)</td></tr>
<tr><td>2.</td><td colspan="7">D.J. Leo, “Engineering Analysis of Smart Material Systems”, Wiley 2007. (Unit IV, V)</td></tr>
<tr><td colspan="8">REFERENCES:</td></tr>
<tr><td>1.</td><td colspan="7">Yui. N, Mrsny. R.J, “Reflexive Polymers and Hydrogels: Understanding and Designing Fast Responsive Polymeric Systems”, CRC Press, 2004.</td></tr>
<tr><td>2.</td><td colspan="7">Ball. P,”Made to Measure: Materials for the 21st Century”, Princeton University Press, 1997.</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	recall 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)

20GEO01 – 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	**Basics of Language**	**4,5,6,8**	**HS**	**4**	**0**	**0**	**4**

Preamble	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.	
Unit - I	**Contacts (Kontakte):**	**12**
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.		
Unit - II	**Accommodation (Die Wohnung):**	**12**
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		
Unit - III	**Working Environment Communication (ArbeitenSie):**	**12**
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*.		
Unit - IV	**Clothes and Style (Kleidung und mode) :**	**12**
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.		
Unit - V	**Health and Vacation (Gesundheit und Urlaub):**	**12**
Personal information, Human Body parts, Sports, Understanding instructions and prompts, health tips. Grammar – Imperative with *du/Ihr*, Modal verbs – sollen, müssen, nichtdürfen, 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, ZumSchl*		

Total:60

TEXT BOOK:

1.	“Stefanie Dengler, Paul Rusch, Helen Schmitz, TanjaSieber, “Netzwerk Deutsch alsFremdsprache A1–ursbuch, Arbeitsbuch und Glossar with 2 CDs”, Goyal Publishers, Delhi, 2015.

REFERENCES:

1.	https://ocw.mit.edu – Massachusetts Institute of Technology Open Courseware Refer: German 1 for undergraduate students
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	understanding letters and simple texts	Remembering (K1)
CO2	assimilating vocabulary on accommodation and invitation	Understanding (K2)
CO3	comprehend concept of time, telephonic conversation and job-related information	Understanding (K2)
CO4	understanding how to do shopping in a German store	Understanding (K2)
CO5	understanding 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	1	3		3		
CO2								1	1	3		3		
CO3								1	1	3		3		
CO4								1	1	3		3		
CO5								1	1	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	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)**

20GEO02 – JAPANESE LANGUAGE LEVEL 1

(Offered by Department of Electronics and Communication Engineering)

Programme& Branch	**All BE/BTech Engineering & Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Basics of Language**	**4/5/6/8**	**HS**	**4**	**0**	**0**	**4**

Preamble	To understand the basics of Japanese language 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	
Unit - I	**Introduction to groups of verbs:**	**12**
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		
Unit - II	**Introduction to Casual Form:**	**12**
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		
Unit - III	**Express opinions and thoughts:**	**12**
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		
Unit - IV	**Introduction to If clause and Kanjis:**	**12**
If clause tara form-Express gratitude for an action done by other person-Hypothetical situation-Particles to use in case of Motion verbs-110 Kanjis		
Unit - V	**Introduction to Counters:**	**12**
How to use numbers-How to use quantifiers-Past form of adjectives and Nouns-Way to say preference-Way of expression degrees of an action-Other necessary particles-How to use numbers-How to use quantifiers-Past form of adjectives		

Total:60

TEXT BOOK:

1. "MINNA NO NIHONGO–Japanese for Everyone", 2nd Edition, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1. MargheritaPezzopane, "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	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	Understanding (K2)
CO5	comprehend concept of time, counters 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	1	3		3		
CO2								1	1	3		3		
CO3								1	1	3		3		
CO4								1	1	3		3		
CO5								1	1	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	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)**

20GEO03 - DESIGN THINKING FOR ENGINEERS

(Offered by Department of Computer Science and Engineering)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Problem Solving and Programming	6	OE	3	0	0	3

