KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADU INDIA

Estd : 1984

REGULATIONS, CURRICULUM & SYLLABI - 2018

(CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION)

(For the students admitted during 2018 - 2019 and onwards)

BACHELOR OF TECHNOLOGY DEGREE
IN
CHEMICAL ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

KONGU
Assuring the Best

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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 Sciences, Technology, Engineering and Management for the Nation and beyond.

INSTITUTE MISSION

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

QUALITY POLICY

We are committed to

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

DEPARTMENT OF CHEMICAL ENGINEERING

VISION

To be a centre of excellence for development and dissemination of knowledge in 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 2018
(Revision: 4)

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 2018 – 2019 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
BTech	Chemical Engineering
	Information Technology
	Food Technology

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/Industrial Training, Comprehensive Test & Viva, Entrepreneurships/Start ups and Internship in Industry or elsewhere

viii. Audit Courses (AC)

ix. Mandatory Courses (MC)

4.2 Credit Assignment

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 programme shall vary from 168 to 173 as per the chosen programme of study.

4.3 Employability Enhancement Courses

A candidate shall be offered with the employability enhancement courses like project work, professional skills training/industrial training, comprehensive test & viva, industrial training, 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 course 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 or Professional Skills Training II. The area in which the candidate wants to initiate a start up may be interdisciplinary or multidisciplinary. The progress of the startup shall be evaluated by a panel of members constituted by the Principal through periodic reviews.

4.3.2 Comprehensive Test and Viva

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

4.3.3 Internships

The curriculum enables a candidate to go for full time projects 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 approval from 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 courses or dropping of already registered additional elective 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) and earn continuous assessment marks. This will be considered as an attempt for the purpose of classification.

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

7. ASSESSMENT AND EXAMINATION PROCEDURE FOR AWARDING MARKS

7.1 The BE/BTech programmes consist of Theory Courses, Theory cum Practical courses, Practical courses, Comprehensive Test and Viva, Project Work, 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:

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

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

7.3 Theory Courses

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

7.5.1 The apportionment of continuous assessment marks for each course shall be decided by the course coordinator based on rubrics of that particular course.

Type	Max. Marks	Remarks
Assessment based on rubrics for each experiment	50	Absolute Mark System
Assessment Test	50	
Total	100	Rounded off to one decimal place

7.6 Project Work II / Project Work I 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/ Project Work I Phase II and the Viva-Voce Examination shall be distributed as below:

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

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

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

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

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

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

7.7 Project Work I 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	Supervisor	Review Committee (excluding supervisor)	Supervisor	Review Committee (excluding supervisor)	Supervisor	Review Committee	Supervisor	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 the 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 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 Universal Human Values

The course imparting the human values shall be taught for all candidates who have joined in various branches of all BE/BTech programmes. This course shall carry a maximum of 100 marks and shall be evaluated through continuous assessment tests only vide clause 7.1. The candidate(s) can earn 2 credits by successfully completing this course. Two continuous assessment tests will be conducted and the average marks will be taken for the GPA and CGPA calculations.

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 and satisfy the attendance requirements.

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-2018 (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 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.

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.

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	**3**	**4**		**1**	**2**		**3**		**13**	**7.69**
BS	**11**	**11**	**4**	**4**					**30**	**17.75**
ES	**7**	**3**	**8**	**3**					**21**	**12.42**
PC		**3**	**11**	**15**	**17**	**12**			**58**	**34.32**
PE						**3**	**9**	**3**	**15**	**8.87**
OE					**4**	**4**	**3**	**3**	**14**	**8.28**
EC					**2**	**4**	**6**	**6**	**18**	**10.65**
Semesterwise Total	**21**	**21**	**23**	**23**	**25**	**23**	**21**	**12**	**169**	**100.00**

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.	18EGT11	English for Communication I	3	0	0	3	I
2.	18EGT21	English for Communication II	3	0	0	3	II
3.	18VEC11	Value Education	2	0	1	1	II
4.	18EGL31	English for Workplace Communication	0	0	2	1	IV
5.	18CHT71	Process Engineering and Economics	3	0	0	3	VII
6.	18GET51	Universal Human Values	0	0	0	2	V
Total Credits to be earned						**13**	

BASIC SCIENCE (BS)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	18MAC11	Mathematics I	3	1*	2*	4	I
2.	18PHC11	Applied Physics	3	0	2*	3.5	I
3.	18CYC11	Applied Chemistry	3	0	2*	3.5	I
4.	18MAC21	Mathematics II	3	1*	2*	4	II
5.	18PHC26	Materials Science and Characterization Techniques	3	0	2*	3.5	II
6.	18CYC26	Industrial Chemistry	3	0	2*	3.5	II
7.	18MAC31	Mathematics III	3	1*	2*	4	III
8.	18MAC41	Statistics and Numerical Methods	3	1*	2*	4	IV
Total Credits to be earned						**30**	

ENGINEERING SCIENCE (ES)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	18GET11	Introduction to Engineering	3	0	0	3	I
2.	18MEC11	Engineering Drawing	2	0	2	3	I
3.	18MEL11	Engineering Practices Laboratory	0	0	2	1	I
4.	18CSC11	Problem Solving and Programming	2	0	2	3	II
5.	18CHT33	Fluid Mechanics	3	1	0	4	III
6.	18EET35	Electrical Drives and Industrial Electronics	3	0	0	3	III
7.	18CHL32	Fluid Mechanics Laboratory	0	0	2	1	III
8.	18CHT44	Chemical Plant Utilities	3	0	0	3	IV
Total Credits to be earned						**21**	

EMPLOYABILITY ENHANCEMENT COURSES (EC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	18GEL51/ 18GEI51	Professional Skills Training I / Industrial Training I	0	0	0	2	V
2.	18GEL61/ 18GEI61	Professional Skills Training II / Industrial Training II	0	0	0	2	VI
3.	18GEP71	Comprehensive Test and Viva	0	0	0	2	VII
4.	18CHP61	Project Work I Phase I	0	0	4	2	VI

5.	18CHP71	Project Work I Phase II	0	0	8	4	VII
6.	18CHP81	Project Work II	0	0	12	6	VIII
Total Credits to be earned						**18**	

PROFESSIONAL CORE (PC)								
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**	**Domain/ Stream**
1.	18CHT21	Principles of Chemical Engineering	3	0	0	3	II	T.O
2.	18CHT31	Applied Organic Chemistry	3	0	0	3	III	PSS&RE
3.	18CHT32	Chemical Process Calculations	3	1	0	4	III	T.O
4.	18CHT34	Chemical Process Plant Safety	3	0	0	3	III	PSS&RE
5.	18CHL31	Applied Chemistry Laboratory – I	0	0	2	1	III	PSS&RE
6.	18CHT41	Mechanical Operations	3	0	0	3	IV	T.O
7.	18CHT42	Process Heat Transfer	3	1	0	4	IV	T.O
8.	18CHT43	Process Thermodynamics I	3	0	0	3	IV	TM&TD
9.	18CHT45	Chemical Process Industries	3	0	0	3	IV	PSS&RE
10.	18CHL41	Applied Chemistry Laboratory II	0	0	2	1	IV	T.O
11.	18CHL42	Mechanical Operations Laboratory	0	0	2	1	IV	T.O
12.	18CHT51	Mass Transfer I	3	1	0	4	V	S.T
13.	18CHT52	Process Thermodynamics II	3	0	0	3	V	TM&TD
14.	18CHT53	Chemical Reaction Engineering	3	0	0	3	V	PSS&RE
15.	18CHT54	Chemical Equipment Design and Drawing	3	1	0	4	V	DMPC&E
16.	18CHL51	Process Heat Transfer Laboratory	0	0	2	1	V	T.O
17.	18CHL52	Process Computation Laboratory	0	0	2	1	V	TM&TD
18.	18CHL53	Chemical Reaction Engineering Laboratory	0	0	2	1	V	PSS&RE
19.	18CHT61	Mass Transfer II	3	0	0	3	VI	S.T
20.	18CHT62	Process Dynamics and Control	3	0	0	3	VI	DMPC&E
21.	18CHT63	Process Modeling and Simulation	3	0	0	3	VI	DMPC&E
22.	18CHL61	Mass Transfer Laboratory	0	0	2	1	VI	S.T
23.	18CHL62	Process Dynamics and Control Laboratory	0	0	2	1	VI	DMPC&E
24.	18CHL63	Process Modeling and Simulation Laboratory	0	0	2	1	VI	DMPC&E
Total Credits to be earned						**58**		

PROFESSIONAL ELECTIVE (PE)								
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**	**Domain/ Stream**
		Elective – I						
1.	18CHE01	Oil and Natural Gas Engineering	3	0	0	3	VI	E&EM
2.	18CHE02	Fluid Movers	3	0	0	3	VI	T.O
3.	18CHE03	Chemical Analysis	3	0	0	3	VI	PSS&RE
4.	18CHE04	Bio Chemical Engineering	3	0	0	3	VI	E&EM
		Elective – II						
5.	18CHE05	Petroleum Refinery Engineering	3	0	0	3	VII	E&EM
6.	18CHE06	Fundamentals of Computational Fluid Dynamics	3	0	0	3	VII	T.O
7.	18CHE07	Organic Synthesis	3	0	0	3	VII	PSS&RE
8.	18CHE08	Pharmaceutical Process Technology	3	0	0	3	VII	TM&TD
		Elective - III						
9.	18CHE09	Piping Engineering	3	0	0	3	VII	T.O
10.	18CHE10	Complex Fluids	3	0	0	3	VII	T.O
11.	18CHE11	Heterogeneous Catalytic Reactions	3	0	0	3	VII	PSS&RE
12.	18CHE12	Pulp and Paper Technology	3	0	0	3	VII	TM&TD
13.	18GEE01	Fundamentals of Research	3	0	0	3	VII	GE
		Elective – IV						
14.	18CHE13	Air Pollution Control	3	0	0	3	VII	T.O
15.	18CHE14	Transport Phenomena	3	0	0	3	VII	T.O
16.	18CHE15	Electrochemical Engineering	3	0	0	3	VII	E&EM
17.	18CHE16	Modern Separation Processes	3	0	0	3	VII	S.T
18.	18CHE17	Total Quality Management	3	0	0	3	VII	GE
		Elective - V						
19.	18CHE18	Process Instrumentation	3	0	0	3	VIII	DMPC&E
20.	18CHE19	Industrial Waste Water Treatment	3	0	0	3	VIII	E&EM
21.	18CHE20	Corrosion Technology	3	0	0	3	VIII	S.T
22.	18CHE21	Ores and Mineral Processing	3	0	0	3	VIII	S.T
23.	18MBE49	Entrepreneurship Development	3	0	0	3	VIII	GE
Total Credits to be earned						**15**		

***** Domain/Stream Abbreviations: T.O-Transport Operations, S.T-Separation Techniques, DMPC&E- Design, Modeling, Process Control and Economics, PSS&RE -Process Synthesis, Safety and Reaction Engineering , TM&TD-Thermal, Materials and Thermodynamics, E&EM -Energy and Environment

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)								
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Pre-requisites**	**Sem**
1.	18CHO01	Polymer Technology	3	1	0	4	Nil	V
2.	18CHO02	Introduction to drugs and pharmaceuticals	3	1	0	4	Nil	V
3.	18CHO03	Bio Energy Resources	3	1	0	4	Nil	VI
4.	18CHO04	Fundamentals of Nanoscience and Nanotechnology	3	1	0	4	Nil	VI
5.	18CHO05	Enzyme Engineering	3	0	0	3	Nil	VII
6.	18CHO06	Nuclear Engineering	3	0	0	3	Nil	VII
7.	18CHO07	Fertilizer Technology	3	0	0	3	Nil	VIII

OPEN ELECTIVE COURSES OFFERED BY OTHER DEPARTMENTS (OE)

S.No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**OFFERED BY**
		SEMESTER V					
8.	18MAO01	Mathematical Foundations of Machine Learning	3	1	0	4	MATHS
9.	18PHO01	Thin film Technology	3	1	0	4	PHYSICS
10.	18CYO01	Corrosion Science and Engineering	3	1	0	4	CHEMISTRY
11.	18CEO01	Remote Sensing and its Applications	3	0	2	4	CIVIL
12.	18MEO01	Renewable Energy Sources	3	0	2	4	MECH
13.	18MTO01	Design of Mechatronics Systems	3	1	0	4	MTS
14.	18AUO01	Automotive Engineering	3	0	2	4	AUTO
15.	18ECO01	PCB Design and Fabrication	3	0	2	4	ECE
16.	18ECO02	Neural Networks and Fuzzy Logic for Engineering Applications	3	0	2	4	ECE
17.	18EEO01	Electrical Wiring and Lighting	3	1	0	4	EEE
18.	18EEO02	Solar and Wind Energy Systems	3	1	0	4	EEE
19.	18EIO01	Neural Networks and Deep Learning	3	1	0	4	EIE
20.	18CSO01	Data Structures and its Applications	3	0	2	4	CSE
21.	18CSO02	Formal Languages and Automata Theory	3	1	0	4	CSE
22.	18CSO03	Computational Science for Engineers	3	1	0	4	CSE
23.	18ITO01	Python Programming	3	0	2	4	IT
24.	18ITO02	Advanced Java Programming	3	0	2	4	IT

25.	18FTO01	Food Processing Technology	3	1	0	4	FT
26.	18FTO02	Baking Technology	3	0	2	4	FT
		SEMESTER VI					
27.	18MAO02	Graph Theory and its Applications	3	1	0	4	MATHS
28.	18MAO03	Number Theory and Cryptography	3	1	0	4	MATHS
29.	18CYO02	Instrumental Methods Of Analysis	3	1	0	4	CHEMISTRY
30.	18CEO02	Disaster Management	3	1	0	4	CIVIL
31.	18MEO02	Design of Experiments	3	0	2	4	MECH
32.	18MTO02	Factory Automation	3	0	2	4	MTS
33.	18MTO03	Data Acquisition and Virtual Instrumentation	3	0	2	4	MTS
34.	18AUO02	Autonomous Vehicles	3	1	0	4	AUTO
35.	18ECO03	Principles of Quantum Computing	3	0	2	4	ECE
36.	18EEO03	Energy Conservation and Management	3	1	0	4	EEE
37.	18EIO02	Digital Image Processing and Its Applications	3	1	0	4	EIE
38.	18EIO03	Industrial Automation	3	1	0	4	EIE
39.	18CSO04	Web Engineering	3	0	2	4	CSE
40.	18CSO05	Foundations of Data Analytics	3	1	0	4	CSE
41.	18CSO06	Nature Inspired Optimization Techniques	3	1	0	4	CSE
42.	18CSO07	Introducing Data Science	3	1	0	4	CSE
43.	18ITO03	Java Programming	3	1	0	4	IT
44.	18ITO04	Next Generation Databases	3	1	0	4	IT
45.	18FTO03	Processing of Milk and Milk Products	3	0	2	4	FT
46.	18FTO04	Processing of Fruits and Vegetables	3	0	2	4	FT
		SEMESTER VI					
47.	18MAO04	Advanced Linear Algebra	3	0	0	3	MATHS
48.	18MAO05	Optimization Techniques	3	0	0	3	MATHS
49.	18PHO02	Structural and Optical Characterization of Materials	3	0	0	3	PHYSICS
50.	18CYO03	Waste and Hazardous Waste Management	3	0	0	3	CHEMISTRY
51.	18CEO03	Introduction to Smart Cities	3	0	0	3	CIVIL
52.	18CEO04	Environmental Health and Safety	3	0	0	3	CIVIL
53.	18MEO03	Fundamentals of Ergonomics	3	0	0	3	MECH
54.	18MEO04	Principles of Management and Industrial Psychology	3	0	0	3	MECH

55.	18MTO04	3D Printing and Design	3	0	0	3	MTS
56.	18MTO05	Drone System Technology	3	0	0	3	MTS
57.	18AUO03	Alternate Fuels for Automobile	3	0	0	3	AUTO
58.	18ECO04	Electronic Hardware and Troubleshooting	2	0	2	3	ECE
59.	18ECO05	Principles of Communication Techniques	3	0	0	3	ECE
60.	18EEO04	Micro Grid and Smart Grid	3	0	0	3	EEE
61.	18EEO05	Electrical Safety	3	0	0	3	EEE
62.	18EIO04	Biomedical Instrumentation and Applications	3	0	0	3	EIE
63.	18EIO05	PLC Programming and Its Applications	3	0	0	3	EIE
64.	18CSO08	Artificial intelligence and its Applications	3	0	0	3	CSE
65.	18ITO05	Business Continuity Planning	3	0	0	3	IT
66.	18ITO06	Mobile Application Development	3	0	0	3	IT
67.	18FTO05	Principles of Food Safety	3	0	0	3	FT
68.	18FTO06	Food and Nutrition	3	0	0	3	FT
		SEMESTER VIII					
69.	18CEO05	Infrastructure Planning and Management	3	0	0	3	CIVIL
70.	18CEO06	Environmental Laws and Policy	3	0	0	3	CIVIL
71.	18MEO05	Safety Measures for Engineers	3	0	0	3	MECH
72.	18MEO06	Energy Conservation in Thermal Equipments	3	0	0	3	MECH
73.	18MTO06	Robotics	3	0	0	3	MTS
74.	18MTO07	Virtual and Augment Reality in Industry 4.0	3	0	0	3	MTS
75.	18AUO04	Automotive Electronics	3	0	0	3	AUTO
76.	18AUO05	Vehicle Maintenance	3	0	0	3	AUTO
77.	18ECO06	Bioinspired Computing Technologies	2	0	2	3	ECE
78.	18EEO06	Electric Vehicle	3	0	0	3	EEE
79.	18EIO06	Measurements and Instrumentation	3	0	0	3	EIE
80.	18EIO07	Graphical Programming using Virtual Instrumentation	3	0	0	3	EIE
81.	18CSO09	Applied Machine Learning	3	0	0	3	CSE
82.	18CSO10	Fundamentals of Blockchain	3	0	0	3	CSE
83.	18CSO11	Fundamentals of Internet of Things	3	0	0	3	CSE
84.	18ITO07	Essentials of Information Technology	3	0	0	3	IT
85.	18ITO08	Virtual and Augmented Reality Frameworks	3	0	0	3	IT

86.	18FTO07	Food Ingredients	3	0	0	3	FT
87.	18FTO08	Fundamentals of Food Packaging and Storage	3	0	0	3	FT

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

S. No.	Course Code	Course Title	L	T	P	C	Offering Department	Semester
88.	18GEO01	German Language Level 1	4	0	0	4	ECE	V/ VI/ VII/ VIII
89.	18GEO02	Japanese Language Level 1	4	0	0	4	ECE	V/ VI/ VII/ VIII
90.	18GEO03	Design Thinking for Engineers	3	0	0	3	CSE	VI
91.	18GEO04	Innovation and Business Model Development	3	0	0	3	MTS	VIII
92.	18GEO05	German Language Level 2	4	0	0	4	ECE	V/ VI/ VII/ VIII
93.	18GEO06	German Language Level 3	3	0	0	3	ECE	V/ VI/ VII/ VIII
94.	18GEO07	German Language Level 4	3	0	0	3	ECE	V/ VI/ VII/ VIII
95.	18GEO08	Japanese Language Level 2	4	0	0	4	ECE	V/ VI/ VII / VIII
96.	18GEO09	Japanese Language Level 3	3	0	0	3	ECE	V/ VI/ VII / VIII
97.	18GEO10	Japanese Language Level 4	3	0	0	3	ECE	V/ VI/ VII / VIII
98.	18GEO11	NCC Studies (Army Wing) – I	3	0	2	4	EEE	V/ VI
99.	18GEO12	NCC Studies (Air Wing) – I	3	0	2	4	IT	V / VI

KEC R2018: SCHEDULING OF COURSES – B.Tech. (Chemical Engineering) Total Credits : 169