Preamble	In this course, systematic process of thinking which empowers even the most traditional thinker to develop new, innovative solutions to the problem at handare studied with an emphasis on bringing ideas to life based on how real users think, feel and behave.	
Unit - I	**Introduction::**	**9**
Introduction – Need for design thinking – Design and Business – The Design Process – Design Brief –Visualization – Four Questions, Ten Tools – Explore – STEEP Analysis – Strategic Priorities – Activity System – Stakeholder Mapping – Opportunity Framing.		
Unit - II	**Visualization:**	**9**
Introduction – Visualization – Journey Mapping – Value Chain Analysis – Mind Mapping – Empathize –Observations – Need Finding – User Personas.		
Unit - III	**Brainstorming:**	**9**
Introduction – Brainstorming – Concept Development – Experiment – Ideation – Prototyping – Idea Refinement.		
Unit - IV	**Assumption Testing:**	**9**
Introduction – Assumption Testing – Rapid Prototyping – Engage – Storyboarding.		
Unit - V	**Customer Co-Creation Learning Launch:**	**9**
Introduction – Customer Co-Creation Learning Launch – Leading Growth and Innovation – Evolve– Concept Synthesis – Strategic Requirements – Evolved Activity Systems – Quick Wins.		

Total:45

TEXT BOOK:

1. Jeanne Liedtka and Tim Ogilvie, "Designing for Growth: A Design Thinking Tool Kit for Managers", Columbia University Press, 2011.

REFERENCES:

1. Lee Chong Hwa, "Design Thinking The Guidebook", Design Thinking Master Trainers of Bhutan, 2017.
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	outline the basic concepts of design thinking	Understanding (K2)
CO2	make use of the mind mapping process for designing any system	Applying (K3)
CO3	develop many creative ideas through structured brainstorming sessions.	Applying (K3)
CO4	develop rapid prototypes to bring the ideas into reality	Applying (K3)
CO5	plan the implementation of the any system considering the real time feedback	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	1	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	70	20				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)**

20GEO04 - 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	8	OE	3	0	0	3

Preamble	This course will inspire the students to think innovation concepts and ideas for business model developments.	
Unit - I	**Innovation and Design Thinking:**	**9**
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**
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**
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**
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**
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		

Total:45

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	2	2
CO2	3	3	3	3	2	2	2	2	3	3	3	3	2	2
CO3	2	2	3	3	3	3	3	3	3	3	3	3	2	2
CO4				3	2	2	2	3	3	3	3	3	2	2
CO5				3	2	2		3	2	3	3	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	30	40	10			100
CAT2	20	30	40	20			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)**

20GEO05 - GERMAN 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	German Language Level 1	4/5/6/8	HS	4	0	0	4

Preamble	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.	
Unit - I	**Contacts(Kontakte):**	**12**
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.		
Unit - II	**Accomodation(Die Wohnung):**	**12**
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		
Unit - III	**Are you Working?(Arbeiten Sie):**	**12**
Daily Schedule, speaking about past, understanding Job openings advertisements, Opinions, Telephoni conversations, Speaking about Jobs. Grammar – Perfect tense, Participle II – regular and irregular verbs, Conjunction – *und, oder, aber*.		
Unit - IV	**Clothes and Style(Kleidung und mode):**	**12**
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		
Unit - V	**Health and Vacation(Gesundheit und Urlaub):**	**12**
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*		

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 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	1	3		3		
CO2								1	1	3		3		
CO3								1	1	3		3		
CO4								1	1	3		3		
CO5								1	1	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)**

20GEO06 - GERMAN 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	German Language Level 2	**4/5/6/8**	**HS**	**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.	
Unit - I	**All about food (Rund Ums Essen):**	**9**
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’		
Unit - II	**School days (Nach der Schulzeit):**	**9**
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.		
Unit - III	**Media in everyday life (Medien in Alltag):**	**9**
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.		
Unit - IV	**Feelings and expressions (Gefühle):**	**9**
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.		
Unit - V	**Profession and Travel (Beruf und Reisen):**	**9**
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.		

Total: 45

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.	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	1	3		3		
CO2								1	1	3		3		
CO3								1	1	3		3		
CO4								1	1	3		3		
CO5								1	1	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)**

20GEO07 - 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**	**4/5/6/8**	**HS**	**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	1	3		3		
CO2								1	1	3		3		
CO3								1	1	3		3		
CO4								1	1	3		3		
CO5								1	1	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)**

20GEO08 - JAPANESE 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	Japanese Language Level 1	4/5/6/8	HS	4	0	0	4

Preamble	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	
Unit - I	**Introduction to groups of verbs:**	**12**
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		
Unit - II	**Introduction to Casual Form:**	**12**
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		
Unit - III	**Express opinions and thoughts:**	**12**
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		
Unit - IV	**Introduction to If clause and remaining Kanjis:**	**12**
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		
Unit - V	**Introduction to giving and receiving with te form and "when, even if" usages:**	**12**
Providing to and getting from differences - Understanding of situations and framing sentences using when and even if..etc.		

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	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)**

20GEO09 - 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	4/5/6/8	HS	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)**

20GEO10 - 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	4/5/6/8	HS	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)**

20GEO11 - 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 and 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 and 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", 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.						

20GEO12 - 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**
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**
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**
Laws of motion-Forces acting on aircraft–Bernoulli's theorem-Stalling-Primary control surfaces – secondary control surfaces-Aircraft recognition.		
Unit - IV	**Aero Engines:**	**9**
Introduction of Aero engine-Types of engine-piston engine-jet engines-Turboprop engines-Basic Flight Instruments-Modern trends.		
Unit – V	**Aero Modeling:**	**9**
History of aero modeling-Materials used in Aero-modeling-Types of Aero-models – Static Models-Gliders-Control line models-Radio Control Models-Building and Flying of Aero-models.		

Lecture :45, Practical30, 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" by DG NCC, New Delhi.
2	"Cadets Handbook – Specialised Subjects SD/SW" by DG NCC, New Delhi.
3	"NCC OTA Precise" by DGNCC, 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 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 airplanes 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.						

20GEO13 - FRENCH LANGUAGE LEVEL 1

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Fundamentals of French Language	5/6/7/8	HS	3	1	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
3.	.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)**

20GEO14 - FRENCH LANGUAGE LEVEL 2

Programme & Branch	**All Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of French Language**	**5/6/7/8**	**HS**	**3**	**1**	**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

TEXTBOOK:

1.	A2 – Saison

REFERENCES:

1.	Apprenons les francais – 0 and 1
2.	Grammaire – langue et de civilization francaises – Mauger G
3.	.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		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)**

20GEO15 - FRENCH LANGUAGE LEVEL 3

Programme& Branch	**All Engineering courses**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of French Language**	**5/6/7/8**	**HS**	**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
3.	.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	know about Letter writing, Creating Ads, Expressing Desires, and Instructing Others.	Understanding (K2)
CO4	understand rules for travel and Enhancing communications.	Understanding (K2)
CO5	express 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)**

20GEO16 - SPANISH LANGUAGE LEVEL 1

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Fundamentals of Spanish Language	5/6/7/8	HS	3	1	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)**

20GEO17 - SPANISH LANGUAGE LEVEL 2

Programme & Branch	**All Engineering and Technology Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Fundamentals of Spanish Language**	**5/6/7/8**	**HS**	**3**	**1**	**0**	**4**

Preamble	This course aims to help the Learner to acquire the vocabulary as per the framework of Spanish language A2 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 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, 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	understand the Spanish 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 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)**

20GEO18 - SPANISH LANGUAGE LEVEL 3

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Fundamentals of Spanish Language	5/6/7/8	HS	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 (Seamos creatives):**	**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 INTERNACIONAL 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	know about Letter writing, Creating Ads, Expressing Desires and Instructing Others.	Understanding (K2)
CO4	understand rules for travel and Enhance communications.	Understanding (K2)
CO5	express 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)**

20GEO19 - ENTREPRENEURSHIP DEVELOPMENT

(Offered by Department of Mechatronics Engineering)

Programme & Branch	All BE/BTech Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Economics and Management for Engineers	6	EC	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.		
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		1
CO2	1	2	2	2		2	2	1	1		3	2		2
CO3	2	2	2	2	2	2	2	2	2	2	3	2		1
CO4	1	1	2	1		2	1	1	1	2	3	2		1
CO5	1	1	2	1		2	1	1	1	2	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	40	40				100
CAT2	20	30	30	20			100
CAT3	30	30	40				100
ESE	20	30	40	10			100

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

20MAO01 - MATHEMATICAL FOUNDATIONS FOR MACHINE LEARNING

(Common to all Engineering and Technology Branches)