Sem.	Course1	Course2	Course3	Course4	Course5	Course6	Course7	Course8	Course9	Course10	Credits
I	18EGT11 English for Communi-cation I (3-0-0-3)	18MAC11 Mathematics I (3-1*-2*-4)	18PHC11 Applied Physics (3-0-2*-3.5)	18CYC11 Applied Chemistry (3-0-2*-3.5)	18GET11 Introduction to Engineering (3-0-0-3)	18MEC11 Engineering Drawing (2-0-2-3)	18MEL11 Engineering Practices Laboratory (0-0-2-1)				**21**
II	18EGT21 English for Communi-cation II (3-0-0-3)	18MAC21 Mathematics II (3-1*-2*-4)	18PHC26 Materials Science and Characterization Techniques (3-0-2*-3.5)	18CYC26 Industrial Chemistry (3-0-2*-3.5)	18CSC11 Problem Solving and Programming (2-0-2-3)	18CHT21 Principles of Chemical Engineering (3-0-0-3)	18VEC11 Value Education (2-0-1-1)				**21**
III	18MAC31 Mathematics III (3-1*-2*-4)	18CHT31 Applied Organic Chemistry (3-0-0-3)	18CHT32 Chemical Process Calculations (3-1-0-4)	18CHT33 Fluid Mechanics (3-1-0-4)	18CHT34 Chemical Process Plant Safety (3-0-0-3)	18EET35 Electrical Drives and Industrial Electronics (3-0-0-3)	18CHL31 Applied Chemistry Laboratory – I (0-0-2-1)	18CHL32 Fluid Mechanics Laboratory (0-0-2-1)			**23**
IV	18MAC41 Statistics and Numerical Methods (3-1*-2*-4)	18CHT41 Mechanical Operations (3-0-0-3)	18CHT42 Process Heat Transfer (3-1-0-4)	18CHT43 Process Thermodynami cs I (3-0-0-3)	18CHT44 Chemical Plant Utilities (3-0-0-3)	18CHT45 Chemical Process Industries (3-0-0-3)	18CHL41 Applied Chemistry Laboratory II (0-0-3-1)	18CHL42 Mechanical Operations Laboratory (0-0-3-1)	18EGL31 English for Workplace Communica-tion (0-0-3-1)		**23**
V	18CHT51 Mass Transfer I (3-1-0-4)	18CHT52 Process Thermodynami cs II (3-0-0-3)	18CHT53 Chemical Reaction Engineering (3-0-0-3)	18CHT54 Chemical Equipment Design and Drawing (3-1-0-4)	Open Elective I (3-1/0-0/2-4)	18CHL51 Process Heat Transfer Laboratory (0-0-2-1)	18CHL52 Process Computation Laboratory (0-0-2-1)	18CHL53 Chemical Reaction Engineering Laboratory (0-0-2-1)	18GEL51/ 18GEI51 Professional Skills Training I / Industrial Training I (0-0-0-2)	18GET51 Universal Human Values (0-0-0-2)	**25**
VI	18CHT61 Mass Transfer II (3-0-0-3)	18CHT62 Process Dynamics and Control (3-0-0-3)	18CHT63 Process Modeling and Simulation (3-0-0-3)	Professional Elective I (3-0-0-3)	Open Elective II (3-1/0-0/2-4)	18CHL61 Mass Transfer Laboratory (0-0-2-1)	18CHL62 Process Dynamics and Control Laboratory (0-0-2-1)	18CHL63 Process Modeling and Simulation Laboratory (0-0-2-1)	18GEL61/ 18GEI61 Professional Skills Training II / Industrial Training II (0-0-0-2)	18CHP61 Project Work I Phase I (0-0-4-2)	**23**
VII	18CHT71 Process Engineering and Economics (3-0-0-3)	Open Elective III (3-0-0-3)	Professional Elective II (3-0-0-3)	Professional Elective III (3-0-0-3)	Professional Elective IV (3-0-0-3)	18GEP71 Comprehen-sive Test & Viva (0-0-0-2)	18CHP71 Project Work 1 Phase II (0-0-8-4)				**21**
VIII	Open Elective IV (3-0-0-3)	Professional Elective V (3-0-0-3)	18CHP81 Project Work II (0-0-12-6)								**12**

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	18EGT11	English for Communication I						✓			✓	✓	✓	✓		
1	18MAC11	Mathematics I	✓	✓	✓	✓	✓									
1	18PHC11	Applied Physics	✓	✓	✓	✓										
1	18CYC11	Applied Chemistry	✓	✓	✓	✓										
1	18GET11	Introduction to Engineering	✓	✓	✓	✓		✓	✓					✓		
1	18MEC11	Engineering Drawing	✓	✓	✓	✓						✓	✓	✓	✓	✓
1	18MEL11	Engineering Practices Laboratory	✓	✓	✓	✓	✓				✓	✓	✓	✓		
2	18EGT21	English for Communication II						✓			✓	✓	✓	✓		
2	18MAC21	Mathematics II	✓	✓	✓		✓									
2	18PHC26	Materials Science and Characterization Techniques	✓	✓	✓	✓										
2	18CYC26	Industrial Chemistry	✓	✓	✓	✓										
2	18CSC11	Problem Solving and Programming	✓	✓	✓	✓	✓					✓				
2	18CHT21	Principles of Chemical Engineering	✓	✓	✓	✓	✓					✓		✓	✓	
2	18VEC11	Value Education						✓		✓				✓		
3	18MAC31	Mathematics III	✓	✓	✓	✓	✓								✓	✓
3	18CHT31	Applied Organic Chemistry	✓	✓	✓	✓		✓	✓		✓		✓	✓	✓	✓
3	18CHT32	Chemical Process Calculations	✓	✓	✓			✓	✓		✓		✓	✓	✓	✓
3	18CHT33	Fluid Mechanics	✓	✓	✓	✓			✓					✓	✓	✓
3	18CHT34	Chemical Process Plant Safety	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
3	18EET35	Electrical Drives and Industrial Electronics	✓	✓	✓	✓										
3	18CHL31	Applied Chemistry Laboratory – I	✓	✓		✓		✓	✓	✓	✓	✓		✓	✓	✓
3	18CHL32	Fluid Mechanics Laboratory	✓	✓	✓			✓		✓	✓	✓		✓	✓	✓
4	18MAC41	Statistics and Numerical Methods	✓	✓	✓	✓	✓									
4	18CHT41	Mechanical Operations	✓	✓											✓	✓
4	18CHT42	Process Heat Transfer	✓	✓	✓		✓							✓	✓	✓
4	18CHT43	Process Thermodynamics I	✓	✓											✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
4	18CHT44	Chemical Plant Utilities	✓	✓											✓	✓
4	18CHT45	Chemical Process Industries	✓	✓											✓	
4	18CHL41	Applied Chemistry Laboratory II	✓	✓				✓			✓	✓		✓	✓	✓
4	18CHL42	Mechanical Operations Laboratory	✓	✓				✓	✓	✓	✓	✓		✓	✓	✓
4	18EGL31	English for Workplace Communication									✓	✓		✓		
5	18CHT51	Mass Transfer I	✓	✓	✓										✓	✓
5	18CHT52	Process Thermodynamics II	✓	✓	✓										✓	✓
5	18CHT53	Chemical Reaction Engineering	✓	✓	✓	✓									✓	✓
5	18CHT54	Chemical Equipment Design and Drawing	✓	✓	✓									✓	✓	✓
5	18CHL51	Process Heat Transfer Laboratory	✓	✓				✓	✓	✓	✓	✓		✓	✓	✓
5	18CHL52	Process Computation Laboratory	✓	✓	✓	✓	✓			✓	✓	✓		✓	✓	✓
5	18CHL53	Chemical Reaction Engineering Laboratory	✓	✓		✓	✓			✓	✓	✓		✓	✓	✓
5	18GEL51/ 18GEI51	Professional Skills Training 1 / Industrial Training 1	✓	✓				✓	✓		✓	✓	✓	✓		
5	18GET51	Universal Human Values						✓		✓						
6	18CHT61	Mass Transfer II	✓	✓	✓	✓									✓	✓
6	18CHT62	Process Dynamics and Control	✓	✓	✓										✓	✓
6	18CHT63	Process Modeling and Simulation	✓	✓	✓		✓								✓	✓
6	18CHL61	Mass Transfer Laboratory	✓	✓				✓	✓	✓	✓	✓		✓	✓	✓
6	18CHL62	Process Dynamics and Control Laboratory	✓	✓		✓	✓			✓	✓	✓		✓	✓	✓
6	18CHL63	Process Modeling and Simulation Laboratory	✓	✓	✓		✓			✓	✓	✓		✓	✓	✓
6	18GEL61/ 18GEI61	Professional Skills Training I / Industrial Training I	✓	✓				✓	✓		✓	✓	✓	✓		
6	18CHP61	Project Work I Phase I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	18CHT71	Process Engineering and Economics	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
7	18GEP71	Comprehensive Test and Viva	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓
7	18CHP71	Project Work I Phase II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	18CHP81	Project Work II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Professional Elective Courses														
6	18CHE01	Oil and Natural Gas Engineering	✓	✓	✓										✓	✓

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
6	18CHE02	Fluid Movers	✓	✓	✓										✓	✓
6	18CHE03	Chemical Analysis	✓	✓	✓										✓	✓
6	18CHE04	Bio Chemical Engineering	✓	✓												✓
7	18CHE05	Petroleum Refinery Engineering	✓	✓											✓	✓
7	18CHE06	Fundamentals of Computational Fluid Dynamics	✓	✓	✓	✓	✓							✓	✓	✓
7	18CHE07	Organic Synthesis	✓	✓	✓										✓	
7	18CHE08	Pharmaceutical Process Technology	✓	✓				✓								✓
7	18CHE09	Piping Engineering	✓	✓	✓										✓	✓
7	18CHE10	Complex Fluids	✓	✓	✓										✓	✓
7	18CHE11	Heterogeneous Catalytic Reactions	✓	✓	✓										✓	✓
7	18CHE12	Pulp and Paper Technology	✓	✓	✓										✓	✓
7	18CHE13	Air Pollution Control	✓	✓	✓										✓	✓
7	18CHE14	Transport Phenomena	✓	✓	✓	✓									✓	✓
7	18CHE15	Electrochemical Engineering	✓	✓	✓										✓	✓
7	18CHE16	Modern Separation Processes	✓	✓	✓	✓								✓	✓	✓
7	18CHE17	Total Quality Management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	18GEE01	Fundamentals of Research	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	18CHE18	Process Instrumentation	✓	✓	✓										✓	
8	18CHE19	Industrial Waste Water Treatment	✓	✓	✓				✓					✓	✓	✓
8	18CHE20	Corrosion Technology	✓	✓											✓	✓
8	18CHE21	Ores and Mineral Processing	✓	✓	✓	✓									✓	
8	18MBE49	Entrepreneurship Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓

		Open Elective Courses														
5	18MAO01	Mathematical Foundations of Machine Learning	✓	✓	✓	✓	✓									
5	18PHO01	Thin film Technology	✓	✓	✓											
5	18CYO01	Corrosion Science and Engineering	✓	✓	✓	✓										
5	18CEO01	Remote Sensing and its Applications	✓	✓	✓	✓	✓									

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
5	18MEO01	Renewable Energy Sources	✓	✓	✓	✓			✓			✓		✓		
5	18MTO01	Design of Mechatronics Systems	✓	✓	✓	✓	✓							✓		
5	18AUO01	Automotive Engineering	✓	✓	✓		✓									
5	18ECO01	PCB Design and Fabrication	✓	✓	✓	✓	✓				✓					
5	18ECO02	Neural Networks and Fuzzy Logic for Engineering Applications	✓	✓	✓	✓	✓				✓					
5	18EEO01	Electrical Wiring and Lighting	✓	✓	✓	✓	✓	✓								
5	18EEO02	Solar and Wind Energy Systems	✓	✓	✓	✓										
5	18EIO01	Neural Networks and Deep Learning	✓	✓	✓	✓	✓									
5	18CSO01	Data Structures and its Applications	✓	✓	✓	✓	✓									
5	18CSO02	Formal Languages and Automata Theory	✓	✓	✓	✓										
5	18CSO03	Computational Science for Engineers	✓	✓	✓	✓	✓									
5	18ITO01	Python Programming			✓		✓									
5	18ITO02	Advanced Java Programming			✓		✓									
5	18FTO01	Food Processing Technology	✓	✓	✓	✓										
5	18FTO02	Baking Technology	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		
6	18MAO02	Graph Theory and its Applications	✓	✓	✓											
6	18MAO03	Number Theory and Cryptography	✓	✓	✓		✓									
6	18CYO02	Instrumental Methods of Analysis	✓	✓	✓	✓										
6	18CEO02	Disaster Management	✓	✓	✓			✓	✓					✓		
6	18MEO02	Design of Experiments	✓	✓	✓	✓	✓						✓	✓		
6	18MTO02	Factory Automation	✓	✓	✓	✓	✓	✓			✓	✓		✓		
6	18MTO03	Data Acquisition and Virtual Instrumentation	✓	✓	✓	✓	✓				✓	✓		✓		
6	18AUO02	Autonomous Vehicles	✓	✓	✓											
6	18ECO03	Principles of Quantum Computing	✓	✓	✓	✓	✓									
6	18EEO03	Energy Conservation and Management	✓	✓	✓		✓									
6	18EIO02	Digital Image Processing and Its Applications	✓	✓	✓	✓	✓									
6	18EIO03	Industrial Automation	✓	✓	✓	✓	✓									

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
6	18CSO04	Web Engineering	✓	✓	✓	✓										
6	18CSO05	Foundations of Data Analytics	✓	✓	✓											
6	18CSO06	Nature Inspired Optimization Techniques	✓	✓	✓	✓										
6	18CSO07	Introducing Data Science	✓	✓	✓											
6	18ITO03	Java Programming	✓	✓	✓	✓	✓	✓						✓		
6	18ITO04	Next Generation Databases	✓	✓	✓	✓										
6	18FTO03	Processing of Milk and Milk Products	✓	✓	✓		✓	✓		✓	✓	✓		✓		
6	18FTO04	Processing of Fruits and Vegetables	✓	✓	✓		✓	✓		✓	✓	✓		✓		
7	18MAO04	Advanced Linear Algebra	✓	✓	✓											
7	18MAO05	Optimization Techniques	✓	✓	✓											
7	18PHO02	Structural and Optical Characterization of Materials	✓	✓	✓											
7	18CYO03	Waste and Hazardous Waste Management	✓	✓	✓	✓			✓							
7	18CEO03	Introduction to Smart Cities	✓	✓	✓				✓							
7	18CEO04	Environmental Health and Safety	✓	✓	✓	✓										
7	18MEO03	Fundamentals of Ergonomics	✓	✓	✓	✓		✓	✓			✓		✓		
7	18MEO04	Principles of Management and Industrial Psychology			✓			✓	✓	✓	✓	✓				
7	18MTO04	3D Printing and Design	✓	✓	✓	✓	✓						✓	✓		
7	18MTO05	Drone System Technology	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		
7	18AUO03	Alternate Fuels for Automobile	✓	✓												
7	18ECO04	Electronic Hardware and Troubleshooting	✓	✓	✓	✓	✓	✓								
7	18ECO05	Principles of Communication Techniques	✓	✓	✓	✓	✓									
7	18EEO04	Micro Grid and Smart Grid	✓	✓	✓	✓	✓									
7	18EEO05	Electrical Safety	✓	✓	✓											
7	18EIO04	Biomedical Instrumentation and Applications	✓	✓	✓	✓	✓									
7	18EIO05	PLC Programming and Its Applications	✓	✓	✓	✓	✓									

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
7	18CSO08	Artificial Intelligence and its Applications	✓	✓	✓											
7	18ITO05	Business Continuity Planning	✓	✓	✓	✓										
7	18ITO06	Mobile Application Development	✓	✓	✓	✓										
7	18FTO05	Principles of Food safety	✓	✓	✓		✓	✓	✓	✓				✓		
7	18FTO06	Food and Nutrition	✓	✓	✓	✓								✓		
7	18CEO05	Infrastructure Planning and Management	✓	✓	✓											
8	18CEO06	Environmental Laws and Policy	✓	✓	✓	✓										
8	18MEO05	Safety Measures for Engineers		✓		✓	✓	✓	✓	✓	✓			✓		
8	18MEO06	Energy Conservation in Thermal Equipments	✓	✓	✓			✓	✓			✓	✓	✓		
8	18MTO06	Robotics	✓	✓	✓	✓	✓							✓		
8	18MTO07	Virtual and Augment Reality in Industry 4.0	✓	✓	✓	✓	✓	✓						✓		
8	18AUO04	Automotive Electronics	✓	✓	✓											
8	18AUO05	Vehicle Maintenance	✓		✓			✓								
8	18ECO06	Bioinspired Computing Technologies	✓	✓	✓	✓										
8	18EEO06	Electric Vehicle	✓	✓	✓	✓	✓									
8	18EIO06	Measurements and Instrumentation	✓	✓	✓	✓	✓									
8	18EIO07	Graphical Programming using Virtual Instrumentation	✓	✓	✓	✓	✓									
8	18CSO09	Applied Machine Learning	✓	✓	✓											
8	18CSO10	Fundamentals of BlockChain	✓	✓	✓	✓										
8	18CSO11	Fundamentals of Internet of Things	✓	✓	✓	✓	✓									
8	18ITO07	Essentials of Information Technology	✓	✓	✓	✓										
8	18ITO08	Virtual and Augmented Reality Frameworks	✓	✓	✓	✓										
8	18FTO07	Food Ingredients	✓	✓	✓			✓						✓		
8	18FTO08	Fundamentals of Food Packaging and Storage	✓	✓	✓		✓	✓		✓				✓		

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		General Open Elective														
5,6,7,8	18GEO01	German Language Level 1								✓	✓	✓		✓		
5,6,7,8	18GEO02	Japanese Language Level 1								✓	✓	✓		✓		
7	18GEO03	Design Thinking for Engineers	✓	✓	✓	✓										
8	18GEO04	Innovation and Business Model Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5,6,7,8	18GEO05	German Language Level 2								✓	✓	✓		✓		
5,6,7,8	18GEO06	German Language Level 3								✓	✓	✓		✓		
5,6,7,8	18GEO07	German Language Level 4								✓	✓	✓		✓		
5,6,7,8	18GEO08	Japanese Language Level 2								✓	✓	✓		✓		
5,6,7,8	18GEO09	Japanese Language Level 3								✓	✓	✓		✓		
5,6,7,8	18GEO10	Japanese Language Level 4								✓	✓	✓		✓		
5,6	18GEO11	NCC Studies (Army Wing) – I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
5,6	18GEO12	NCC Studies (Air Wing) – I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				

B.Tech. CHEMICAL ENGINEERING CURRICULUM – R2018

SEMESTER – I									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
18EGT11	English for Communication I	3	0	0	3	50	50	100	HS
18MAC11	Mathematics I	3	1*	2*	4	50	50	100	BS
18PHC11	Applied Physics	3	0	2*	3.5	50	50	100	BS
18CYC11	Applied Chemistry	3	0	2*	3.5	50	50	100	BS
18GET11	Introduction to Engineering	3	0	0	3	50	50	100	ES
18MEC11	Engineering Drawing	2	0	2	3	50	50	100	ES
Practical / Employability Enhancement									
18MEL11	Engineering Practices Laboratory	0	0	2	1	50	50	100	ES
Total Credits to be earned					**21**				

***Alternate Weeks**

SEMESTER – II									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
18EGT21	English for Communication II	3	0	0	3	50	50	100	HS
18MAC21	Mathematics II	3	1*	2*	4	50	50	100	BS
18PHC26	Materials Science and Characterization Techniques	3	0	2*	3.5	50	50	100	BS
18CYC26	Industrial Chemistry	3	0	2*	3.5	50	50	100	BS
18CSC11	Problem Solving and Programming	2	0	2	3	50	50	100	ES
18CHT21	Principles of Chemical Engineering	3	0	0	3	50	50	100	PC
Practical / Employability Enhancement									
18VEC11	Value Education	2	0	1	1	100	0	100	HS
Total Credits to be earned					**21**				