Programme & Branch	**All Engineering and Technology branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	**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**
Definition – Subspaces – Linear dependence and independence – Basis and dimension – Row space, Column space and Null Space – Rank and nullity.		
Unit - II	**Linear Transformations:**	**9+3**
Introduction – Kernel and range – Matrices of linear transformations – Change of basis – Rank and nullity.		
Unit - III	**Inner Product Spaces:**	**9+3**
Norms – Inner products – Length and Distance – Angle and Orthogonality – Orthonormal Basis – Gram-Schmidt Process – QR-Decomposition – Orthogonal Projection – Rotations.		
Unit - IV	**Matrix Decomposition and Continuous Optimization:**	**9+3**
Matrix Decomposition: Cholesky decomposition – Singular Value Decomposition. Continuous Optimization: Introduction – Unconstrained Optimization – Gradient Descent method – Constrained Optimization – Lagrange Multipliers method – Convex Optimization.		
Unit - V	**Linear regression and Support Vector Machines:**	**9+3**
Linear Regression: Parameter Estimation – Maximum Likelihood estimation – Bayesian linear regression. Support Vector Machines: Introduction – Linear and Non-linear Support vector machine – Margin and support vectors – Hard and Soft margins in Support vector machines – Kernels – Primal support vector machine – Dual support vector machine.		

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.	EthemAlpaydin, “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	apply the concepts of linear mappings in machine learning.	Applying (K3)
CO3	understand the concept of inner product space and decompose the given matrix by means of orthonormal vectors.	Understanding (K2)
CO4	apply the knowledge of factorisation of matrices and optimization techniques in clustering and classification of data.	Applying (K3)
CO5	describe the concepts of parameter estimation and support vector machine.	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	1												
CO3	3	2												
CO4	3	3		1	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	10	50	40				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	5	25	70				100

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

20MAO02 - GRAPH THEORY AND ITS APPLICATIONS
(Common to all Engineering and Technology branches)

Programme & Branch	All Engineering and Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**4**	**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 – Representations of graphs: Adjacency matrix – Incidence matrix.		
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 – Finding all spanning trees of a graph – Fundamental circuits.		
Unit - III	**Graph Coloring:**	**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 – Finding all spanning trees of a graph – Fundamental circuits.		
Unit - IV	**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.		
Unit - V	**Graph Theoretic Algorithms:**	**9+3**
Shortest paths – Shortest path algorithms: Dijkstra's algorithm – Warshall's algorithm – The Chinese Postman Problem – Fleury's Algorithm – Travelling salesman problem – Minimum Spanning tree – Minimal spanning tree algorithms: Prim's algorithm – Krushkal's algorithm – Optimal assignment – Kuhn and Munkres algorithm.		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	NarsinghDeo, "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	understand basic graph theoretic concepts.	Understanding (K2)
CO2	intrepret the concepts 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	identify the maximal flow in network by means of algorithms.	Applying (K3)
CO5	apply various graph theoretic algorithms to communication and network 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	2	1											
CO2	3	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	10	50	40				100
CAT2	10	30	60				100
CAT3	10	20	70				100
ESE	10	35	55				100

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

20MAO03 - DATA ANALYTICS USING R PROGRAMMING
(Common to all Engineering and Technology Branches)

Programme & Branch	All Engineering and Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**6**	**OE**	**3**	**0**	**0**	**3**

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.		

Total: 45

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.

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)
CO2	understand the concepts of decision, looping structures and functions.	Understanding (K2)
CO3	apply R programming to descriptive statistics.	Applying (K3)
CO4	apply the libraries for data manipulation and data visualization in R.	Applying (K3)
CO5	use R studio to identify the probability and test statistical hypothesis.	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											
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	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)**

20MAO04 - NUMBER THEORY AND CRYPTOGRAPHY
(Common to all Engineering and Technology branches)

Programme & Branch	All Engineering and Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**6**	**OE**	**3**	**0**	**0**	**3**

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 and Canonical Decompositions:**	**9**
Division algorithm- Base-b representations – number patterns – Prime and composite numbers – Fibonacci and Lucas numbers – Fermat numbers – GCD – Euclidean Algorithm – Fundamental theorem of Arithmetic – LCM.		
Unit - II	**Theory of Congruences:**	**9**
Basic concepts – Properties of congruences – Linear congruences – Solution of congruences – Fermat's Little theorem – Euler's theorem – Chinese remainder theorem.		
Unit - III	**Number Theoretic Functions:**	**9**
Introduction – Functions τ and σ – Mobius function – Greatest integer function – Euer's Phi function – Euler's theorem – Properties of Euler's function – Applications to Cryptography.		
Unit - IV	**Primality testing and Factorization:**	**9**
Primality testing: Fermat's pseudo primality test – Solvay-Strassen test – Miller-Rabin test – Fibonacci test – Lucas test – Integer factorization: Trial division – Pollard's Rho method – Quadratic sieve method.		
Unit - V	**Classical Cryptographic Techniques:**	**9**
Introduction – Substitution techniques – Transposition techniques – Encryption and decryption – Symmetric and asymmetric key cryptography – Steganography.		

Total: 45

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)**

20MAO05 -ADVANCED LINEAR ALGEBRA
(Common to all Engineering and Technology branches)

Programme & Branch	All Engineering and Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	OE	3	0	0	3

Preamble	To provide the skills for solving linear equations, decomposition of matrices and linear transformations in real time engineering problems and impart knowledge of vector spaces.	
Unit - I	**Linear Equations:**	**9**
System of linear equations – Row reduction and echelon forms – Vector equations – Matrix equations – Solution sets of linear systems – Applications of Linear systems: Matrix operations – inverse of a matrix, Matrix factorization – Applications to computer graphics.		
Unit - II	**Vector Spaces:**	**9**
Definition – Subspaces – Linear independence – Basis and dimension – Row space, Column space and Null Space – Rank and nullity.		
Unit - III	**Inner Product Spaces:**	**9**
Inner products – Angle and Orthogonality in inner product spaces – Orthonormal Bases – Gram-Schmidt Process – QR-Decomposition – Orthogonal Projection – Least square technique.		
Unit - IV	**Linear Transformations:**	**9**
General linear transformation – Kernel and range – Matrices of linear transformations – Change of basis – Rank and nullity.		
Unit - V	**Quadratic form and Matrix Decomposition:**	**9**
Quadratic forms – Quadratic surfaces – Hermitian, Unitary and Normal matrices – LU decomposition – Singular value decomposition.		

Total: 45

TEXT BOOK:

1. Howard Anton and Chris Rorres, "Elementary Linear Algebra", 11th Edition, John Wiley & Sons, New Delhi, 2014.

REFERENCES:

1. David C. Lay, Steven R. Lay, Judith McDonald, "Linear Algebra and its Applications", 5th Edition, Pearson Education, New Delhi, 2016.
2. Gareth Williams, "Linear Algebra with Applications", 9th Edition, Jones & Bartlett Publishers, Canada, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the concepts of matrices and vectors in solving the system of linear equations.	Applying (K3)
CO2	understand the concept of vector spaces.	Understanding (K2)
CO3	apply the concept of inner product spaces in orthogonalization.	Applying (K3)
CO4	apply the concepts of linear transformation to engineering problems	Applying (K3)
CO5	apply the knowledge of quadratic forms and matrix decompositions in practical 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	2	1											
CO2	3	1												
CO3	3	1	1											
CO4	3	2	1											
CO5	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	10	20	70				100
CAT2	10	40	50				100
CAT3	10	20	70				100
ESE	10	30	60				100

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

20MAO06 - OPTIMIZATION TECHNIQUES

(Common to all Engineering and Technology branches)

Programme & Branch	All Engineering and Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	OE	3	0	0	3

Preamble	To provide the skills for solving the real time engineering problems involving linear and non-linear problems and also impart knowledge in project management and game theoretic concepts.	
Unit - I	**Linear Programming:**	**9**
Introduction – Formulation of Linear Programming Problem – Basic assumptions – Limitations of Linear Programming models – Standard form of LPP – Graphical Method – Simplex Method – Artificial variable techniques – Big M Method.		
Unit - II	**Transportation and Assignment problems:**	**9**
Transportation problem: Mathematical Formulation of Transportation Problem – Initial basic feasible solution – North West Corner Method – Least Cost Method – Vogel's approximation method – Optimal solution – MODI Method – Degeneracy – Unbalanced transportation problem – Maximization transportation problem. Assignment Problem: Mathematical model of Assignment problem – Hungarian Method – Unbalanced assignment problem.		
Unit - III	**Theory of Games:**	**9**
Two-person zero-sum game – Pure strategies - Game with mixed strategies – Rules of Dominance – Solution methods: Algebraic method – Matrix method – Graphical method.		
Unit - IV	**Network Scheduling:**	**9**
Basic Concept of network Scheduling – Construction of network diagram – Critical path method – Programme evaluation and review technique – Project crashing – Time-cost trade-off procedure.		
Unit - V	**Non-Linear Programming:**	**9**
Formulation of non–linear programming problem – Constrained optimization with equality constraints – Kuhn-Tucker conditions – Constrained optimization with inequality constraints.		