***Alternate Weeks**

SEMESTER – III									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
18MAC31	Mathematics III	3	1*	2*	4	50	50	100	BS
18CHT31	Applied Organic Chemistry	3	0	0	3	50	50	100	PC
18CHT32	Chemical Process Calculations	3	1	0	4	50	50	100	PC
18CHT33	Fluid Mechanics	3	1	0	4	50	50	100	ES
18CHT34	Chemical Process Plant Safety	3	0	0	3	50	50	100	PC
18EET35	Electrical Drives and Industrial Electronics	3	0	0	3	50	50	100	ES
Practical / Employability Enhancement									
18CHL31	Applied Chemistry Laboratory I	0	0	2	1	100	0	100	PC
18CHL32	Fluid Mechanics Laboratory	0	0	2	1	100	0	100	ES
Total Credits to be earned					**23**				

***Alternate Weeks**

SEMESTER – IV									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
18MAC41	Statistics and Numerical Methods	3	1*	2*	4	50	50	100	BS
18CHT41	Mechanical Operations	3	0	0	3	50	50	100	PC
18CHT42	Process Heat Transfer	3	1	0	4	50	50	100	PC
18CHT43	Process Thermodynamics I	3	0	0	3	50	50	100	PC
18CHT44	Chemical Plant Utilities	3	0	0	3	50	50	100	ES
18CHT45	Chemical Process Industries	3	0	0	3	50	50	100	PC
Practical / Employability Enhancement									
18CHL41	Applied Chemistry Laboratory II	0	0	2	1	100	0	100	PC
18CHL42	Mechanical Operations Laboratory	0	0	2	1	100	0	100	PC
18EGL31	English for Workplace Communication	0	0	2	1	100	0	100	HS
Total Credits to be earned					**23**				

***Alternate Weeks**

B.Tech. CHEMICAL ENGINEERING CURRICULUM – R2018

SEMESTER – V									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
18CHT51	Mass Transfer I	3	1	0	4	50	50	100	PC
18CHT52	Process Thermodynamics II	3	0	0	3	50	50	100	PC
18CHT53	Chemical Reaction Engineering	3	0	0	3	50	50	100	PC
18CHT54	Chemical Equipment Design and Drawing	3	1	0	4	50	50	100	PC
	Open Elective I	3	1/0	0/2	4	50	50	100	OE
Practical / Employability Enhancement									
18CHL51	Process Heat Transfer Laboratory	0	0	2	1	100	0	100	PC
18CHL52	Process Computation Laboratory	0	0	2	1	100	0	100	PC
18CHL53	Chemical Reaction Engineering Laboratory	0	0	2	1	100	0	100	PC
18GEL51/ 18GEI51	Professional Skills Training I / Industrial Training I*	--	--	--	2	100	0	100	EC
Mandatory Non Credit									
18GET51	Universal Human Values	2	0	0	2	100	0	100	HS
Total Credits to be earned					**25**				

*** 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									
18CHT61	Mass Transfer II	3	0	0	3	50	50	100	PC
18CHT62	Process Dynamics and Control	3	0	0	3	50	50	100	PC
18CHT63	Process Modeling and Simulation	3	0	0	3	50	50	100	PC
	Professional Elective I	3	0	0	3	50	50	100	PE
	Open Elective II	3	1/0	0/2	4	50	50	100	OE
Practical / Employability Enhancement									
18CHL61	Mass Transfer Laboratory	0	0	2	1	100	0	100	PC
18CHL62	Process Dynamics and Control Laboratory	0	0	2	1	100	0	100	PC
18CHL63	Process Modeling and Simulation Laboratory	0	0	2	1	100	0	100	PC
18GEL61/ 18GEI61	Professional Skills Training II / Industrial Training II*	---	---	---	2	100	0	100	EC
18CHP61	Project Work I Phase I	0	0	4	2	100	0	100	EC
Total Credits to be earned					**23**				

*** 80 hours of Training**

B.Tech. CHEMICAL ENGINEERING CURRICULUM – R2018

SEMESTER – VII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
18CHT71	Process Engineering and Economics	3	0	0	3	50	50	100	HS
	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
	Open Elective III	3	0	0	3	50	50	100	OE
Practical / Employability Enhancement									
18GEP71	Comprehensive Test and Viva	---	---	---	2	100	0	100	EC
18CHP71	Project Work I Phase II	0	0	8	4	50	50	100	EC
Total Credits to be earned					**21**				

SEMESTER – VIII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
	Professional Elective V	3	0	0	3	50	50	100	PE
	Open Elective IV	3	0	0	3	50	50	100	OE
Practical / Employability Enhancement									
18CHP81	Project Work II	---	---	12	6	50	50	100	EC
Total Credits to be earned					**12**				

Total Credits: 169

LIST OF PROFESSIONAL ELECTIVE COURSES (PE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
		Elective – I					
1.	18CHE01	Oil and Natural Gas Engineering	3	0	0	3	VI
2.	18CHE02	Fluid Movers	3	0	0	3	VI
3.	18CHE03	Chemical Analysis	3	0	0	3	VI
4.	18CHE04	Bio Chemical Engineering	3	0	0	3	VI
		Elective – II					
5.	18CHE05	Petroleum Refinery Engineering	3	0	0	3	VII
6.	18CHE06	Fundamentals of Computational Fluid Dynamics	3	0	0	3	VII
7.	18CHE07	Organic Synthesis	3	0	0	3	VII
8.	18CHE08	Pharmaceutical Process Technology	3	0	0	3	VII
		Elective - III					
9.	18CHE09	Piping Engineering	3	0	0	3	VII
10.	18CHE10	Complex Fluids	3	0	0	3	VII
11.	18CHE11	Heterogeneous Catalytic Reactions	3	0	0	3	VII
12.	18CHE12	Pulp and Paper Technology	3	0	0	3	VII
		Elective – IV					
13.	18CHE13	Air Pollution Control	3	0	0	3	VII
14.	18CHE14	Transport Phenomena	3	0	0	3	VII
15.	18CHE15	Electrochemical Engineering	3	0	0	3	VII
16.	18CHE16	Modern Separation Processes	3	0	0	3	VII
17.	18CHE17	Total Quality Management	3	0	0	3	VII
18.	18GEE01	Fundamentals of Research	3	0	0	3	VII

		Elective - V					
19.	18CHE18	Process Instrumentation	3	0	0	3	VIII
20.	18CHE19	Industrial Waste Water Treatment	3	0	0	3	VIII
21.	18CHE20	Corrosion Technology	3	0	0	3	VIII
22.	18CHE21	Ores and Mineral Processing	3	0	0	3	VIII
23.	18MBE49	Entrepreneurship Development	3	0	0	3	VIII

LIST OF OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	18CHO01	Polymer Technology	3	1	0	4	V
2.	18CHO02	Introduction to Drugs and Pharmaceuticals Technology	3	1	0	4	V
3.	18CHO03	Bio Energy Resources	3	1	0	4	VI
4.	18CHO04	Fundamentals of Nanoscience and Nanotechnology	3	1	0	4	VI
5.	18CHO05	Enzyme Engineering	3	0	0	3	VII
6.	18CHO06	Nuclear Engineering	3	0	0	3	VII
7.	18CHO07	Fertilizer Technology	3	0	0	3	VIII

18EGT11 - ENGLISH FOR COMMUNICATION I

(Common to all Engineering and Technology Branches)

Programme & Branch	B.Tech. & Chemical Engineering	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 B1 level in the Common European Framework (CEFR).	
Unit - I	**Listening, Speaking, Reading and Writing. Activity Based Learning – Phase – I:**	**9**
Listening - People talking about their 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.		
Unit - II	**Listening, Speaking, Reading and Writing. 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.		
Unit - III	**Listening, Speaking, Reading and Writing. 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.		
Unit - IV	**Listening, Speaking, Reading and Writing. 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.		
Unit - V	**Listening, Speaking, Reading and Writing. 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.		

Total: 45

TEXT BOOK:

1. Jack C. Richards, "Interchange, Student's Book 2", 4th Edition, Cambridge University Press, New York, 2017.

REFERENCES:

1. Jack C. Richards & Theodore Rodgers, "Approaches and Methods in Language Teaching", 3rd Edition, Cambridge University Press, New York, 2014.
2. Penny Ur, "A Course in English Language Teaching", 2nd Edition, Cambridge University Press, New York, 2012.

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		3	47	17		33	100
CAT2			37	23		40	100
CAT3		3	47	33		17	100
ESE		2	42	27		29	100

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

18MAC11 - MATHEMATICS I

(Common to All Engineering and Technology Branches)

Programme & Branch	B.Tech. & Chemical Engineering	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, multivariable functions and differential equations.	
Unit - I	**Matrices:**	**9**
Introduction to Matrices in Engineering – Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen vectors (without proof) – Cayley – Hamilton theorem (Statement and applications only) - Orthogonal matrices – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic form – Nature of Quadratic forms - Reduction of quadratic form to canonical form by orthogonal transformation – Applications of Eigen values and Eigen vectors: Electric circuit – Mass string problems.		
Unit - II	**Multivariable Calculus:**	**9**
Functions of two 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 - III	**First Order Ordinary Differential Equations:**	**9**
Solutions of differential equations in variables separable form – Exact differential equations – Linear first order differential equations – Bernoulli's equation – Clairaut's equation.		
Unit - IV	**Ordinary Differential Equations of Higher Order:**	**9**
Linear differential equations of second and higher order with constant coefficients - Particular Integrals for the types: e^{ax} – cosax, sinax – x^n – e^{ax} x^n , e^{ax} sinbx and e^{ax} cosbx – x^n sinax and x^n cosax – Differential Equations with variable coefficients: Euler-Cauchy's equation – Legendre' s equation.		
Unit - V	**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).		

List of Exercises / Experiments:

1.	Introduction to MATLAB
2.	Matrix operations : Addition, Multiplication, Transpose and Inverse
3.	Computation of eigen values and eigen vectors
4.	Finding ordinary and partial derivatives
5.	Computing extremes of a single variable function
6.	Plotting and visualizing single variable functions
7.	Solving first and second order ordinary differential equations
8.	Solution of Simultaneous first order ODEs

***Alternate Weeks**

Lecture:45, Practical:15, Total:60

TEXT BOOK:

1. Grewal B. S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, New Delhi, 2011.

REFERENCES:

1. Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics - I", 2nd Edition, Pearson India Education, New Delhi, 2018.
2. Won Y. Yang, Young K. Choi, Jaekwon Kim, Man Cheol Kim, Jin Kim H. and Taeho Im, "Engineering Mathematics with MATLAB", 1st Edition, CRC Press, London, 2018.

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	compute extremal values which arise in function of several	Understanding (K2)
CO3	identify the appropriate method for solving first order ordinary differential equations	Applying (K3)
CO4	solve higher order linear differential equations with constant and variable coefficients	Applying (K3)
CO5	apply the concept of ordinary differential equations for modeling and finding solutions to engineering problems	Applying (K3)
CO6	determine eigen values and eigen vectors of a given matrix using MATLAB	Applying (K3), Manipulation (S2)
CO7	compute maxima and minima of a single variable function, plot and visualize single variable function using MATLAB	Applying (K3), Manipulation (S2)
CO8	solve first and second order ordinary differential equations and simultaneous first order ordinary differential equations using MATLAB	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	1										
CO2	3	2												
CO3	3	3	1	1										
CO4	3	3	1	1										
CO5	3	3	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	20	10	70				100
CAT2	20	10	70				100
CAT3	20	10	70				100
ESE	20	10	70				100

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

18PHC11 - APPLIED PHYSICS

(Common to All Engineering and Technology Branches)

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	1	BS	3	0	2*	3.5

Preamble	This course aims to impart the essential concepts of properties of matter, acoustics, ultrasonics, quantum physics, laser and fibre optics, 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	**Properties of Matter:**	**9**
Elasticity: Stress – Strain – Hooke's law – Stress-strain diagram – Poisson's ratio - Modulus of elasticity - Beams – Bending of beams – Expression for bending moment - Cantilever – Depression of the loaded end of a cantilever - Young's modulus by uniform and non-uniform bending methods - I-shaped girders. Viscosity: Viscous force – Viscosity – Co-efficient of viscosity – Importance of viscosity of liquids (qualitative).		
Unit - II	**Acoustics and Ultrasonics:**	**9**
Acoustics: Sound - Reverberation and reverberation time – Growth and decay of sound and Sabine's formula (qualitative) - Absorption coefficient - Factors affecting acoustics of buildings and their remedies. Ultrasonics: Properties of ultrasonic waves - Production of ultrasonic waves - Magnetostrictive generator - Piezoelectric generator - Applications of ultrasonic waves in non destructive testing.		
Unit - III	**Thermal and Quantum Physics:**	**9**
Thermal Physics: Modes of heat transfer - Thermal conductivity - Radial and cylindrical heat flow - Conduction through compound media (series and parallel). Quantum Physics: Matter waves - Schrodinger's time independent and time dependent wave equations – Physical significance of wave function - Particle in a one dimensional box.		
Unit - IV	**Laser, Fibre Optics and Applications:**	**9**
Laser and Applications: Spontaneous emission and stimulated emission - Population inversion - Pumping methods - Einstein's coefficients - Nd:YAG laser - Holography. Fiber Optics and Applications: Principle of propagation of light through optical fibers - Numerical aperture and acceptance angle - Classification of optical fibers based on refractive index, modes and materials - Fiber optical communication links (block diagram).		
Unit - V	**Crystal Physics:**	**9**
Crystal systems - Bravais lattice - Lattice planes - Miller indices - Interplanar spacing in cubic lattice - Atomic radius, Coordination number and Packing factor for SC, BCC and FCC crystal structures - Crystal imperfections: line and surface imperfections.		

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 viscosity of a given liquid using Poiseuilles' method.
3.	Determination of the velocity of ultrasonic waves in a liquid and the compressibility of a liquid using ultrasonic interferometer.
4.	Determination of the wavelength and the angle of divergence of a semiconductor laser.
5.	Determination of the acceptance angle and the numerical aperture of a given optical fiber.

***Alternate Weeks**

Lecture:45, Practical:15, Total:60

TEXT BOOK:

1. Tamilarasan K. and Prabu K., "Engineering Physics - I", 3rd Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2014.

REFERENCES:

1. Gaur R.K. and Gupta S.L., "Engineering Physics", 8th Edition, Dhanpat Rai and Sons, New Delhi, 2009.
2. Mehta and Neeraj, "Applied Physics for Engineers", 1st Edition, Prentice-Hall of India Pvt. Ltd., New Delhi, 2011.
3. Tamilarasan K. and Prabu K., "Physics Laboratory Manual", 3rd Edition, SCM Publishers, Erode, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	make use of the concepts of elasticity and bending moment of a beam to a simple structure under simple loading to compute the Young\'s modulus of a material, and to explain the concepts of viscosity of liquids.	Applying (K3)
CO2	apply the concepts of growth and decay of sound energy in a hall to recognize the requirements of acoustically good buildings, and to describe the production of ultrasonic waves and non-destructive testing using ultrasonic waves.	Applying (K3)
CO3	use the concepts of heat flow to explain heat conduction through materials, and to describe the behavior of electrons in a metal by means of quantum physics.	Applying (K3)
CO4	apply the concepts of laser 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 fiber optic communication link.	Applying (K3)
CO5	explain seven crystal systems, atomic packing factor of the select crystal systems and the types of crystal defects.	Understanding (K2)
CO6	determine the Young\'s modulus of a material using the concepts of elasticity and bending moment of a beam, and to determine the viscosity of a liquid using the concepts of viscosity.	Applying (K3), Precision (S3)
CO7	compute the velocity of ultrasonic waves in a liquid and the compressibility of a liquid using the concepts of propagation of sound through a medium.	Applying (K3), Precision (S3)
CO8	determine the wavelength and the angle of divergence of a semiconductor laser beam using the concepts of propagation of light through a medium, and to compute the acceptance angle and the numerical aperture of an optical fiber using the concept of total internal reflection.	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											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	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	20	40	40				100
CAT2	20	45	35				100
CAT3	20	50	30				100
ESE	20	40	40				100

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

18CYC11 - 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	2*	3.5

Preamble	Applied Chemistry course imparts the basic principles and concepts of chemistry in the field of Engineering and Technology. It also imparts knowledge on Water Technology, Electrochemistry, Corrosion and its control, Fuels & Combustion and Polymers.	
Unit - I	**Water Technology:**	**9**
Introduction - Sources of water - Impurities in water - Types of water – Water Quality Standards - Hardness of water - Expression of hardness - Units of hardness - Estimation of hardness of water by EDTA method - Determination of alkalinity - Disadvantages of using hard water - Boiler troubles - Scale and sludge - Softening of water - External treatment method - Demineralization process - Internal treatment process - Carbonate and Calgon conditioning - Desalination by reverse osmosis method.		
Unit - II	**Electrochemistry:**	**9**
Introduction - Cells - Representation of a galvanic cell - Reversible and irreversible cells - Electrode potential - Nernst equation - Reference electrode - Standard hydrogen electrode - Glass electrode - Electrochemical series and its applications - Conductometric titrations - Mixture of weak and strong acid vs strong base.		
Unit - III	**Corrosion and its Control:**	**9**
Introduction - Chemical corrosion - Electrochemical corrosion - Galvanic corrosion - Concentration cell corrosion - Galvanic series - Factors influencing rate of corrosion - Corrosion control methods - Sacrificial anodic method - Protective coatings - Pretreatment of metal surface - Metallic coating - Electroplating - Nonmetallic coating - Phosphate coating - Organic coating - Paints - Constituents and their functions - Special paints - water repellant and luminescent paints.		
Unit - IV	**Fuels and Combustion:**	**9**
Introduction - Classification of fuels - Requirements of a good fuel - Combustion - Principle of combustion - Calorific value - Gross and net calorific values - Explosive range - Spontaneous ignition temperature - Calorific intensity - Solid fuels - Coal and its varieties - Proximate analysis - Significance - Metallurgical coke - Otto-Hoffman byproduct method - Liquid fuel - Refining of petroleum - Manufacture of synthetic petrol - Hydrogenation of coal - Bergius method - Knocking - Octane number - Cetane number - Gaseous fuel - LPG.		
Unit - V	**Polymers:**	**9**
Introduction - Classification of polymers - Functionality - Polymerization - Plastics - Types - Thermo and thermosetting plastics - Individual polymers - Polypropylene, PVC, PET and epoxy resin - Preparation, properties and uses - Compounding of plastics - Fabrication of plastics - Compression, injection, extrusion and blow moulding methods - Foamed plastics.		

List of Exercises / Experiments:

1.	Estimation of total, temporary and permanent hardness of water by EDTA method.
2.	Estimation of Ca2+ and Mg2+ hardness separately by EDTA method.
3.	Estimation of alkalinity of the given water sample.
4.	Conductometric titration - Mixture of acids.
5.	Estimation of hydrochloric acid using pH meter.

***Alternate Weeks**

Lecture:45, Practical:15, Total:60

TEXT BOOK:

1.	Palanisamy P.N., Manikandan P., Geetha A. & Manjula Rani K., "Applied Chemistry", 5th Edition, Tata McGraw Hill Education Pvt. Ltd, New Delhi, 2018.

REFERENCES:

1.	Jain & Jain, "Engineering Chemistry", 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2016.
2.	Sharma B.K., "Industrial Chemistry", Krishna Prakasan Media Pvt. Ltd, Meerut, 2014.
3.	Palanisamy P.N., Manikandan P., Geetha A & Manjula Rani K., "Chemistry Laboratory Manual", Rajaganapathy Publishers, Erode, 2018.

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 to construct cells and measure the electrode potential	Applying (K3)
CO3	adopt the suitable corrosion control methods for the given practical 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)
CO6	estimate the amount of hardness for the given water sample by EDTA method	Applying (K3), Precision (S3)
CO7	estimate the amount of alkalinity for the given water sample	Applying (K3), Precision (S3)
CO8	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	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2												
CO5	3	2												
CO6	3	2	1	3										
CO7	3	2	1	3										
CO8	3	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)**

18GET11 - INTRODUCTION TO ENGINEERING

(Common to All Engineering and Technology Branches)

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	1	ES	3	0	0	3

Preamble	The objective of this course is to realize the importance of engineering, measurements and the fundamental concepts of common engineering disciplines like Civil, Mechanical, Electrical and Electronics Engineering.	
Unit - I	**Engineering and Measurements**	**9**
Engineering and Measurements: Engineering - Engineer and Engineering Graduate - Graduate attributes - Role of engineer - Professional bodies and their role. Physical Quantities - Dimensions - SI Units, Symbols and Conversions - Mechanical Measuring Instruments - Electrical Measuring Instruments - Accuracy and Precision - Data Acquisition System.		
Unit - II	**Mechanical Engineering**	**9**
Mechanical Engineering: IC Engines - Power Plants - Boilers and Furnaces - Pumps - Refrigeration and Air Conditioner - CAD/CAM - Additive Manufacturing. Hybrid Electric Vehicles, Industry 4.0.		
Unit - III	**Civil Engineering**	**9**
Civil Engineering: Selection of the site for Building - Building approval process - Contract and tenders - Building Materials - Components of Building - Sequence of works for building construction - Prefabricated Structures - Water Management - Rainwater harvesting - Infrastructure - Bridges, Dams and Roads.		
Unit - IV	**Electrical Engineering**	**9**
Electrical Engineering: Terminologies - Current, voltage, potential difference, power, energy - Supply: DC, AC - single phase and three phase - Energy conversion - Utility structure - Single line diagram of power system - Apparatus - Tariff - House wiring. Alternator - Induction motor - Solar and wind energy.		
Unit - V	**Electronics Engineering**	**9**
Electronics Engineering: Resistor, Inductor, capacitor - Diode - LEDs - Rectifier - Power Supply - Transistor - Transistor as an amplifier - MOSFET - Logic Gates - Microprocessor - Micro controller - Radio communication - Internet of Things.		

Total:45

TEXT BOOK:

1. Faculty of Mechanical Engineering, "Introduction to Engineering", McGraw Hill Education India Pvt. Ltd., Chennai.

REFERENCES:

1. Arvid R. Eide, Roland D. Jenison, Steven K. Mickelson and Larry L. Northup. , "Engineering Fundamentals and Problem Solving", 7th Edition, McGraw Hill Education, New York, 2018.
2. Navaneethakrishnan P., Selvakumar P., Rajeshkumar G. and Sangeetha R.K., "Basic Civil and Mechanical Engineering", McGraw Hill Education, New Delhi, 2016.
3. Senthilnathan N., Logeswaran T. and Suresh M., "Basic Electrical and Electronics Engineering", McGraw Hill, New Delhi, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	recognize the roles of engineer, measurement quantities and systems in Engineering	Understanding (K2)
CO2	infer the components and principles of mechanical engineering applications	Understanding (K2)
CO3	summarize the process involved in building construction, infrastructure and water conservation	Understanding (K2)
CO4	recognize the fundamental terms involved in electrical engineering	Understanding (K2)
CO5	explain the working of basic electronic components and its 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										3		
CO2	3	2	1	1		2	1					3		
CO3	3	2	1	1		2	1					3		
CO4	3	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	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)**

18MEC11 - ENGINEERING DRAWING
(Common to all Engineering and Technology Branches)

Programme & Branch	B.Tech. &Chemical Engineering	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**
General Principles of Orthographic Projection: 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 Solid: 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: 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 Surfaces: 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**
Isometric Projection and Introduction to AutoCAD: 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.		

Total:45

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

18MEL11 - ENGINEERING PRACTICES LABORATORY
(Common to all Engineering and Technology Branches)

Programme & Branch	B.Tech. &Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	I	ES	0	0	2	1
Preamble	This course is designed to provide a hands-on experience in the field of mechanical engineering and electrical engineering such as fitting, plumbing, wood working, sheet metal work, welding, safety aspects, assembly and testing of electrical and electronic circuits.						

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.	To prepare a leak proof sheet metal tray/box/funnel using modern power tools.
6.	Welding practice using welding simulator.
7.	Project: Preparing innovative articles using wood/sheet metal.
	PART B – ELECTRICAL AND ELECTRONICS ENGINEERING
8.	Safety Aspects of Electrical Engineering, Electrical Symbols, Components Identification, Fuse selection and installation, Circuit Breakers selection
9.	Wiring circuit for fluorescent lamp and stair case wiring
10.	Measurement of earth resistance
11.	Soldering of simple circuits and trouble shooting
12.	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	3	3	3	3	3				3	3	2	3		
CO2	3	2	1	1					3	2	2	3		
CO3	2	1							3	2	2	3		
CO4	3	2	1	1					3	3	2	3		

Mapping of COs with POs and PSOs														
CO5	3	2	1	1					3	2	2	3		

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

18EGT21 - ENGLISH FOR COMMUNICATION II

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	2	HS	3	0	0	3

Preamble	This course is designed to impart required levels of fluency in using the English Language at B1 level in the 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, "Interchange, Student's Book 3", 4th Edition, Cambridge University Press, New York, 2017.

REFERENCES:

1. Jane Willis, "A Framework for Task Based Learning", Longman, Harlow, 1996.
2. Rod Ellis, "Task Based Language Learning and Teaching", Oxford University Press, London, 2003.

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	3	3	30	40		24	100
CAT2	3	3	33	43		18	100
CAT3	3	3	33	43		18	100
ESE	3	3	31	45		18	100

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

18MAC21 - MATHEMATICS II

(Common to All Engineering and Technology Branches)

Programme & Branch	B.Tech. &Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	BS	3	1*	2*	4

Preamble	To impart the knowledge of 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	**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 - II	**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 and Gauss divergence theorems (without proof) – Verification of the above theorems and evaluation of integrals using them.		
Unit - III	**Beta and Gamma Functions:**	**9**
Definition of beta and gamma Functions – Properties – Relation between beta and gamma functions – Transformations of gamma function – Applications of beta and gamma functions: Evaluation of definite integrals in terms of beta and gamma functions.		
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 – 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.	Evaluating indefinite and definite integrals
2.	Evaluating double and triple integrals
3.	Finding the area between two curves
4.	Computing gradient, divergence and curl
5.	Computation of beta and gamma 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 Weeks**

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

TEXT BOOK:

1.	Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publications, New Delhi, 2014.

REFERENCES:

1.	Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics - II", 2nd Edition, Pearson India Education, New Delhi, 2018.
2.	Won Y. Yang, Young K. Choi, Jaekwon Kim, Man Cheol Kim, Jin Kim H. and Taeho Im, "Engineering Mathematics with MATLAB", 1st Edition, CRC Press, London, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	solve problems involving double and triple integrals	Understanding (K2)
CO2	apply the concept of vectors in engineering problems	Applying (K3)
CO3	use Beta and Gamma functions to improper evaluate integrals	Applying (K3)
CO4	identify, construct and apply analytic functions in electrostatics and fluid flow problems	Applying (K3)
CO5	evaluate complex integrals which is extensively applied in engineering	Applying (K3)
CO6	evaluate line, double and triple integrals and determine area between two curves using MATLAB	Applying (K3), Manipulation (S2)
CO7	compute gradient, curl and divergence of a vector function 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	2	2											
CO2	3	2												
CO3	3	2	1											
CO4	3	1												
CO5	3	2	2											
CO6					3									
CO7					2									
CO8					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	10	70				100
CAT2	20	10	70				100
CAT3	20	10	70				100
ESE	20	10	70				100

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

18PHC26 - MATERIALS SCIENCE AND CHARACTERIZATION TECHNIQUES

Programme & Branch	B.Tech. &Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics	2	BS	3	0	2*	3.5

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		9

Ferrous Metals and Alloys: Introduction - Iron ore - Pig iron – Cast iron – 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		9

Non-Ferrous Metals and Alloys: 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		9

Ceramics and Composites: 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		9

Advanced Functional Materials: Metallic glasses: Preparation, properties and applications – SMA: Characteristics and applications – Superconductors: Properties and applications – Bio materials: Biopolymers and Bio-ceramics – Applications – Introduction to Nanomaterials.

UNIT – V		9

Materials Characterization: Introduction - Raman spectroscopy – X-ray diffraction - Surface analysis: scanning electron microscope (SEM) and transmission electron microscope (TEM) - Thermal analysis: Thermo gravimetric analysis (TGA).

List of 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 nano-crystalline thin film using air-wedge arrangement.
5. Determination of wavelength of Hg spectrum using spectrometer grating.

Lecture:45, Practical: 15, Total: 60

TEXT BOOK:

1. Tamilarasan K. and Prabu K., "Engineering Physics-II", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2014.

REFERENCES / MANUAL:

1. William D. Callister, "Materials Science and Engineering",7th Edition, John Wiley & Sons, Inc.
2. Raghavan V., "Physical Metallurgy: Principles and Practice", PHI Learning Pvt. Ltd., New Delhi, 2015.
3. Tamilarasan K. and Prabu K., "Physics Laboratory Manual", SCM Publishers, Erode, 2018.

* Alternate Weeks

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:	describe the composition, properties and applications of the select ceramics and composites.	Understanding (K2)
CO4:	explain the preparation, properties and applications of the select advanced functional materials (metallic glasses, SMA, superconductors, bio-materials and nanomaterials)	Understanding (K2)
CO5:	apply the concepts of Raman effect, X ray diffraction, matter wave and thermogram to describe the principle and working of the select material characterization techniques (Raman Spectroscopy, XRD, SEM, TEM and TGA)	Applying (K3)
CO6:	determine the Young's modulus of stainless steel using the concepts of elasticity and bending moment of a beam	Applying (K3), Precision (S3)
CO7:	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 flow through materials	Applying (K3), Precision (S3)
CO8:	determine the thickness of nano-crystalline 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	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											
CO2	3	2	1											
CO3	2	1												
CO4	2	1												
CO5	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	20	40	40				100
CAT2	30	40	30				100
CAT3	25	45	30				100
ESE	20	40	40				100

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

18CYC26 - INDUSTRIAL CHEMISTRY

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Chemistry	2	BS	3	0	2*	3.5

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		9

Modern Analytical Techniques: Introduction - Beer Lambert's law - principle, instrumentation and applications of uv-vis spectroscopy, colorimetry, infra red spectroscopy, atomic absorption spectroscopy and mass spectroscopy.

UNIT - II		9

Phase Rule: Statement and explanation of terms involved – one component system – water system – condensed phase rule – construction of phase diagram by thermal analysis – two component system – simple eutectic system (Pb – Ag system) – congruent and incongruent melting.

UNIT - III		9

Chemical Kinetics and Catalysis: Introduction – order- molecularity- review of integrated rate laws - collision theory of reaction rates - Arrhenius equation - Lindeman's equation for unimolecular collision - transition state theory – catalysis - enzyme catalysis - Michaelis Menten equation-catalytic poisoning.

UNIT - IV		9

Colloids, Emulsions and Gels: Introduction to colloids – classification - preparation – properties (kinetic, optical and electrical properties) - Hardy - Schultz rule, gold number - emulsions - types of emulsions - gels - general applications of colloids.

UNIT - V		9

Surface Chemistry: Introduction – types of adsorption - differences between physisorption and chemisorption - adsorption of gases by solid surfaces - adsorption of solutes from solutions - adsorption isotherms - Freundlich, Langmuir adsorption isotherm and BET equation (derivation not required) and their significance - applications of adsorption.

List of Experiments:

1. Estimation of iron by colorimetry.
2. Determination of transition temperature of a hydrated salt.
3. Construction of phase diagram – simple eutectic system.
4. Determination of rate constant of acid – catalyzed hydrolysis of an ester.
5. Verification of Freundlich isotherm –adsorption of oxalic acid on charcoal.

Lecture:45, Practical:15, Total:60

TEXT BOOK:

1. Karthikeyan M. and Palanisamy P.N., "Industrial Chemistry", Pearson Education, New Delhi, New Edition 2019.

REFERENCES/ MANUAL:

1. Arun Bahl, Bahl B.S. and Tuli G.D., "Essentials of Physical Chemistry", S.Chand Publishing, 2012.
2. Puri B.R., Sharma L.R. and Pathania M.S., "Principles of Physical Chemistry", S. Naginchand and Co., 2017.
3. Palanisamy P.N., Manikandan P., Geetha A. and Manjula Rani K., "Chemistry Laboratory Manual", Rajaganapathy Publishers, Erode, 2018.

* Alternate Weeks

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 and catalysis for designing the reactor	Applying (K3)
CO4:	interpret the knowledge of colloids, emulsions and gels	Understanding (K2)
CO5:	experiment with different reaction mechanisms of surface chemistry	Applying (K3)
CO6:	determine the amount of iron using colorimeter	Applying (K3), Precision (S3)
CO7:	demonstrate the simple eutectic system for the determination of eutectic temperature & composition and thermometric method for determination of transition temperature	Applying (K3), Precision (S3)
CO8:	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	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	2												
CO5	3	2	1	1										
CO6	3	2	1	3										
CO7	3	2	1	3										
CO8	3	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)**

18CSC11 - PROBLEM SOLVING AND PROGRAMMING
(Common to All Engineering and Technology Branches)

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

Preamble	This course mainly focuses on the basic concepts of computing, the methodology of problem solving and developing skills in programming using C language.	
Unit - I	**Introduction to Computer and Problem Solving:**	**6**
Overview of computers - Applications of computers - Characteristics of computer - Basic computer Organization - Number System - Problem solving: Planning the computer program – Algorithms - Flowcharts – Pseudocodes - Structuring the logic.		
Unit - II	**Case Study on Problem Solving:**	**6**
Algorithm, Flowchart and Pseudo code for the problems: Exchanging the values of two variables - Finding the biggest number - Counting - Summation of numbers - Factorial computation - Generation of Fibonacci Sequence - Summation of series - Base Conversion - Reversing the digits of an Integer.		
Unit - III	**Introduction to C and Control Statements:**	**6**
Overview of C - Basic structure of a C Program - Executing a C Program - C Character set - Tokens - Keywords and Identifiers - Constants - Variables - Data types - Storage classes - Managing Input and Output operations - Operators and Expressions - Decision making and Branching - Looping - Break and continue statements.		
Unit - IV	**Arrays, Strings and Structures:**	**6**
Arrays - One dimensional and Two dimensional arrays - Handling of character strings: Declaring and initializing string variables - Performing simple string operations - Introduction to structures: Structure definition - Structure declaration - Accessing a structure member - Structure initialization - Unions.		
Unit - V	**Functions:**	**6**
User defined functions: Elements of user defined functions - String handling functions - Library functions (strings and characters manipulation) - Passing arguments to functions – Recursion. Introduction to Pointers: Understanding pointers - Accessing address of a variable - Declaring pointer variables - Initialization of pointer variables - Accessing a variable through its pointer - Parameter passing mechanisms.		

List of Exercises / Experiments :

1.	Writing algorithms and drawing flowcharts using Raptor Tool for problems involving sequential, selective and repetitive structures
2.	Programs for demonstration of working of different types of operators like arithmetic, logical, relational and ternary operators involving sequential structures
3.	Demonstration of programs using decision making statements namely ‘if’, ‘else if’, ‘switch’, conditional and unconditional ‘goto’ (selective structures)
4.	Programs for demonstrating repetitive control statements like ‘for’, ‘while’ and ‘do-while’ (iterative structures)
5.	Demonstration of programs for declaration, initialization and performing operations on one-dimensional and two-dimensional numeric arrays
6.	Demonstration of programs for implementing various string operations like ‘copy’, ‘finding length’, ‘compare’, ‘concatenate’ with and without built-in library functions.
7.	Demonstration of programs for making use of user-defined data types namely structures and unions
8.	Demonstration of modular programming concepts using functions – developing programs using built-in and user-defined functions and parameter passing mechanisms

Lecture:30, Practical:30, Total:60

TEXT BOOK:

1. "Problem Solving and Programming", compiled by Department of CSE, Kongu Engineering College, Internal circulation, 2017.

REFERENCES:

1. Dromey R.G., "How to Solve it by Computer", Pearson Education, 2009.
2. Balagurusamy E., "Fundamentals of Computing and Programming", Tata McGrawHill Education Pvt. Ltd., 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	outline the characteristics, organisation, working principles and applications of computers	Understanding (K2)
CO2	express the solution for the given real world problems in terms of algorithm, flowchart and pseudocode	Applying (K3)
CO3	identify the appropriate looping and control statements in C for providing the solution to the given problems	Understanding (K2)
CO4	demonstrate the usage of arrays, strings and structures to solve the given problems	Understanding (K2)
CO5	apply fundamental modular programming knowledge to solve the given problems and recall the basic concepts of pointers	Understanding (K2)
CO6	demonstrate the execution of flowchart for the given problem using Raptor	Applying (K3), Precision (S3)
CO7	demonstrate the application of control statements using simple C programs	Applying (K3), Precision (S3)
CO8	implement solutions to the given problem using user defined functions and data types	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	2													
CO2	2	2	2		2									
CO3		2	1											
CO4		2	1											
CO5		2	1											
CO6	3	2	1	1	1					1				
CO7	3	2	1	1	1					1				
CO8	3	2	1	1	1					1				

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	15	25				50
CAT2	5	15	30				50
CAT3	5	15	30				50
ESE	20	30	50				100

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

18CHT21 - PRINCIPLES OF CHEMICAL ENGINEERING

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

Preamble: This course presents the fundamental aspects of chemical engineering and their applications.

UNIT – I		**9**

Introduction to Units and Dimensions: Introduction to Chemical Engineering: History of Chemical Engineering, role of Chemical Engineers– a broad overview; Chemical Industries in India; Basic concepts: units and dimensions, systems of units, conversion and conversion factors of units, concept of mole, weight percent, mole percent, normality, molarity, molality, vapor pressure, partial pressure, concept of ideal gas and equations of state – van der Waals equation of state.

UNIT – II		**9**

Basics of Momentum Transfer: Fluid flow- laminar and turbulent flow; Introduction to transportation of fluids; Types and applications of pumps and valves; Principles of size separation and size reduction

UNIT – III		**9**

Principles of Heat and Mass Transfer: Modes of heat transfer-principles of conduction, convection and radiation; heat exchangers; Overview of unit operations such as distillation, evaporation, absorption, extraction, crystallization, drying, leaching

UNIT – IV		**9**

Fundamentals of Unit Processes: Classification of chemical reactions; order of reaction; rate equation; Arrhenius equation; conversion and yield; Importance and Classification of Catalysts; Overview of Unit Processes- Saponification, Polymerization

UNIT – V		**9**

Foundations of Process Flow and Instrumentation Diagrams: Block diagram; process flow diagram for DCDA process for Sulphuric acid manufacture; basic concepts of P&I diagram; Introduction to process instrumentation and control: common methodologies of measurements, measuring instruments – Pressure and Temperature

Total: 45

TEXT BOOK:

1. Walter L. Badger, Julius T. Banchero, “Introduction to Chemical Engineering”, Tata McGraw Hill Publishing Company Ltd., 1955.