Total: 45

TEXT BOOK:

1. Hamdy A. Taha, "Operations Research: An Introduction", 10th Edition, Dorling Kindersley, Pvt. Ltd, Uttar Pradesh, 2016.

REFERENCES:

1. Sharma J.K, "Operations Research – Theory and Applications", 4th Edition, Macmillan Publishers India Ltd, New Delhi, 2009.
2. Gupta P.K. and Hira D.S., "Operations Research: An Introduction", 6th Edition, S.Chand and Co. Ltd., New Delhi, 2008.
3. KantiSwarup, Gupta P.K. and Man Mohan, "Operation Research", 14th Edition, Sultan Chand & Sons, New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	solve linear programming problems.	Applying (K3)
CO2	apply transportation algorithms in engineering problems	Applying (K3)
CO3	use assignment and game theory concepts in practical situations	Applying (K3)
CO4	handle the problems of Project Management using CPM and PERT	Applying (K3)
CO5	solve various types of Non-linear Programming 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	2	1											
CO2	3	1	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	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)**

20PHO01 - THIN FILM TECHNOLOGY
(Common to all Engineering and Technology branches)

Programme & Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	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 for Units I, II, III & IV.
2	Sam Zhang, Lin Li and Ashok Kumar, Materials Characterization Techniques, 1st edition, CRC Press, Boca Raton, 2008, for 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	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	20	40	40				100
ESE	20	40	40				100

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

20PHO02- HIGH ENERGY STORAGE DEVICES

(Common to all Engineering and Technology branches)

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 and Optical storage:**	**9+3**
Magnetic storage: Principle of operation, Emerging challenges and a review on devices and technology. Electro-optic and Optical storage: Principles of operation, Device fabrication, Emerging devices and Upcoming technologies.		
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 1- 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, Elsevier, 2016
3.	D. Linden and T. S. Reddy, Handbook of Batteries, McGraw Hill, Newyork, 2002

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 storage systems.	Applying (K3)
CO3	Ultilize the principle of operation of magnetic storage systems, electro-optic and optical storage systems to illustrate the respective device fabrication 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	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	20	40	40				100
ESE	20	40	40				100

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

20PHO03 - STRUCTURAL AND OPTICAL CHARACTERIZATION OF MATERIALS
(Common to all Engineering and Technology branches)

Programme & Branch	All BE / BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	0	0	3

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**
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, Strain calculation - Applications of X ray diffraction measurements.		
Unit - II	**Electron Microscopy:**	**9**
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, Short details of each component and working – Field emission scanning electron microscope – Different types of filaments - Wavelength dispersive x-ray analysis – Three parameter equation for quantitative composition analysis.		
Unit - III	**Scanning Tunneling Microscopy:**	**9**
Introduction to quantum mechanical tunneling - Basic principles of scanning tunneling microscopy - Two modes of scanning - Interpreting scanning tunneling microscopic images -Applications of scanning tunneling microscopy.		
Unit - IV	**Raman Spectroscopy:**	**9**
Introduction – Pure rotational Raman spectra – Vibrational Raman spectra – Polarization of light and Raman effect – Structure determination – Instrumentation – Near-Infra-Red FT Raman Spectroscopy.		
Unit - V	**Ultra Violet &Visible Spectroscopy:**	**9**
Regions of UV-Visible radiation - Colour and light absorption - The chromophore concept - Beer's and Lambert's laws – Theory of electronic transition - Frank Condon principle – Instrumentation and Working of UV vis spectrometer - Applications of UV visible spectroscopy.		