REFERENCES:

1. McCabe W.L., Smith J.C. and Harriot P., “Unit Operations in Chemical Engineering”, 7th Edition, McGraw Hill International Edition, New York, 2006.
2. Pushpavanam S., “Introduction to Chemical Engineering”, PHI Learning Pvt. Ltd., 2012.
3. Salil K. Goshal, Shyamal K. Sanyal, Siddhartha Datta, “Introduction to Chemical Engineering”, Tata McGraw Hill Publishing Company Ltd., 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	describe the role of Chemical Engineers and basic concepts of units and dimensions	Understanding (K2)
CO2:	explain the principles of unit operations	Understanding (K2)
CO3:	describe the fundamental concepts of heat and mass transfer	Understanding (K2)
CO4:	illustrate the foundations of chemical reactions	Understanding (K2)
CO5:	explain the fundamentals of PFD and PID	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	
CO2	3	3	1	1								1	1	
CO3	3	3	1	1								1	1	
CO4	3	3	1	1								1	1	
CO5	3	3	1	1	1					1		1	1	

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	90					100
CAT2	5	95					100
CAT3	5	95					100
ESE	10	90					100

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

18VEC11 - VALUE EDUCATION

(Common to All Engineering and Technology Branches)

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	1	HS	2	0	1	1

Preamble	The aim of the course is to make the students to understand the purpose and value of life and to exhibit positive human values.	
Unit - I	**Philosophy of Life Science:**	**4**
Life - Purpose of life (four stages of life) - Philosophy of life (who am I') – Law of nature (cause of the life and body) - Content of the Life (five sheaths) - Goal of life. Five duties in life. Methodology: Life and messages of spiritual and national leaders - The forgotten hero, etc. Project report: Complementing with happiness - Every soul is potentially divine.		
Unit - II	**Human Values - Moral Foundation:**	**4**
Truth, forgiveness, compassion, endurance, humility, non violence,moderate diet, non stealing, self purification, self discipline, self study, content, cleanliness, honesty, and totality in faith - Good habits - Attitude forming for Individual peace. Practical Methods: Personal experience with above characters, Puranic Stories - Self resolve diary maintenance.		
Unit - III	**Social Values:**	**4**
Family - Family System - Greatness of women - World brotherhood (vasudeiva kudumbagam) - Glorious Bharath - Bharathian systems - Past-Present-Future - Team spirit - Goal setting - Economics - Education - Politics - Responsibilities of people - Preserving natural resources. Methodology: Preparing an album on glorious Bharath Past, Present and Future Plans. Goal setting - Management Games.Team Spirit - Yogic Games.		
Unit - IV	**Development of Mental Prosperity:**	**4**
Prosperity of mind - Functions of mind - Obstacles of mind - Practical method to perfect mind is yoga - Types - Uses - Precaution - Contradiction - Kriyas - Asanas - Pranayamas - Meditative techniques. Methodology: Asana - Pranayama - Cyclic meditation - Nada anu sandhana - Meditation - Yogic games for memory. Album on asanas, pranayama and mantra.		
Unit - V	**Maintenance of Physical Health:**	**4**
Human body - Structure - Ten Systems of the body as per modern science.Five elements - Harmonious relationship - Life force - Conserving vitality and health through natural life -Pranic food and its importance - Uses of herbs - Right way of cooking to preserve nutrients - Cause of the disease - Acute and chronic - Disease - Life and death. Methodology: Natural food making, traditional millet dishes. Asanas, pranayamas, cleansing procedures, Quiz on healthy living, Uses of herbs or kitchen garden.		

List of Exercises / Experiments:

1.	List of Loosening Exercises: Neck Movements, Shoulder Joint Movements, Elbow Joint Movement, Wrist Joint Movements, Finger Joint Movements, Rip Joint Movement, Hip Joint Movements, Spinal Cord Movement, Knee Joint Movements, Ankle Joint Movements, Toe Joint Movements.
2.	List of Asanas: Surya Namaskara, Shavasana, Makarasanas, Uttanpadasana, Pawanamuktasana, Sedubandasana, Naukasana, Vipareetakarani, Bhujangasana, Sarpasana, Shalabasana, Dhanurasana, Padmasana,Parvatasana, Vakrasana, Janu Sirashasana, Ustrasana, Yoga Mudra, Meru Tandasana, Tadasana, Katichakrasana, Paadahastasana, Parivarta Trikonasana, Ardha Chakrasana, Viruksasana.
3.	List of Pranayamas: Naadi Sodhana Pranayama, Bhastrika Pranayama, Bhramari Pranayama, Sheetali Pranayama.

Lecture:20, Practical:10, Total:30

TEXT BOOK:

1. Value Education, "Compiled by Vethathiri Maharishi Institute for Spiritual and Intuitional Education", Aliyar, Pollachi, 2018.

REFERENCES:

1. Value Education - Yoga Practical Guide, "Compiled by Padmasoorya Naturopathy and Yoga Foundation", Coimbatore, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the purpose and value of life.	Understanding (K2)
CO2	exhibit positive human values.	Understanding (K2)
CO3	understand social values.	Understanding (K2)
CO4	take steps to develop mental and physical health	Applying (K3), Imitation (S1)

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		
CO2						3		3				3		
CO3						3		3				3		
CO4						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							0
CAT2							0
CAT3							0
ESE	25	75					100

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

18MAC31 - MATHEMATICS III

(Common to Civil Engineering, Mechanical Engineering, Mechatronics Engineering, Automobile Engineering, Electronics And Communication Engineering, Electrical And Electronics Engineering , Electronics And Instrumentation Engineering, Chemical Engineering & Food Technology Branches)

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	BS	3	1*	2*	4

Preamble	To provide the skills for solving the real time engineering problems involving partial differential equations and impart knowledge in Fourier transform and Z-Transform.	
Unit - I	**Fourier Series:**	**9**
Dirichlet's conditions – General Fourier series – Change of interval – Odd and even functions – Half range Sine series – Half range Cosine series – Harmonic analysis.		
Unit - II	**Partial Differential Equations:**	**9**
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 - III	**Applications of Partial Differential Equations:**	**9**
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).		
Unit - IV	**Fourier Transform:**	**9**
Fourier Integral theorem (without proof) – Fourier transform pair – Properties (without proof) – Transforms of simple functions – Fourier Sine and Cosine transforms – Properties (without proof) – Convolution theorem and Parseval's identity (Statement and applications only).		
Unit - V	**Z –Transform:**	**9**
Definition – Z-transform of some basic functions – Elementary properties – Inverse Z- transform: Partial fraction method – Residue method – Convolution theorem – Applications of Z-transforms: Solution of difference equations.		

List of Exercises / Experiments :

1.	Expressing given function in terms of Fourier series.
2.	Harmonic Analysis of given data.
3.	Solving second order partial differential equations.
4.	Solution of One dimensional wave equation.
5.	Solution of Two dimensional heat equation.
6.	Determining Fourier and inverse Fourier transform of a given function.
7.	Computing Z- transform of a discrete sequence.
8.	Apply Z- transforms to obtain the solution of difference equations.

***Alternate Weeks**

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

TEXT BOOK:

1. Veerarajan T., "Transforms and Partial Differential Equations", 3rd Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2013.

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons Ltd., USA, 2019.
2. Duraisamy C., Vengataasalam S., Arun Prakash K. & Suresh M., "Engineering Mathematics – III", 2nd Edition, Pearson India Education, New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	express given function or data in terms of Fourier series	Applying (K3)
CO2	solve the given standard partial differential equations	Applying (K3)
CO3	apply Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations	Applying (K3)
CO4	use the mathematical principles of Fourier transforms which will provide the ability to formulate and solve some of the physical problems of engineering	Applying (K3)
CO5	apply Z transform techniques for analyzing linear time invariant systems	Applying (K3)
CO6	express the given data in Fourier series using MATLAB	Applying (K3), Manipulation (S2)
CO7	solve partial differential equations using PDE Modeler	Applying (K3), Manipulation (S2)
CO8	find Fourier and Z-Transforms using MATLAB built in functions	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										
CO2	3	3	1	1										
CO3	3	3	1	1										
CO4	3	3	1	2										
CO5	3	3	1	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	20	10	70				100
CAT2	20	10	70				100
CAT3	20	10	70				100
ESE	20	10	70				100

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

18CHT31 - 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		**9**
Basic Principles: Classification, Shapes and structural representation of organic compounds, Isomerism, Steric-hinderence, Inductive effect and Resonance structures. Separation and Purification of organic compounds.		
UNIT – II		**9**
Organic Reaction: Mechanism of Electrophilic reaction - Friedel craft reaction, Riemer Tiemann Reaction, Beckmann rearrangements; Mechanism of Nucleophilic reactions-Aldol condensation, Perkins reaction, Benzion condensation; Mechanism of Free radical reaction- Halogenations of Alkanes, Addition of HBr on Alkenes in presence of peroxide, Thermal halogenations reaction.		
UNIT – III		**9**
Carbohydrates and Amino Acids: Classification of carbohydrates, Mono, Di and Polysaccharides – Glucose, Starch and Cellulose. Derivatives of Cellulose - Structural aspects. Industrial uses of starch and cellulose. Classification and Properties of Amino Acids.		
UNIT – IV		**9**
Synthesis of Dyes and Drugs: Classification of Dyes; Synthesis of Dyes - Congo red. Triphenylmethane dyes -Malachite green, Para Rosaniline, Alizarin, Eosin; Drug Synthesis - Sulphanilamide, Sulphapyridine, Chloroquine, penicillin, erythromycin.		
UNIT – V		**9**
Oils, Fats, Soaps and Detergents: Oil and Fat - Occurrence and Extraction, Physical and chemical characteristics, Analysis 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. Robert Thornton Morrison, Robert Neilson Boyd, “A Text Book of Organic Chemistry”, 7th Edition, Pearson Education, India, 2010.

REFERENCES:

1. Graham Solomons T.W., Craig B. Fryhle, Scott A. Snyder, “Organic Chemistry”, 11th Edition, International Student version, John Wiley & Sons Inc., New York, 2013.
2. Jonathan Clayden, Nick Greeves, Stuart Warren, “Organic Chemistry”, 2nd Edition, Oxford University Press Inc., USA, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	write the organic compounds and separate the compounds using simple techniques	Understanding (K2)
CO2:	develop simple mechanism of the organic reactions	Applying (K3)
CO3:	illustrate the classification and properties of carbohydrates and amino acids	Applying (K3)
CO4:	demonstrate the synthesis of dyes and drugs	Applying (K3)
CO5:	discuss extraction and uses of oils and carry out the synthesis of soaps and detergents	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			2	1	2
CO2	3	2	1	1		2	2		1		1	3	3	2
CO3	3	2	1	1					1			2	3	2
CO4	2	1				1			1			3	3	3
CO5	2	1										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	35	65					100
CAT2	35	60	5				100
CAT3	35	60	5				100
ESE	30	60	10				100

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

18CHT32 - 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		**9+3**
Basics of Process Calculation: Methods of expression- compositions of mixtures and solutions - Ideal and real gas law: Calculations of pressure, volume and temperature using ideal and van der Waals equation - Use of partial pressure, vapor pressure, mole fraction, pure component volume and total pressure in vapor mixture calculations.		
UNIT – II		**9+3**
Material Balance for Unit Operation: Application of material balance for unit operation - distillation, evaporation, crystallization, drying, extraction and blending - Humidification and Dehumidification**:** Calculation of absolute, molal, relative and percentage humidity – use of Psychrometric chart - Material balance calculation for unit operation using spread sheet		
UNIT – III		**9+3**
Material Balance for Unit Process: Stoichiometric principles: conversion, limiting and excess reactants, yield and selectivity - Material balance for the systems involving chemical reaction, bypass operation, recycle and purging system.		
UNIT – IV		**9+3**
Energy Balance: Thermal physics: Heat capacity - enthalpy changes of solids, liquids, gases and solutions - Thermal chemistry: Heat of reaction, formation, solution, mixing and combustion - Effect of pressure and temperature on heat of reaction- Adiabatic flame temperature.		
UNIT – V		**9+3**
Fuels and Combustion: 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. Himmelblau D.M., “Basic Principles and Calculations in Chemical Engineering”, 8th Edition, Prentice Hall of India, New Delhi, 2013.

REFERENCES:

1. Venkataramani V., Anantharaman N. and Sheriffa Begam K.M., “Process Calculations”, 2nd Edition, Prentice Hall of India, New Delhi, 2011.
2. Richard M. Felder, Ronald W. Rosseau, and Lisa G. Bullard., “Elementary Principles of Chemical Processes”, 4th Edition, Wiley, 2015.

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 and van der waals equation of state for gas mixture	Applying (K3)
CO2:	calculate the mass/ molar flow rate and composition of streams for diverse unit operation and compute material balance for the given system using spread sheet	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	PSO 2
CO1	2	1				1	1						3	2
CO2	3	2	1									1	3	2
CO3	3	2	1						1			2	3	2
CO4	2	1				2	2		1		1	2	3	2
CO5	2	1				2	2		1		1	2	3	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		10	90				100
CAT2		10	90				100
CAT3			20	80			100
ESE			50	50			100

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

18CHT33 - FLUID MECHANICS

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	ES	3	1	0	4
Preamble	This course provides a brief knowledge about the fundamentals of momentum transfer, metering and transportation of fluids						

UNIT – I		**9**
Fluid Properties and Fluid Statics: Nature of fluids - Properties of fluids - Rheology of fluids- Classification of fluids - Fluid statics and application - Pressure measurement – Manometers: Units and Dimensions- Dimensional analysis - types and principles of Similarity.		
UNIT – II		**9**
Incompressible flow in Pipes and Channels: Types of flow – Boundary layer formation - Basic equation of fluid flow: Equation of Continuity- Bernoulli's equation and applications - Shear stress distribution - laminar and turbulent flow in pipes and closed channels - Friction factor - Moody's Chart.		
UNIT – III		**9**
Flow past immersed bodies: Drag and drag coefficients; Flow through beds of solids - determination of pressure drop using Ergun equation; Fluidization-types, determination of minimum fluidization velocity and pressure drop**;** Motion of particles through fluids – calculation of terminal settling velocity		
UNIT – IV		**9**
Metering of Fluids: Classification and selection of flow meters - Venturi, Orifice and Rotameters - determination of discharge coefficient - Principle and applications of Pitot tube, Anemometers, Turbine, Coriolis, Vortex flow and Magnetic flow meters - Introduction to notches and weirs.		
UNIT – V		**9**
Transportation of Fluids: Classification and selection of fluid moving machinery - Centrifugal pump-characteristics and applications - elementary principles of Reciprocating, gear, air lift, diaphragm and submersible pumps - Introduction to valves and pipe fittings - Introduction to compressors, blowers, fans - Compressors: types and applications		
		Lecture:45, Tutorial:15, Total: 60

TEXT BOOK:

1. McCabe W.L., Smith J.C. and Harriot P., "Unit Operations in Chemical Engineering", 7th Edition, McGrawHill Education, 2013.

REFERENCES:

1. Frank M. White, "Fluid Mechanics", 8th Edition, McGrawHill Education, 2015.
2. Cengel Yunus and Cimbala John M., "Fluid Mechanics Fundamentals and Applications", 4th Edition, McGrawHill Education, 2017.

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:	analyse the choice of flow meters for the given fluid flow application	Analyzing (K4)
CO5:	inspect the selection of pumps 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	PSO 2
CO1	3	2	1				1					3	3	2
CO2	3	2	1				1					3	3	2
CO3	3	3	2				1					3	3	2
CO4	3	3	3	1								3	3	2
CO5	3	3	3	1								3	3	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1			65	35			100
CAT2			60	40			100
CAT3			65	35			100
ESE			60	40			100

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

18CHT34 - CHEMICAL PROCESS PLANT SAFETY

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	PC	3	0	0	3
Preamble	This course highlights various safety measures practiced in Chemical Process Industries.						

UNIT – I		**9**
Safety Principles: Need for safety, Safety programs, Training and Education - Personal protective Equipments, Safety codes: NFPA, IS and OSHA standards - Colour codes for pipe lines. Materials Safety Data sheets - Safety in storage and handling of chemicals.		
UNIT – II		**9**
Hazards: Hazards - fire, explosion and radiation; Designs to prevent fire and explosion hazards - Relief and relief sizing - Occupational diseases – Types, Causes and effects.		
UNIT – III		**9**
Safety in Operations and Processes: Safety in operations and processes. Runaway reactions, unstable products - Safety Studies – HAZOPS, HAZANS, Fault tree, Event tree and risk analysis		
UNIT – IV		**9**
Industrial Accidents: Industrial accidents – types, causes, effects, costs, prevention, investigation and analysis, accident proneness, case studies		
UNIT – V		**9**
Legal Aspects: Factories act, ESI act and Workmen's compensation act - Role of Government, safety organizations, management and trade unions in promoting industrial safety - Emergency response systems for hazardous goods - Rules and requirements which govern the chemical industries.		
		Total: 45

TEXT BOOK:

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

REFERENCES:

1. Roy E. Sanders, "Chemical Process Safety: Learning from case histories", 4th Edition, Butterworth-Heinemann, 2015.
2. Raju K.S.N., "Chemical Process Industry Safety", 1st Edition, 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 safety measures practiced in handling and storage of chemicals	Applying (K3)
CO2:	classify industrial hazards and apply the safety procedure to prevent fire and explosion hazards	Applying (K3)
CO3:	examine safety in operation and processes through hazop and hazan studies	Analyzing (K4)
CO4:	describe the causes to prevent industrial accidents	Applying (K3)
CO5:	make use of the legal aspects of industrial safety; explain the emergency response 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	2	1				3	3	1		2	1	2	2	2
CO2	2	1				3	3	1		1		2	2	2
CO3	3	3	2			3	2					2	2	2
CO4	2	1				3	1	1	1	2		2	2	2
CO5	2	1				3	2	2	1	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	20	50	30				100
CAT2	20	30	30	20			100
CAT3	20	40	20	20			100
ESE	20	50	30	20			100

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

18EET35 - ELECTRICAL DRIVES AND INDUSTRIAL ELECTRONICS
(Common to Mechanical & Chemical branches)

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	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		9
Electrical Drives and Motor Characteristics: 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		**9**
Motor Starting and Braking Methods: 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		**9**
Power Electronics: 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		**9**
Conventional and Solid State Speed Control of DC Drives: 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		**9**
Conventional and Solid State Speed Control of AC Drives: 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 Education, 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	20	80					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)**

18CHL31 - APPLIED CHEMISTRY LABORATORY I

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	PC	0	0	2	1
Preamble	This course provides an hands on experience on analysis of various commercial chemicals.						

List of Experiments:

1. Determination of partition co-efficient
2. Determination of Kinetics of persulphate-iodide reaction
3. Estimate the acid value and iodine value of the given oil sample
4. Determine the alkali content and fatty acid content in the given sample of soap
5. Estimate the amount of moisture content and mixed oxide in the given sample of cement
6. Determine the sucrose content in the given sample of sugar
7. UV Spectro photometer: Estimation of ferrous ions present in the given sample
8. Flame Photometer: Determination the amount of Sodium and Potassium ions present in samples
9. Nephelometer: Determination of turbidity and colour of the given waste water
10. Estimate the amount of nitrogen in urea by Kjeldahl's method

Total: 30

REFERENCES/MANUAL/SOFTWARES:

1. Laboratory Manual

Course Outcomes: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	determine the rate constant of a reaction/ acid value / iodine value of oils and alkali / fatty acid content of soaps	Applying (K3), Manipulation (S2)
CO2:	estimate the purity of sugar and moisture/ mixed oxide content of cement/ concentration of sample ions using UV Spectrometer/ Flame Photometer	Applying (K3), Manipulation (S2)
CO3:	estimate the turbidity of water using Nephelometer and the Nitrogen content of urea by Kjeldahl's method	Applying (K3), Imitation (S1)

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		1	3	1
CO2	3	2		1		2		1	3	2		1	3	2
CO3	2	1		1		1	1	1	3	2		1	3	1

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

18CHL32 - FLUID MECHANICS LABORATORY

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	ES	0	0	2	1
Preamble	This course enables the students to understand and study the working of flow meters, pumps, valves and fittings.						

List of Experiments:

1. Determination of discharge coefficient of variable head flow meters
2. Experimental investigation of flow characteristics of Rotameter
3. Estimate the discharge coefficient of V- notch and open drum
4. Measurement of air velocity using Pitot tube
5. Determination of loss coefficient of valves and pipe fittings
6. Verification of Moody diagram for flow through straight pipe and Helical coils
7. Study the effect of Reynolds s number on friction factor for flow through concentric pipes
8. Experimental verification of Bernoulli's Theorem
9. Determination of Pressure drop for flow through Packed bed
10. Determination of minimum fluidization velocity for flow through fluidized bed
11. Characteristics of centrifugal and reciprocating pump
12. Characteristics of vaccum and gear pump

Total: 30

REFERENCES/MANUAL/SOFTWARES:

1. 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	PSO 2
CO1	3	2	1			2		1	3	2		2	3	1
CO2	3	2	1			2		1	3	2		2	3	2
CO3	3	2	1			2		1	3	2		2	3	1

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

18MAC41 STATISTICS AND NUMERICAL METHODS

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

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	4	BS	3	1*	2*	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		**9**
Testing of Hypothesis: Introduction – Critical region and level of significance – Types of Errors – Large sample tests: Z-test for single mean and difference of means – Small sample tests: Student's t-test for significance of means – F-test for comparison of variances – Chi-square test for goodness of fit and independence of attributes		
UNIT – II		**9**
Design of Experiments: Analysis of variance – One way classification: Completely Randomized Design – Two way classification: Randomized Block Design – Three way classification: Latin Square Design.		
UNIT – III		**9**
Solution to Algebraic and Transcendental Equations: 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		**9**
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 and backward interpolation formulae – Numerical integration: Trapezoidal rule – Simpsons 1/3rd rule.		
UNIT – V		**9**
Numerical Solution of First order Ordinary Differential Equations: 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 and Practical:15, Total: 60

List of Exercises:

1. Testing significance of means by student's t - test
2. Testing the independence of attributes by Chi-square test
3. Analyze the difference in means is statistically significant by Completely Randomized Design
4. Finding positive root by Regula – Falsi method
5. Solving simultaneous linear equations by Gauss – Seidel Method
6. Evaluating definite integrals by Trapezoidal and Simpson's rules
7. Solution of ODE by Euler and Modified Euler methods
8. Solution of ODE by Runge-Kutta method

TEXT BOOK:

1. Veerarajan T. & Ramachandran T. , "Statistics and Numerical Methods ", 1st Edition, Tata McGraw Hill Education, New Delhi, 2018.

REFERENCES:

1. Jay L. Devore. , "Probability and Statistics for Engineering and the Sciences ", 9th Edition, Cengage Learning , USA, 2016.
2. Steven C. Chapra & Raymond P. Canale. , "Numerical Methods for Engineers ", 7th Edition, McGraw-Hill Education, New York, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify large and small samples and apply suitable tests for solving engineering problems	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 ordinary differential equations numerically	Applying (K3)
CO6	test whether the given data is significant by hypothesis testing and ANOVA using MATLAB	Applying (K3), Manipulation (S2)
CO7	use MATLAB for determining numerical solutions of algebraic equations and integral values	Applying (K3), Manipulation (S2)
CO8	obtain the numerical solution of ordinary differential equations 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	2	1	2										
CO2	3	1	2	2										
CO3	3	2	1	1										
CO4	3	1	1	1										
CO5	3	2	1	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)**

18CHT41 - 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		**9**
Properties and Handling of Particulate Solids: Particle characterization, agglomeration and segregation; Methods of handling, transportation and storage of bulk solids.		
UNIT – II		**9**
Size Reduction: Laws and mechanism of size reduction; types of crushing equipment; industrial screens and screen effectiveness.		
UNIT – III		**9**
Separation of Particulate Solids: Principles of classifier, gravity settling, sedimentation and centrifugal separation; flotation, magnetic separators and electrostatic precipitator.		
UNIT – IV		**9**
Filtration: Filtration theory, classification of filtration process, Selection of filters; Industrial filtration equipments.		
UNIT – V		**9**
Agitation and Mixing: 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", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1. Coulson J.M. and Richardson J.F., "Chemical Engineering", Volume II, 5th Edition, Butterworth-Heinemann Ltd., 2002.
2. Badger Walter L. and Banchero Julius T., "Introduction to Chemical Engineering", Tata McGraw Hill Publishing Company, New Delhi, 21st Reprint 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	determine the characteristics of solids, size analysis and 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	Analyzing (K4)
CO3:	examine the separation equipment for solid-solid, solid-liquid and solid-gas system and design of thickener	Analyzing (K4)
CO4:	categorize various filters and determine the rate of filtration	Analyzing (K4)
CO5:	analyze the working of various types of impellers, mixers and determine the power consumption for mixing	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											3	1
CO2	3	2											3	1
CO3	2	1											2	2
CO4	3	2											3	2
CO5	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		40	40	20			100
ESE	10	35	35	20			100

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

18CHT42 - PROCESS HEAT TRANSFER

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PC	3	1	0	4
Preamble	This course will help the students to apply the modes of heat transfer and its application in design of heat transfer equipments.						

UNIT – I	9+3
Conduction: 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 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	**9+3**
Convection: 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	**9+3**
Radiation: 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.	
UNIT – IV	**9+3**
Heat Transfer with Phase Change: Introduction to boiling and condensation, condensers-vertical and horizontal types, Evaporator- Types and method of feed - steam economy and surface area calculations for single effect evaporator.	
UNIT – V	**9+3**
Heat Exchangers: 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.	

Lecture:45, Tutorial:15, Total: 60

TEXT BOOK:

1. Holman. J.P. and Souvik Battacharyya, "Heat Transfer", 10th Edition, McGraw Hill, 2011.

REFERENCES:

1. Yunus A. Cengel, "Heat Transfer: A Practical Approach", 2nd Edition, McGraw Hill, 2003.
2. Kern D.Q., "Process Heat Transfer, 1st Edition, Mc Graw Hill, 1950.

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.	Applying (K3)
CO3:	apply the laws of radiation heat transfer for different configurations.	Applying (K3)
CO4:	inspect the fundamentals of boiling and condensation and determine the economy of evaporator	Analyzing (K4)
CO5:	design and analyze the performance of heat exchangers	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	3	2
CO2	3	3	2									2	3	2
CO3	3	3	2									2	3	2
CO4	3	3	3		1							2	3	3
CO5	3	3	3		1							2	3	3

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

ASSESSMENT PATTERN - THEORY

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

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

18CHT43 - PROCESS THERMODYNAMICS I

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Material and Energy Balance Calculations	4	PC	3	0	0	3
Preamble	This course introduces the basic principles and the applications of the laws of thermodynamics to various systems in process industries.						

UNIT – I		9
Basic Concepts and First Law of Thermodynamics: Thermodynamic systems; Properties- intensive and extensive, point and path, specific and molar; Processes – reversible and irreversible, rapid and quasi-equilibrium, cyclic; Energy –potential, kinetic, internal; enthalpy; Energy in transit – heat and work; Equilibrium – mechanical, thermal, phase, chemical, thermodynamic; First law of thermodynamics – statement, applications to closed systems and open systems.		
UNIT – II		**9**
Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, heat engine, Carnot engine, Carnot cycle, Carnot theorem, performance of heat engine, Clausius theorem, feasibility analysis of devices and processes based on Carnot theorem and Clausius theorem; entropy, Entropy change – mixing of gases, quenching, heat exchange.		
UNIT – III		**9**
Properties of Real Gases: PVT behavior of real fluids, compressibility factor, critical pressure, critical temperature, reduced pressure, reduced temperature, acentric factor, two and three–parameter theorem of corresponding states, volume expansivity, isothermal compressibility, compressibility chart and generalized compressibility chart; Models for real gases – Virial equation of state, van der Waals equation, Redlich-Kwong equation.		
UNIT – IV		**9**
Thermodynamic Formulations: Measurable and non-measurable properties, basic energy relations, Maxwell equations, thermodynamic formulations to calculate enthalpy, internal energy and entropy as function of pressure and temperature; thermodynamic formulations involving heat capacity at constant pressure and heat capacity at constant temperature.		
UNIT – V		**9**
Compression and Expansion of Fluids: Thermodynamic aspects and classification of compression process, isothermal and isentropic compression, determination of work requirement for single stage and multi-stage compression, factors affecting compressor performance, convergent divergent flow in nozzles, steam-jet ejectors.		

Total :45

TEXT BOOK:

1. Milo D. Koretsky, “Engineering and Chemical Thermodynamics”, 2nd Edition, Wiley, 2012.

REFERENCES:

1. Smith J.M., Hendrick Van Ness, Michael Abbott, Mark Swihart, “Introduction to Chemical Engineering Thermodynamics”, 8th Edition, McGraw Hill Education, 2018.
2. Kyle B.G., “Chemical and Process Thermodynamics”, 3rd Edition, Pearson Education, India, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the first law of thermodynamics to closed and open systems	Applying (K3)
CO2	determine the performance and analyze the feasibility of devices and processes using second law	Analyzing (K4)
CO3	determine and analyze the volumetric properties of real gases	Analyzing (K4)
CO4	develop relations among measurable and non-measurable properties	Applying (K3)
CO5	determine and analyze work requirement for various methods of compression	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											3	1
CO2	3	2											3	1
CO3	3	2											3	1
CO4	3	2											3	2
CO5	3	2											3	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	5	25	50	20			100
CAT2	5	25	40	30			100
CAT3	5	25	40	30			100
ESE	10	10	50	30			100

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

18CHT44 - CHEMICAL PLANT UTILITIES

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PC	3	0	0	3
Preamble	This course highlights the working of various utilities used in chemical process industries.						

UNIT – I		**9**
Water and Steam: Source and characteristics of water; soft and Demineralised water. Treatment of water for boiler and cooling towers. Properties of steam; waste heat boilers. Thermic fluid System for process applications. Steam trap - classification, selection and applications. Efficient use of steam in process plants		
UNIT – II		**9**
Air and Humidification: Air, Compressed air, Types and characteristics of fans, blowers and compressors. Air drying systems. Humidification and dehumidification of air. Production of oxygen and nitrogen by PSA systems.		
UNIT – III		**9**
Refrigeration: Principles, compression and absorption refrigeration systems. Types and properties of refrigerants, eco- friendly refrigerants		
UNIT – IV		**9**
Vacuum System: Selection of vacuum systems; types and characteristics of vacuum pumps, steam jet ejectors and auxiliaries. Process equipment under vacuum – Separation columns, Reactors Evaporators and Dryers		
UNIT – V		**9**
Insulation and Inert Gas: Importance of insulation. Insulation materials for high, intermediate, low and very low temperatures. Calculation of critical thickness of insulation. Properties of inert gases and their uses		

Total: 45

TEXT BOOK:

1. Jack Broughton, “Process Utility System - Introduction to Design Operation and Maintenance”, Institution of Chemical Engineers, UK, 1994.

REFERENCES:

1. Lyle O., “Efficient use of Steam”, HMSO Publishers, 2000.
2. Eskel Nordell, “Water treatment for industrial and other uses”, 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	determine the quality of air using psychometric charts and perceive the importance of compressed air and PSA systems	Applying (K3)
CO3	describe the principles of refrigeration processes and analyze their performance	Analyzing (K4)
CO4	select suitable vacuum systems for different chemical processes	Analyzing (K4)
CO5	calculate optimum critical thickness of insulation for process piping and gain an insight on characteristics of inert gases	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						2	2
CO2	3	1					1						2	1
CO3	3	2											2	1
CO4	3	2											2	1
CO5	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	10	65	25				100
CAT2	10	65	25				100
CAT3	15	75	10				100
ESE	12	68	20				100

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

18CHT45 - CHEMICAL PROCESS INDUSTRIES

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PC	3	0	0	3
Preamble	This course will able to help the students to be aware of manufacture process of various chemical.						

UNIT – I		**9**
Sugar and Paper Industries: Classification of unit operations and unit processes - Construction of block diagrams and process flow diagram; Sugar industries : production of sugar and sugar refining process; Paper industries : Manufacture of chemical pulp and paper, recovery of chemicals in pulping process .		
UNIT – II		**9**
Inorganic Alkalies and Acids Industries: Manufacture of sodium chloride, soda ash, sodium bicarbonate, caustic soda and chlorine, hydrochloric acid, sulfuric acid phosphoric acid, nitric acid- Chemical coagulants: aluminum sulfate and aluminum oxide		
UNIT – III		**9**
Fertilizer Industries: Manufacture of ammonia, urea, ammonium phosphate, ammonium nitrate, ammonium sulphate, single and triple super phosphate, potassium nitrate, potassium sulphate and potassium chloride- compound fertilizers of N-P-K.		
UNIT – IV		**9**
Polymer Industries: Polymerization technology - Manufacture of polypropylene , polystyrene, PVC, nylons 6 , nylons 6 6 , viscose rayon, cellulose acetate**,** polyesters, ABS and SBR, vulcanization of rubber.		
UNIT – V		**9**
Cement, Glass and Paint Industries: Manufacture of cement - Manufacture of glass - Paint industries: introduction, classification, Constituents, Manufacture of white gloss enamels, red oxide primer and exterior emulsion paint, requirement of good paint, paint failure and applications, Types of pigment		

Total: 45

TEXT BOOK:

1. Austin G.T., “Shreve's Chemical Process Industries”, 5th Edition, McGraw-Hill International Book Company, Singapore, 2012.

REFERENCES:

1. Gopala Rao M. and Marshall Sittig, “Dryden‘s Outlines of Chemical Technology”, 3rd Edition, East-West Press, New Delhi, 2008.
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	develop the process flow diagram for various products and describe the manufacturing process of sugar and paper industries	Applying (K3)
CO2	explain the production of alkali based products and mineral acids	Understanding (K2)
CO3	illustrate the manufacturing process of chemical fertilizers	Understanding (K2)
CO4	describe the manufacturing process of polymer and allied product	Understanding (K2)
CO5	elaborate the cement, glass and paint production process	Understanding (K2)

Mapping of COs with POs and PSOs

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

18CHL41 - APPLIED CHEMISTRY LABORATORY II

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PC	0	0	2	1
Preamble	This course enables the students to prepare organic compounds and perform their qualititative and quantitative analysis.						

List of Experiments:	
1.	Determination of carbohydrates from unknown organic compounds
2.	Identification of acids from unknown organic compounds
3.	Determination of ester from unknown organic compounds
4.	Determination of amine from unknown organic compounds
5.	Determination of amide from unknown organic compounds
6.	Preparation of meta-di nitro benzene from nitro benzene
7.	Preparation of benzoic acid from ethyl benzoate
8.	Preparation of benzoic acid from benzaldehyde
9.	Estimation of phenol and/or aniline using Winklers methods
10.	Determine quantitatively the separation of acid from hydrocarbon mixture

Total: 30

REFERENCES/MANUALS/SOFTWARES:	
1.	Lab 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	2				2			3	2		2	3	1
CO2	3	2				2			3	2		2	3	2
CO3	2	2				2			3	2		2	3	1

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

18CHL42 - MECHANICAL OPERATIONS LABORATORY

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PC	0	0	2	1
Preamble	This course gives a practical view on various mechanical operations carried out in industries.						

List of 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. Carry out the batch sedimentation test to design a thickener
10. Determine the power consumption for mixing in a liquid agitator

Total: 30

REFERENCES/MANUALS/SOFTWARES:

1. Lab 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 using Jaw and Roll Crusher	Applying (K3), Manipulation (S2)
CO2:	calculate the critical speed and assess work index by using Ball mill and performance analysis of a screw conveyor	Applying (K3), Manipulation (S2)
CO3:	estimate average particle size and specific surface area by conducting Sieve Analysis, Beaker Decantation and Air Permeability experiments	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

18EGL31 - ENGLISH FOR WORKPLACE COMMUNICATION

(Common to all Engineering and Technology branches)

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	HS	0	0	2	1
Preamble	This course is designed to impart required levels of fluency in using the English Language at B2 level in the CEFR through activities, hands-on training and application.						

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

18CHT51 - 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 Humidification, Drying and crystallization.	
Unit – I	**Diffusion:**	**9+3**
Ficks law, Molecular and eddy diffusion in gases and liquids-steady state diffusion under stagnant and laminar flow conditions-Diffusivity measurement and prediction-multi component diffusion-diffusion in solids and its applications		
Unit - II	**Interphase Mass Transfer:**	**9+3**
Equilibria, Mass transfer coefficients -Individual and overall with relations, Theories of mass transfer, Analogies between momentum, heat and mass transfer to predict mass transfer coefficients.		
Unit - III	**Humidification:**	**9+3**
Humidification- Theory, Psychometric Chart, Adiabatic Saturation, Wet Bulb Theory, Methods of Humidification and dehumidification. Cooling tower- theory, Design, Industrial cooling towers		
Unit - IV	**Drying:**	**9+3**
Theory and mechanism of drying-drying characteristics of materials-batch and continuous drying-calculation for continuous drying-various drying equipment and their applications.		
Unit - V	**Crystallization:**	**9+3**
Principles of crystallization-super saturation-theory of homogeneous and heterogeneous nucleation-law of crystal growth and growth coefficients-Calculations involving material and energy balances-Methods of crystallization based on super saturation and industrial equipment.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOKS:

1. Treybal R. E., "Mass-Transfer Operations", 3rd Edition, McGraw Hill Education, India, 1981 for Units I, II, III, IV.
2. Anantharaman N., Meera Sheriffa Begum K.M., "Mass Transfer Theory and Practice", Prentice Hall of India Pvt. Ltd, New Delhi, 2017 for Unit V.

REFERENCE:

1. 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	describe types of diffusion operations in fluids, solids and determine diffusivity	Applying (K3)
CO2	calculate the mass transfer co efficient using theories and analogies	Applying (K3)
CO3	apply the principles of humidification/dehumidification to design cooling towers	Applying (K3)
CO4	determine time of drying and classify dryers	Applying (K3)
CO5	select crystallizers and determine the yield of crystallization	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	1
CO2	2	2											3	2
CO3	3	2	1										3	2
CO4	3	2											3	2
CO5	3	2											3	2

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

ASSESSMENT PATTERN - THEORY

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

18CHT52 - PROCESS THERMODYNAMICS II

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Process Thermodynamics I	5	PC	3	0	0	3

Preamble	This course introduces the applications of thermodynamic principles to separations involving phase and reaction equilibria.	
Unit - I	**Properties of Pure fluids:**	**9**
Chemical potential; Fugacity - fugacity coefficient, effect of temperature and pressure on fugacity, methods for determination of fugacity; Activity – effect of temperature and pressure on activity; residual properties.		
Unit - II	**Properties of solutions:**	**9**
Partial molar properties; fugacity coefficients in solutions;activity in solutions, activity coefficient; Gibbs-Duhem equation; property change of mixing –enthalpy, entropy, Gibbs free energy, molar volume; excess properties of mixtures		
Unit - III	**Phase Equilibria:**	**9**
Phase equilibrium and stability, equilibrium between phases in single/ multi component non-reacting systems in terms of chemical potential and fugacity, vapour-liquid equilibrium, P-x-y and T-x-y diagrams using Antoine equation; azeotrope, effect of temperature and pressure on azeotrope; models for excess Gibbs free energy – Margules two-suffix, van Laar, Wilson equations.		
Unit - IV	**Chemical Reaction Equilibria:**	**9**
Reaction stoichiometry –stoichiometric co-efficient, stoichiometric number, sign convention of stoichiometric number, reaction co-ordinate; Thermodynamic analysis of reactions – single, parallel; standard Gibbs free energy change and reaction equilibrium constant, effect of temperature on equilibrium constant, analysis of homogeneous gas phase and liquid phase reactions, law of mass action.		
Unit - V	**Refrigeration and Liquefaction:**	**9**
Refrigeration – principle, methods of production, reversed Carnot cycle, vapour compression and absorption systems, co-efficient of performance of refrigeration cycle, ton of refrigeration, choice of refrigerant, air refrigeration cycle, cascade refrigeration system, evaluation of the performance of various refrigeration cycles; Liquefaction – methods, Claude and Linde process.		

Total:45

TEXT BOOK:

1. Joseph Mauk Smith, Hendrick C. Van Ness, Michael M. Abbott, Mark Thomas Swihart, "Introduction to Chemical Engineering Thermodynamics", 8th Edition, McGraw Hill Book Co, India, 2017 for Units I, II, III, IV.
2. Narayanan K.V., "A Textbook of Chemical Engineering Thermodynamics", 2nd Edition, PHI Learning Pvt. Ltd., India, 2017 for Unit V.