Total: 45

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	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	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)**

20CYO01 - INSTRUMENTAL METHODS OF ANALYSIS

(Common to all Engineering and Technology branches)

Programme & Branch	**All BE / BTech Branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**4**	**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 – elucidation of 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 Emission 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)**

20CYO02 - CORROSION SCIENCE AND ENGINEERING

(Common to all Engineering and Technology branches)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	Corrosion science and engineering aims to equip the students to have a wide-range knowledge of corrosion and prevention methods in order to meet the industrial needs.	
Unit – I	**Corrosion and its Units**	**9+3**
Localized corrosion: 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 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 corrosion		
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 – Their and limitations–Methods of Determining Corrosion Rates - Weight Loss Method, Weight Gain Method and Chemical Analysis of Solution.		
Unit - III	**Types of Corrosion**	**9+3**
Introduction - (i) Crevice - differential aeration corrosion, (ii) pitting – mechanism, factors (iii) intergrannular- chromium depletion theory, weld decay and knife line attack, (iv) stress - SCC mechanism, and fatique- Cavitation damage – Fretting damage, (v) stray current corrosion - causes and its control.		
Unit - IV	**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 – V	**Prevention of Corrosion**	**9+3**
Inhibitors – types of inhibitors, chemisorption of inhibitors, effect of concentration, effect of molecular structure, V.P. 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		

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, Revie 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	organize the various types of corrosion to understand the corrosion problems	Applying (K3)
CO4	utilize the theories corrosion to interpret with the real time applications	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)**

20CYO03 - CHEMISTRY OF COSMETICS IN DAILY LIFE

(Common to all Engineering and Technology branches)

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 provide knowledge for engineering students on chemistry of cosmetics.	
Unit 1	**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) - Polymers in Cosmetics - Polymer Solubility and Compatibility, polymer conformation - Basics of Dispersions - Electrical Charges Associated With Surfaces and Barriers – Basics of emulsion (stability, Ostwald Ripening, Prevention of Creaming and Sedimentation).

Unit 2	**Structuring Materials 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 - Precautions on Cosmetic Ingredients - Future Challenges in Cosmetics Material Development.

Unit 3	**Polymers in Cosmetic Products**	**9+3**

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 4	**Powders and Fragrance in Cosmetics**	**9+3**

Inorganic Pigments – extender pigment, coloured pigment, white pigment, pearlescent Pigments – organic pigments - extender pigment, coloured pigment.

Fragrance – Introduction – natural products – aroma chemicals - fragrance creation and duplication - fragrance applications - encapsulation and controlled release – malodor - natural, green, organic, and sustainable fragrances.

Unit 5	**Preparation of Cosmetics**	**9+3**

Brief introduction of the following cosmetic preparation and a detailed study on their quality control: shampoo, tooth paste, skin powder, skin creams, hair creams, nail polish, after shave lotion, bath and toiletries, lipstick and hair dyes, perfumes, depilatories.

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, JayeshGadiya, MeenakshiDhanawat 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 form cosmetics	Applying (K3)
CO3	interpret the polymers in cosmetics	Understanding (K2)
CO4	develop knowledge about Powders and Fragrance in Cosmetics	Applying (K3)
CO5	apply the preparation methodology of cosmetics to explain the 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)**

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20CYO04 - CHEMISTRY OF NUTRITION FOR WOMEN HEALTH
(Common to all Engineering and Technology branches)

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 provide knowledge for engineering students on components of health and fitness and the role of nutrition for women health.	
Unit - I	**Nutrition**	**9+3**
Energy- Functions, sources and concept of energy balance, Functions, Recommended Dietary Allowances, dietary sources, effects of deficiency and/ or excess consumption on health of the following nutrients: • Carbohydrates and dietary fibre, 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	**Role of women in national development**	**9+3**
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.		
Unit - III	**Women and health**	**9+3**
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 - IV	**Nutrition during Lactation and for Infants**	**9+3**
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 - V	**Physical fitness and nutrition**	**9+3**
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.		

Lecture:45,Tutorial:15, Total: 60

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	Interpret the various role of women in society	Understanding (K2)
CO3	Explain the disease pattern and policies towards women health	Understanding (K2)
CO4	Develop knowledge about nutrition during lactation and for infants	Applying (K3)
CO5	Utilize the knowledge of physical fitness and nutrition towards achieving a good health	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	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)**

20CYO05 - CHEMISTRY CONCEPTS FOR COMPETITIVE EXAMINATIONS
(Common to all Engineering and Technology branches)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**6**	**OE**	**3**	**0**	**0**	**3**

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**
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**
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**
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**
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**
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.		