REFERENCES:

1. Kyle B.G., "Chemical and Process Thermodynamics", 3rd Edition, Pearson Education, India, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	calculate the thermodynamic properties of pure fluids	Applying (K3)
CO2	estimate the thermodynamic properties of solutions	Applying (K3)
CO3	analyze the systems at Vapour-Liquid Equilibrium	Analyzing (K4)
CO4	determine the equilibrium composition of homogeneous reactions	Applying (K3)
CO5	determine the performance of refrigeration and liquefaction 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	2											3	1
CO2	3	2											3	1
CO3	3	3	1										3	1
CO4	3	2											3	2
CO5	3	2											3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	60				100
CAT2	10	25	40	25			100
CAT3	10	30	60				100
ESE	10	10	55	25			100

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

18CHT53 - CHEMICAL REACTION ENGINEERING

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; Temperature dependency on rate equation. Integral and differential methods for analyzing kinetic data-constant volume batch reactor, half life period, irreversible and reversible reaction.		
Unit - II	**Ideal Reactor:**	**9**
Interpretation of kinetic data in variable volume batch reactor. 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.

REFERENCE BOOKS:

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 and 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	2											3	2
CO2	3	3	2	1									3	3
CO3	3	3	1	1									3	3
CO4	3	2											3	3
CO5	3	2	1										3	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	30	40				100
CAT2	20	20	30	30			100
CAT3	10	30	50	10			100
ESE	20	20	30	30			100

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

18CHT54 - CHEMICAL EQUIPMENT DESIGN AND DRAWING

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Chemical Process Calculations, Fluid Mechanics, 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 Coulson and Richardson”s Chemical Engineering Series”, 6th Edition, Butterworth – Heinemann, Elsevier, United States of America, 2019 for Units I, II, III, IV.
2. Bhatt Bl, Thakore SB, "Introduction to Process Engineering and Design", 2nd Edition, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2015 for Units V.

REFERENCE BOOKS:

1. Luyben W L , "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 States 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	3	1									2	3	2
CO2	3	3	1									2	3	2
CO3	3	3	1									2	2	2
CO4	3	3	1									2	2	2
CO5	3	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		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)**

18CHL51 - PROCESS HEAT TRANSFER 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.	Calculation of thermal conductivity of a material.
2.	Estimation of transient heat conduction- constant flux and constant temperature
3.	Evaluation of overall heat transfer coefficient and heat transfer rate in a Column.
4.	Calculation of heat transfer coefficient and fin efficiency in an extended surface
5.	Ascertain heat transfer coefficient under natural convective heat transfer.
6.	Estimation of heat transfer coefficient under forced convective condition heat transfer
7.	Evaluation of Stefan Boltzmann constant
8.	Determination of combined convective and radiative heat transfer coefficient
9.	Ascertain boiling mechanism in heat transfer equipment
10.	Estimation of steam economy and efficiency of a single effect evaporator.
11.	Calculation of heat transfer coefficient in a jacketed vessel.
12.	Evaluation of heat transfer coefficient in horizontal and vertical condenser
13.	Comparison of heat transfer coefficient in a double pipe heat exchanger for co-current and counter current flow.
14.	Determination of overall heat transfer coefficient in a shell and tube heat exchanger for parallel flow

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	apply the heat transfer concepts to solve steady and unsteady 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

18CHL52 - PROCESS COMPUTATION LABORATORY

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	PC	0	0	2	1
Preamble							

List of Exercises / Experiments :

1.	Performing basic chemical calculations using spreadsheet
2.	Linearization & Error Analysis of graphical data using spreadsheet
3.	Performing Mass & Energy Balance using spreadsheet
4.	Generation of a Process Flow Diagram using AutoCAD
5.	Generation 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.	Estimation of major and minor losses in fluid flow using MATLAB
8.	Design of Shell and Tube & Double pipe heat exchanger using MATLAB
9.	Design of Condenser using MATLAB
10.	Design of Single effect evaporator using MATLAB
11.	Design of Plug Flow & Mixed Flow Reactor for a given reaction using MATLAB
12.	Optimization of experimental data using Response Surface Methodology

Total:30

REFERENCES/MANUAL/SOFTWARE: Book information not available.

1.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	perform fundamental chemical calculations using spreadsheet	Applying(K3), Manipulation (S2)
CO2	sketch PFD, P&ID and 3D drawings using software	Applying(K3), Manipulation (S2)
CO3	perform equipment design calculations and optimization using software	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	2		2			1	3	2		3	2	1
CO2	3	2	2		2			1	3	2		3	2	1
CO3	3	3	2	2	2			1	3	2		3	2	1

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

18CHL53 - CHEMICAL REACTION ENGINEERING 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.	Kinetics of equimolar and non-equimolar reactions in a batch reactor
2.	Effect of flow rate of reactants on conversion in a plug flow reactor
3.	Effect of flow rate of reactants on conversion in a mixed flow reactor
4.	Comparison of plug flow and mixed flow reactors
5.	Effect of flow rate of reactants on conversion in a combined reactor
6.	Effect of temperature on reaction rate and conversion in a batch reactor
7.	Effect of temperature on reaction rate and conversion in a plug flow reactor/ mixed flow reactors
8.	Residence time distribution in a plug flow and mixed flow reactors
9.	Evaluation of non-ideal reactors using dispersion and tank in series models
10.	Residence time distribution studies in fixed bed/ fluidized bed reactors
11.	Determination of surface area using BET isotherm
12.	Comparison of catalytic and non catalytic systems in batch reactor

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	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

18GEL51 - 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)**

18GET51 - 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)**

18CHT61 - 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 absorption, distillation, adsorption, ion exchange, extraction and leaching.	
Unit - I	**Absorption:**	**9**
Co-current and counter current operations-Concept of Equilibrium and operating lines- Stage wise and Differential contactors, Concept of HTU and NTU, Tower packings and packing characteristics. Choice of solvent, Co-current and counter-current operations, Kresmer Equation for plate tower, overall volumetric mass transfer coefficients; Equipment for gas absorption: Mechanically agitated vessels, Packed column and plate columns.		
Unit - II	**Distillation:**	**9**
Vapor-Liquid Equilibria- Raoult's law and deviations from ideality - Methods of distillations-flash, steam, simple, azeotropic, extractive, vacuum, molecular distillation- Design of single stage simple and flash distillation columns		
Unit - III	**Fractionation Analysis:**	**9**
Continuous fractionation- Fenske equation-fractionation of binary and multi component system-Design calculations of continuous distillation columns using Mc-Cabe Thiele Method and Ponchon Savarit methods- continuous contact distillation tower (packed tower) design calculations.		
Unit - IV	**Extraction and Leaching:**	**9**
Equilibrium in ternary systems- equilibrium stage wise contact calculations for batch and continuous extractors- calculation of number of stages- differential contact extraction equipment- spray, packed and mechanically agitated contactors, pulsed extractors, centrifugal extractors. Solid -Liquid equilibria- - calculations in single stage, multi stage cross flow and counter current leaching - Equipment and industrial applications.		
Unit - V	**Adsorption and Ion Exchange:**	**9**
Characteristics and choice of adsorbents- Theories of adsorption of gases and liquids- Adsorption isotherms and breakthrough curve- calculations of adsorption - equipment for batch and continuous operation, Ion Exchange – Selectivity, univalent, divalent-univalent, ion diffusion – particle and film control, Equipment – Fixed bed, Fluidized bed, Higgins moving packed bed, Industrial applications.		

Total: 45

TEXT BOOK:

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

REFERENCE BOOKS:

1. Coulson J.M., Richardson J.F., "Chemical Engineering", 5th Edition, Vol. II, P. Butterworth Heinemann, New Delhi, 2002.
2. Geankoplis C.J., “Transport Processes and Separation Process Principles”, 4th Edition, Prentice-Hall of India, New Delhi, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	determine HTU and NTU for absorption column	Applying(K3)
CO2	explain the methods and perform the design of distillation equipment	Applying(K3)
CO3	analyze design parameters of distillation column	Analyzing(K4)
CO4	calculate extraction efficiency for the extraction and leaching processes	Applying(K3)
CO5	determine the adsorbent quantity for adsorption process and describe ion exchange concepts	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
CO2	3	3	2										2	2
CO3	2	3	2	2									2	2
CO4	3	3	2										2	2
CO5	3	3	1										2	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	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)**

18CHT62 - PROCESS 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 able to help the students to compute the response of various control system strategies for different process dynamics	
Unit - I	**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 systems - Linearization of nonlinear systems.		
Unit - II	**Development of Closed Loop Control System:**	**9**
Controllers: Types and Transfer functions - Principles of pneumatic and electronic controllers. final control elements: function and Transfer functions. Feed-back control systems: concept and development of block diagrams. Transportation lag.		
Unit - III	**Transient Response and Stability Analysis:**	**9**
Transient Response: Servo and regulator mechanism problems - dynamic response of closed loop system-offset calculations. Stability analysis: Routh test and root locus diagrams.		
Unit - IV	**Frequency Response Analysis:**	**9**
Introduction to frequency response - frequency response characteristic - Bode diagrams - Bode stability criterion - Phase and gain margin - Nyquist plot.		
Unit - V	**Controller Tuning and Advance Control System:**	**9**
Tuning of controller settings: Ziegler-Nichols and Cohen-Coon methods. Advanced control systems: principle and applications - cascade - ratio and feed forward - feed backward control.		

Total:45

TEXT BOOK:

1. Donald R. Coughanowr, Steven E. LeBlanc, "Process Systems Analysis and Control", 3rd Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2013.

REFERENCE BOOKS:

1. Bhagade Sudheer S. and Nageshwar Govind Das, "Process Dynamics and Control", Prentice Hall of India Pvt. Ltd., New Delhi, 2011.
2. Stephanopoulos S.G., "Chemical Process Control: An Introduction to Theory and Practice", Prentice Hall of India Pvt. Ltd., New Delhi, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	classify forcing functions and develop response equations of open loop control systems	Applying (K3)
CO2	explain the principles of controllers and control elements for different applications	Applying (K3)
CO3	analyze the closed loop control systems to determine the transient response, offset and stability	Analyzing (K4)
CO4	analyze the stability of control system using frequency response	Analyzing (K4)
CO5	perform controller tuning and describe the advanced control strategies	Applying (K3)

Mapping of COs with POs and PSOs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1										3	1
CO2	3	3	1										3	1
CO3	3	3	2										3	1
CO4	3	3	2										3	1
CO5	3	3	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	10	10	80				100
CAT2	10	10	30	50			100
CAT3	10	20	30	40			100
ESE	10	20	35	35			100

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

18CHT63 - PROCESS MODELING AND SIMULATION

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Chemical Process Calculations, Fluid Mechanics, Process Heat Transfer, Process Thermodynamics I, Chemical Reaction Engineering	6	PC	3	0	0	3

Preamble	To make the students knowledgeable in different aspects of modeling chemical process systems & familiarizes 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	**Introduction to Fundamentals of Process Modeling:**	**9**
Basics of Modeling: Introduction - Physical modeling - mathematical modeling and its classification - chemical systems modeling - Principles of formulation - Representation of a model - Model building - Boundary conditions - Black box principles. Fundamental laws used in modeling: Continuity equations - Energy equation - Equation of Motion - Transport equations - Equations of state - Equilibrium relations - Chemical kinetics.		
Unit – II	**Models in Separation Processes:**	**9**
Mathematical model aspects: Multi component flash drum - Compartmental distillation model - Ideal binary distillation column - Binary continuous distillation column - Absorption column - steady state single stage and two stage solvent extraction – Forward and backward feed triple effect evaporator –Double pipe heat exchanger.		
Unit - III	**Mathematical Modeling of Reactors:**	**9**
The Process and the model aspects: Batch reactor - Tubular reactor - Jacketed tubular reactor - isothermal and non-isothermal CSTR - CSTR with cooling jacket - CSTRs in series - constant and variable holdup - Continuous stirred tank bioreactor.		
Unit - IV	**Models in Fluid Flow Operations:**	**9**
The process and the model aspects: Mixed vessel - laminar flow in pipe - Gravity flow tank - Cone shaped tank - Mixing tank - Stirred tank heater - Two stirred tank heaters - Interacting stirred tank heaters - Interacting and Non-interacting tanks - Agitated tank for solid dissolution.		
Unit – V	**Process Simulation:**	**9**
Process Simulation: Introduction - Scope of process simulation - Formulation of problem - Steps in steady state simulation - Simulation approach for steady state process. Process Simulator: Introduction - Structure of Process Simulator - Professional Simulation Packages (ASPEN and HYSYS) -Selection of Proper Equation of State/Fluid packages -Available Unit Operation Models – HTRI Exchanger Suite modules.		

Total:45

TEXT BOOK:

1. Babu B.V, "Process Plant Simulation", 1st Edition, Oxford University Press, New Delhi, 2004.

REFERENCE BOOKS:

1. Luyben W.L, "Process Modeling, Simulation and Control for Chemical Engineers", 2nd Edition, Tata McGraw Hill Publishing Company Ltd, New York, 1990.
2. Amiya K. Jana, "Chemical Process Modeling and Computer Simulation", 2nd Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2014.
3. https://www.htri.net

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the basic concepts of mathematical models and fundamental laws	Understanding (K2)
CO2	build up mathematical models for distillation and separation columns	Applying (K3)
CO3	derive mathematical models for various reactors	Applying (K3)
CO4	develop mathematical models for various fluid flow systems	Applying (K3)
CO5	describe the concepts of simulations using simulators	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		1								3	2
CO2	3	3	2		1								3	2
CO3	3	3	2		1								3	2
CO4	3	3	2		1								3	2
CO5	3	2	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		25	75				100
CAT2		25	75				100
CAT3	10	40	50				100
ESE	10	30	60				100

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

18CHL61 - MASS TRANSFER LABORATORY

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

List of Exercises / Experiments:

1.	Determination of the diffusivity of a fluid – fluid and fluid - solid system
2.	Estimation of mass transfer co-efficient using Wetted wall column
3.	Determination of the activity coefficients & Van Laar constant for the given system by performing VLE experiments
4.	Verifying Raleigh's equation for the given system using simple distillation setup
5.	Estimation of 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
6.	Determination of vaporization efficiency (Ev) and thermal efficiency (Et) of the given system using steam distillation apparatus
7.	Conduction of batch drying study and estimation of mass transfer coefficient and psychometric ratio
8.	Conduction of simple Leaching studies using given system
9.	Conduction of liquid - liquid extraction studies and plot binodal curve for the given ternary system
10.	Verification of adsorption isotherms by Batch Adsorption
11.	Conduction of drying experiments using Vacuum dryer
12.	Determination of the exchange rate and saturation point by deionising water using Ion-Exchange experiment
13.	Estimation of mass transfer coefficient of a air-water system in a cooling tower.

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 diffusivity and mass transfer co-efficient of a given system using humidification equipment	Applying (K3), Manipulation (S2)
CO2	evaluate the performance and design parameters for various distillation operations	Applying (K3), Manipulation (S2)
CO3	estimate the separation efficiency of various mass transfer equipment	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

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

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

18CHL62 - PROCESS DYNAMICS AND CONTROL LABORATORY

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

List of Exercises / Experiments :

1.	Estimation of time constant for first order system
2.	Study the response and evaluation of time constant for two tank non-interacting level systems
3.	Evaluation of time constant for two tank interacting level systems
4.	Verification of 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.	Performance comparison of ON-OFF and different gain value for P controller in flow control loop
9.	Estimation of optimum controller settings using shell and tube heat exchanger.
10.	Analysis 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: Book information not available.

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	analysis the response of controllers for different applications	Applying (K3), Manipulation (S2)
CO3	estimate optimum controller setting and study the advance 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			1	3	2		2	3	1
CO2	3	2		2	2			1	3	2		2	3	1
CO3	3	2		2	2			1	3	2		2	3	1

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

18CHL63 - 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
Preamble							

List of Exercises / Experiments :

1.	Analysis of physical properties and thermodynamic equilibrium diagram construction
2.	Estimation of physical property for a non- data bank component
3.	Simulation of heat exchanger using Aspen Plus by short cut and detailed method
4.	Simulation of mixer and flash separator
5.	Simulation of steady state plug flow reactor
6.	Simulation of distillation column
7.	Simulation and analysis of extraction column
8.	Sensitivity analysis and influence of flow rate of single component on absorption and its optimization
9.	Generate a simple process flow diagram and perform simulation study
10.	Design of shell and tube heat exchanger using HTRI

Total:30

REFERENCES/MANUAL/SOFTWARE:

1. Aspen Plus
2. HTRI

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 and estimate the physical properties of chemicals using aspen plus software	Applying (K3), Manipulation (S2)
CO2	simulate heat and mass transfer equipment using various simulation software	Analyzing (K4), Manipulation (S2)
CO3	perform simulation of reactors; simulate a simple process flow diagram	Analyzing (K4), Manipulation (S2)

Mapping of COs with POs and PSOs

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

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

18GEL61 - 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: 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 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)**

18CHP61 - PROJECT WORK I PHASE I

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites		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	3	3	2	2	3	2	3	3	3	3	3	3
CO2	3	2	3	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	3	3	3	2	2	2	3	3	3	3	2	2
CO5	3	2	3	2	2	2	2	2	3	3	3	3	2	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

18CHT71 - 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 Micro, Macroeconomics, functions of management and decision making techniques	
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	**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.		
Unit – V	**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.		

Total:45

TEXT BOOK:

1. Peter and Timmerhaus, "Plant Design and economics for Chemical Engineers", 4th Edition, McGraw Hill Book Co, New York, 1999.

REFERENCE BOOKS:

1. Robin Smith, "Chemical Process Design and Integration", 2nd Edition, John Wiley & Sons Inc, United Kingdom, 2014.
2. Harry Silla, " Chemical Process Engineering: Design and Economics", 1st Edition, CRC press, USA, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the procedure for process design development in process industries.	Applying (K3)
CO2	select and describe the factors affecting plant location and layout	Applying (K3)
CO3	estimate the cost for industrial operations	Applying (K3)
CO4	calculate the capital cost investment for process industries	Applying (K3)
CO5	Determine taxes and depreciation for industrial operations	Applying (K3)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

18GEP71 – COMPREHENSIVE TEST AND VIVA
(Common to all BE/BTech branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	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														

18CHP71 - PROJECT WORK I PHASE II

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	--	7	EC	0	0	8	4

Total:120

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	3	3	2	2	3	2	3	3	3	3	3	3
CO2	3	2	3	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	3	3	3	2	2	2	3	3	3	3	2	2
CO5	3	2	3	2	2	2	2	2	3	3	3	3	2	2

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

18CHP81 – PROJECT WORK II

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	---	8	EC	0	0	12	6

Total:180

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	3	3	2	2	3	2	3	3	3	3	3	3
CO2	3	2	3	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	3	3	3	2	2	2	3	3	3	3	2	2
CO5	3	2	3	2	2	2	2	2	3	3	3	3	2	2

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

18CHE01 - OIL AND NATURAL GAS ENGINEERING

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	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:**	**9**
Natural gas origin and sources, classification of traps – conventional and non-conventional traps, classification and composition of natural gas; Properties of natural gas – chemical and physical properties, properties of rocks.		
Unit - II	**Exploration and production:**	**9**
Exploration techniques – Direct, Geo-physical, Geo-chemical methods, comparison. Rigs – components, types– On shore and Off shore rig platforms; Drilling Operations – Conventional and Shale drilling, well completionand stimulation techniques.		
Unit - III	**Multiphase gas transmission and operation:**	**9**
Multiphase flow – fundamentals, two and three phase flow regimes – horizontal, vertical and inclined, flow pattern maps. Multiphase pipeline operations – leak detection, pipeline depressurization, pigging – types. Gas hydrates and prevention techniques.		
Unit - IV	**Purification, Transportation and Storage:**	**9**
Gas treatment process – specifications, amine treatment, absorption process, fluor solvent process – innovations. Transportation – pipelines, LNG, LPG and comparison; Storage of Natural Gas – Regular and Supplementary storage mechanisms.		
Unit - V	**Applications and Safety:**	**9**
Applications of Natural Gas – domestic, industrial, power generation and transportation sectors, safety and environmental; Oil spill management - Natural Gas accident case studies – Exxon Valdez oil spill and Deepwater Horizon oil spill.		