Total: 45

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", 6th Edition, 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 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)**

20CYO06 - WASTE AND HAZARDOUS WASTE MANAGEMENT
(Common to all Engineering and Technology branches)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	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, segregation of waste-generation, 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 INDUSTRIES AND MANAGEMENT**	**9**
Introduction- sources and characteristics - waste treatment flow sheets for selected industries such as Textiles, Tanneries, Pharmaceuticals, Sugar, Petroleum refinery, fertilizer, dairy industries.		
Unit - V	**SOLID WASTE MANAGEMENT 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 Units - 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	select the various disposal methods of hazardous wastes like radioactive wastes	Understanding (K2)
CO3	organize the appropriate method for managing e-waste and biomedical waste	Applying (K3)
CO4	identify to plan minimization of industrial wastes	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)**

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.	20CHJ01	Testing and Analysis of Petroleum Products	4	Nil	5
2.	20CHH01	Petroleum Production and Artificial Lift Systems	3	Nil	5
3.	20CHJ02	Petroleum Refinery Modeling and Simulation	4	Nil	6
4.	20CHH02	Petroleum Reservoir and Natural Gas Engineering	4	Nil	6
5.	20CHH03	Petrochemical Technology	3	Nil	7
		TOTAL	**18**		

20CHJ01 - 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 various standard tests on crude oil	Applying (K3)
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)
CO5	Perform various standard tests on Kerosene, diesel, Lubricating oil and other petroleum products	Applying (K3)
CO6	Perform ASTM distillation of crude and determine octane number, cetane number, smoke point and calorific value for the given liquid fuel.	Applying (K3)/ Manipulating(S2)
CO7	Identify flash point, fire point, cloud point, pour point of petroleum product and measure the viscosity and vapor pressure of gasoline fuel	Applying (K3)/ Manipulating(S2)
CO8	Conduct tests to find the carbon residue, corrosive nature of liquid fuel/ lubricant and identify 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
CO6	3	3	2	1	1				1	1			3	2
CO7	3	3	2	1	1				1	1			3	2
CO8	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	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)

20CHH01 - 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, for Units I & II
2.	Kermit Brown, “The Technology of Artificial Lift Methods”, Pennwell Books, 1984, for Units III, IV & V.

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	Discuss various techniques for oil pumping and lift systems from reservoirs	Understanding (K2)
CO3	Discuss the aspects of Progressive cavity pumps system	Understanding (K2)
CO4	Understand Electric submersible pumps and its power requirement and design calculations	Understanding (K2)
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	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)

20CHJ02 - 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**
Crude Distillation Unit – Model Development, Overall Column Efficiency and Murphree Efficiency, Algorithm, Model Development. Vacuum Distillation Unit – Data requirements, Feedstock representation, Model Development.		
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. HCR process – Modelling Tools, MP and HP HCR Models.		
Unit – V	**Modeling of Miscellaneous Operations:**	**9**
Alkylation – Feed Components, Alkylation Kinetics, Simulation of HF Alkylation Process. Coking – Feed Characterization, Kinetic Lumps, Coking Reactions, Simulation of Delayed Coking Process. Refinery Wide Simulation – Introduction of Integrated Process Modeling Tools, Example Cases.		

LIST OF EXPERIMENTS / EXERCISES:	
1.	Interconvert Distillation Curves and Extrapolate an Incomplete Distillation 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 Coking Process
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	Develop models for crude and vacuum distillation units	Applying (K3)
CO3	Discuss the aspects of downstream fractionation and develop models for FCC, Side-stripper and absorber	Applying (K3)
CO4	Develop kinetic models for catalyst regenerator and HCR unit	Applying (K3)
CO5	Understand the auxiliary processes in refinery and develop basic models with the help of case studies.	Applying (K3)
CO6	Simulate Crude Oil Distillation Units and allied operations using Aspen HYSYS	Applying (K3)/ Manipulating(S2)
CO7	Simulate Cracking & Regenerator unit and downstream fractionation using Aspen HYSYS	Applying (K3)/ Manipulating(S2)
CO8	Simulate alkylation, coking, stabilization and refrigeration systems using Aspen HYSYS	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				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
CO6	3	3	2	2	3				1	1			3	2
CO7	3	3	2	2	3				1	1			3	2
CO8	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)

20CHH02 - 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 and Enhanced 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, for Units I, II & III.
2. B. Guo and A. Ghalambor, “Natural Gas Engineering Handbook”, Gulf Publishing Company, 2005, for Units IV & V.

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)

20CHH03 - 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)