Total:45

TEXT BOOKS:

1. Saeid Mokhatab, William Poe and John Mak, “Handbook of Natural Gas Transmission and Processing”, 4th Edition, Gulf Professional Publishing, USA, 2019 for Units I,II,III,IV.
2. Primož Potocnik, “Natural Gas”, Intech Open, Croatia, 2010 for Unit V.

REFERENCE BOOK:

1. Charles Sheppard, “World Seas: An Environmental Evaluation: Volume III: Ecological Issues and Environmental Impacts”, 2nd Edition, Academic Press, UK, 2019.

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 techniques involved in exploration and drilling of natural gas	Understanding (K2)
CO3	exemplify the deliverability and flow behaviour in a reservoir	Understanding (K2)
CO4	describe the purification, compression and liquefaction of oil and natural gas for storage and transportation.	Understanding (K2)
CO5	identify the key applications of natural gas in various sector; apply the knowledge of safety for handling natural gas using case studies.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	3										2	1
CO2	3	1	3										2	1
CO3	3	2	3										3	2
CO4	3	1	3										2	1
CO5	3	1	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	35	65					100
CAT2	40	60					100
CAT3	35	65					100
ESE	40	60					100

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

18CHE02 - FLUID MOVERS

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	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 he, "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, United State of America, 2015. Units IV, V.

REFERENCE BOOKS:

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)**

18CHE03 - CHEMICAL ANALYSIS

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

Preamble	This course helps the student to understand the basic principle, instrumentation and applications of various analysis techniques	
Unit - I	**Analytical Process:**	**9**
Measurement, general steps of analysis, statistics (only theoretical) and error calculation. Quality assurance and calibration methods. Principles of acid-base equilibria and titration. Sample preparation.		
Unit – II	**Chromatographic Methods:**	**9**
Classification of chromatographic methods; Column, Thin layer, Paper, Gas, High Performance Liquid Chromatography. HPLC - principle, mode of separation and technique. Gas chromatography - principle, mode of separation and technique. Estimation of organic compounds by GC and HPLC.		
Unit – III	**Spectrophotometry:**	**9**
Electromagnetic Radiation-Various ranges, Dual properties, Various energy levels, Interaction of photons with matter, absorbance and transmittance. Classification of instrumental methods based on physical properties.		
Unit – IV	**Thermal Methods:**	**9**
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).		
Unit - V	**Molecular Spectroscopy:**	**9**
Principle, Instrumentation and applications of spectroscopy and Ramans spectroscopy. Various electronic transitions in organic and inorganic compounds effected by UV, visible and IR radiations, Woodward-Fischer rules for the calculation of absorption maxima (dienes and carbonyl compounds). Nuclear Magnetic Resonance: principle and instrumentation. Relaxation, Chemical shift and its causes.		

Total:45

TEXT BOOKS:

1. Daniel C. Harris, "Qualitative Chemical Analysis", 9th Edition, W.H. Freeman and Company, New York, 2015 for Units I, II.
2. Banwell G.C., "Fundamentals of Molecular Spectroscopy", 5th Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2013 for Units III, IV, V.

REFERENCE BOOK:

1. Skoog D.A. and West D.M., "Fundamentals of Analytical Chemistry", 7th Edition, Saunders College Publishing, New York, 1996.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the quantitative and qualitative methods of sampling and analytical procedures	Understanding (K2)
CO2	classify chromatographic techniques and elaborate the principle of GC and HPLC	Understanding (K2)
CO3	illustrate the characteristics of EM radiation and classify the instrumental methods based on physical properties	Understanding (K2)
CO4	describe the principle, instrumentation and applications of various thermal analysis methods	Understanding (K2)
CO5	outline the principle, instrumentation and applications of spectroscopy and nuclear magnetic resonance	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	3										2	1
CO2	3	1	3										2	1
CO3	3	1	3										2	1
CO4	3	1	3										2	1
CO5	3	1	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	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)**

18CHE04 - BIO CHEMICAL ENGINEERING

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

Preamble	To gain knowledge in Microbes, Enzymes and Bioreactors for various Industrial applications.	
Unit - I	**Microbes and Microbial Kinetics:**	**9**
Classification of Microbes, Typical growth characteristics of microbial cells- Factors affecting growth, Monod model, immobilization techniques.		
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 KLa, 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. Rao D.G., "Introduction to Biochemical Engineering", 2nd Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.

REFERENCE BOOKS:

1. Bailey J.E. and Ollis D.F., "Biochemical Engineering Fundamentals", 2nd Edition, Tata McGraw-Hill, New Delhi, 2010.
2. Palmer T. and Bonner P. L., "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	Understanding (K2)
CO3	describe the sterilization and fermentation process	Understanding (K2)
CO4	apply theories of mass transfer to microbial systems	Applying (K3)
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
CO2	3	1												2
CO3	3	1												2
CO4	3	2												2
CO5	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	50	50					100
CAT3	30	60	10				100
ESE	40	50	10				100

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

18CHE05 - 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	**Formation and Refinery Products:**	**9**
Origin, formation and composition of petroleum, properties of petroleum; classification of refinery products, additives and test methods.		
Unit - II	**Crude Oil Properties and Test Methods:**	**9**
Crude oil properties; additives for gasoline; Test methods – ASTM distillation, reid vapor pressure, octane number, gum content, sulfur content, pour point, smoke point, fire point, flash point, aniline point, burning quality test, carbon content.		
Unit - III	**Treatment Techniques:**	**9**
Desalting of crudes, dehydration and fractionation methods; thermal and catalytic cracking processes – vis-breaking, Dubbs two coil process, coking, FCC, Hydro cracking processes.		
Unit - IV	**Upgradation Processes:**	**9**
LPG & LNG production processes, Solvent extraction; hydro treatment processes; Reforming and Alkylation		
Unit - V	**Miscellaneous Products:**	**9**
Isomerization; polymerization; finishing and purification processes. Sources of Asphalt, Air blowing of Bitumen, Upgradation of heavy crudes		

Total:45

TEXT BOOK:

1. Bhaskara Rao B.K., "Modern Petroleum Refining Processes", 6th Edition, Oxford and IBH Publishing Company, New Delhi, 2017.

REFERENCE BOOKS:

1. Nelson W.L., "Petroleum Refinery Engineering", 4th Edition, McGraw Hill International Edition, New York, 1958.
2. Mark J. Kaiser, Arno deKlerk, James H. Gary and Glenn E. Handwerk, "Petroleum Refining: Technology, Economics, and Markets", 6th Edition, CRC Press, United Kingdom, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	discuss the formation, classification and properties of petroleum	Understanding (K2)
CO2	explain the crude properties and test methods for petroleum	Understanding (K2)
CO3	describe the various purification methods for petroleum products	Understanding (K2)
CO4	exemplify the production of LPG, LNG and hydro treatment processes	Understanding (K2)
CO5	discuss the process of isomerization, polymerization and processing of heavy crude	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	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	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)**

18CHE06 - 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 Algebraic Stress model.		
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.

REFERENCE BOOK:

1. Anderson John D., "Computational Fluid Dynamics-The Basics with Applications", 1st Edition, Tata McGraw Hill Publishing Company Ltd, United State of America, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain governing equations of fluid flow and heat transfer.	Understanding (K2)
CO2	explain the different types of models for turbulence.	Understanding (K2)
CO3	apply finite volume method for developing solution of steady state diffusion and convection diffusion problems.	Applying (K3)
CO4	describe the solution algorithms for Pressure – velocity coupling in steady flows.	Understanding (K2)
CO5	apply the knowledge of algorithms in solving unsteady flow heat conduction and convection diffusion processes.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2							1	2	2
CO2	3	3	2	2	2							1	2	2
CO3	3	3	2	3	2							1	2	2
CO4	2	3	2	3	2							1	2	2
CO5	2	3	2	3	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	10	60	30				100
CAT2	10	20	70				100
CAT3	20	50	30				100
ESE	20	20	60				100

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

18CHE07 - ORGANIC SYNTHESIS

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 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, United States of America, 2007.

REFERENCE BOOKS:

1. Austin G.T., "Shreve's Chemical Process Industries", 5th Edition, McGraw Hill International Edition, United State of America, 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 theories in various unit processes	Understanding (K2)
CO2	explain the mechanisms for halogenation and sulfonation synthesis process	Applying (K3)
CO3	sketch the process flow diagram for Ammonolysis and oxidation synthesis 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	Understanding (K2)

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

18CHE08 - 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 -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, “Biopharmaceutics 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 Unit IV, V.

REFERENCE BOOK:

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								2
CO2	3	1				1								2
CO3	3	1				1								2
CO4	3	1				1								2
CO5	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	40	60					100
CAT2	60	40					100
CAT3	30	70					100
ESE	40	60					100

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

18CHE09 - 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, United State of America, 2003 for Units I & II.
2. Mohinder L. Nayyar, "Piping Handbook", 7th Edition, Tata McGraw Hill Publishing Company Ltd., United States of America, 2000 for Units III, IV & V.

REFERENCE BOOK:

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 and codes and sketch a piping layout for a given problem	Applying (K3)
CO3	describe the concepts of generic piping design for optimal design of piping systems	Understanding (K2)
CO4	explain the process of design of various pipelines systems	Understanding (K2)
CO5	discuss the techniques involved in inspection and maintenance of pipelines	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										3	1
CO2	3	3	3										3	1
CO3	3	3	3										3	1
CO4	3	3	3										3	1
CO5	3	2	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	60	30				100
CAT2	10	60	30				100
CAT3	10	90					100
ESE	10	60	30				100

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

18CHE10 - COMPLEX FLUIDS

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 understanding about the characteristics of various non Newtonian and unconventional fluids applied in industries	
Unit - I	**Basic Concepts:**	**9**
Complex fluids and Classical Solids and Liquids - Illustrative examples of complex fluids in various fields, Analysis of Complex fluids - Microscopy, Polarimetry, X-ray and Raman Scattering, Molecular simulations		
Unit - II	**Polymer Solutions and Gels:**	**9**
Properties, Theories for Polymer flow behavior – Polymer Stress Tensor, Rubber Elasticity Theory, The Rouse Model. Rheology - Dilute polymers and entangled polymers. Polymer Gels – Rheology of Physical and Chemical Gels		
Unit - III	**Glassy Liquids:**	**9**
Introduction to Glassy liquids – examples. Phenomenon of Glass Transition, Non linear relaxation and Aging, Rheology of Glassy Liquids – Linear, Non linear and Thermo-rheology.		
Unit - IV	**Electro and Magneto-responsive fluids:**	**9**
Electro-rheological fluids – Phenomena, polarization models, applications. Magneto-rheological fluids – Phenomena, Flow behavior and applications. Ferro fluids – Phenomena, Dipole orientation and interactions, flow characteristics and applications		
Unit - V	**Foams and Emulsions:**	**9**
Foams – Structure of dry foams, Coarsening 2D and 3D foams, Rheology. Emulsion – Phase separation, Mechanical Mixing, droplet dynamics, Rheology of emulsions		

Total:45

TEXT BOOK:

1. Ronald G. Larson, "The Structure and Rheology of Complex Fluids", 1st Edition, Oxford University Press Inc, United State of America, 1999.

REFERENCE BOOKS:

1. Irgens, Fridtjov, "Rheology and Non Newtonian Fluids", 1st Edition, Springer Inc, United State of America, 2014.
2. Abdollah Hajalilou, Saiful Amri Mazlan, "Field Responsive fluids as Smart Materials", 1st Edition, Springer Inc, United States of America, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	compare complex and classical fluids and explain the analytical techniques for characterization of complex fluids	Understanding (K2)
CO2	describe the properties and flow characteristics of polymer solutions and gels	Understanding (K2)
CO3	discuss the phenomenon of glass transition and explain the rheology of glassy liquids	Understanding (K2)
CO4	illustrate the characteristics and flow behavior of electic and magnetic responsive fluids	Understanding (K2)
CO5	explain the rheological behavior of foams and emulsions	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	3										2	1
CO2	3	1	3										2	1
CO3	3	1	3										2	1
CO4	3	1	3										2	1
CO5	3	1	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)**

18CHE11 - HETEROGENEOUS CATALYTIC REACTIONS

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Chemical Reaction Engineering	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.

REFERENCE BOOKS:

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.

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 design of non ideal reactors	Applying (K3)
CO2	discuss the types of catalysts and their preparation techniques; analyze the mechanism of catalysis	Applying (K3)
CO3	describe the mechanism of catalysis for porous catalysts and determine the effectiveness factor	Applying (K3)
CO4	discuss the multiphase reactors used in industries	Understanding (K2)
CO5	explain the principles of non-catalytic fluid solid reactions and analyze the mechanism	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	1
CO2	3	3	1										3	1
CO3	3	3	1										3	1
CO4	3	3	1										3	1
CO5	3	3	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	30	30	40				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)**

18CHE12 - 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 Semichemical 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, United States of America, 2003.

REFERENCE BOOKS:

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 various methods for wood preparation and pulping	Understanding (K2)
CO2	explain the processing and bleaching of pulp	Understanding (K2)
CO3	deduce the finishing and surface treatment of various grades of paper	Understanding (K2)
CO4	demonstrate various methods for testing of pulp and paper	Understanding (K2)
CO5	demonstrate control measures relevant to solid , liquid and gaseous pollution from pulp and paper industry	Understanding (K2)

Mapping of COs with POs and PSOs

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

18CHE13 - AIR POLLUTION CONTROL

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

Preamble	The course delivers the framework of different air pollutants and the controlling equipment	
Unit - I	**Air Pollution Introduction:**	**9**
Air pollutants – History, air quality standards measurement, sampling and analysis- classifications of pollutants – sources and effects. Regulatory system: Framework in India- clean air act – provisions for recent development		
Unit - II	**Gases Pollutants and Particulates:**	**9**
Chemical and physical properties of gaseous pollutants- Stack Plumes – general characteristic and types. Particulates: Collection mechanism- particle size distribution- collection efficiency.		
Unit - III	**Pollution Controlling Equipment:**	**9**
Incinerators, Absorbers, Thermal oxidizers, Gravity settling chambers – classifications, operation, typical applications and suggestions.		
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: Selection, Design, Operation and Maintenance", 1st Edition, Springer Inc, United States of America, 2011 for unit I,II,III,IV.
2. Rao M.N. and Rao H.V.N, "Air Pollution", 1st Edition, McGraw Hill International Edition, India, 2001 for unit IV,V.

REFERENCE BOOK:

1. Cooper C.D. and Alley F.C., "Air Pollution Control-A Design Approach", 4th Edition, Waveland Pr Inc., United State of America, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the evolution procedure in analyzing the air pollutants based on air quality standards	Understanding (K2)
CO2	review the fundamentals for gaseous pollutants and particulates	Understanding (K2)
CO3	explicate the operations and applications of air pollution equipment	Understanding (K2)
CO4	perform the design and performance equation of different pollution equipment.	Applying (K3)
CO5	exhibit the concepts involved in hybrid systems and conduct audits	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	2	1										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	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)**

18CHE14 - TRANSPORT PHENOMENA

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Chemical Process Calculations, Fluid Mechanics, Chemical Reaction Engineering, Mass Transfer I, Process Heat Transfer	7	PE	3	0	0	3

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

Total:45

TEXT BOOK:

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

REFERENCE BOOKS:

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.
3. https://nptel.ac.in/courses/103/102/103102024/

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

18CHE15 - ELECTROCHEMICAL ENGINEERING

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

Preamble	This course deals with the fundamentals of electrochemical engineering and its applications.	
Unit - I	**Basics of Electrochemistry:**	**9**
Importance of electrochemical systems: Faraday's law - Current density - Potential and Ohm's law. Cell potential. Electrochemical kinetics: Double layer - Butler–Volmer Kinetic Expression - Influence of Mass Transfer on the Reaction Rate - Current efficiency.		
Unit - II	**Mass Transfer in Electrochemical Systems:**	**9**
Fick's law - Nernst-Planck equation - Conservation of material - Transference Numbers - Mobilities and Migration - Convective Mass Transfer - Concentration Over potential - Current Distribution and Membrane Transport. Electro analytical Techniques and Analysis of Electrochemical Systems: Electrochemical Cells, Instrumentation, and Some Practical Issues - Cyclic Voltammetry - Stripping Analyses - Electrochemical Impedance and Rotating Disk Electrodes.		
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	**Applications of Electrodes:**	**9**
Metals – graphite - Lead dioxide - Titanium substrate insoluble electrodes - Iron oxide and semi conducting electrodes. Metal finishing: cell design - types of electrochemical reactors - batch cell - fluidized bed electrochemical reactor		
Unit – V	**Electro-deposition and Corrosion:**	**9**
Electrodeposition: 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, United States of America, 2018.

REFERENCE BOOK:

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	apply 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	demonstrate the applications of different types of electrodes.	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	3										2	1
CO2	3	2	3										2	1
CO3	3	2	3										2	1
CO4	3	2	3										2	1
CO5	3	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	80					100
CAT2	20	80					100
CAT3	20	80					100
ESE	20	70					100

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

18CHE16 - 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:**	**9**
Principle and Applications of Ion Exchange, Electrophoresis, Dielectrophoresis, Chromatography in large scale		
Unit - V	**Current Trends:**	**9**
Principles and Applications of Supercritical Fluid Extraction, Zone melting, Reversible Chemical Complexation, Foam Separation, Thermal Diffusion, Cryoseperations.		

Total:45

TEXT BOOKS:

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

REFERENCE BOOKS:

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. Rosseau, “Handbook of Advanced 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 super critical fluid extraction in chemical process industries	Applying (K3)
CO5	discuss the advancement of recent membrane 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								3	3	2
CO2	3	3	2	2								3	3	2
CO3	3	3	3	2								3	2	2
CO4	3	3	3	3								3	2	2
CO5	3	2	3	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	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)**

18CHE17 - 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 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**
Quality Concepts and Principles: Definition of Quality - Dimensions of Quality - Quality Planning - Quality costs - Basic concepts of Total Quality Management - Historical Review. Principles of TQM - Leadership –Concepts - Quality Council - Quality Statements - Strategic Planning - Deming Philosophy - Barriers to TQM Implementation.		
Unit - II	**Total Quality Management-Principles and Strategies**	**9**
Total Quality Management-Principles and Strategies: Customer satisfaction –Customer Perception of Quality - Customer Complaints - Customer Retention - Employee Involvement –Motivation - Empowerment - Teams - Recognition and Reward - Performance Appraisal - Benefits. Continuous Process Improvement –Juran Trilogy - PDSA Cycle - 5S - Kaizen - Supplier Partnership –Partnering - sourcing - Supplier Selection - Supplier Rating - Relationship Development - Performance Measures		
Unit - III	**Control Charts for Process Control**	**9**
Control Charts for Process Control: The seven tools of quality - Statistical Fundamentals –Measures of central Tendency and Dispersion - Population and Sample - Normal Curve - Control Charts for variables and attributes - Process capability - Concept of six sigma.		
Unit - IV	**TQM-Modern Tools:**	**9**
TQM-Modern Tools: The new seven tools of quality - Benchmarking-Need - Types and process; Quality Function Deployment-HOQ construction - case studies; Taguchi's Robust design-Quality loss function - DOE; Total Productive Maintenance-uptime enhancement; Failure Mode and Effect Analysis-Risk Priority Number - Process - case studies.		
Unit - V	**Quality Systems**	**9**
Quality Systems: Need for ISO 9000 and Other Quality Systems - ISO 9000 : 2015 Quality System –Elements - Implementation of Quality System - Documentation - Quality Auditing - Introduction to TS 16949 - QS 9000 - ISO 14000 - ISO 18000 - ISO 20000 - ISO 22000. Process of implementing ISO - Barriers in TQM implementation.		

Total: 45

TEXT BOOK:

1. Dale H.Besterfield , "Total Quality Management", 3rd Edition, Pearson Education, New Delhi, 2011.

REFERENCES:

1. Subburaj Ramasamy, "Total Quality Management", Tata McGraw Hill, New Delhi, 2008.
2. Feigenbaum A.V. , "Total Quality Management", 4th Edition, Tata McGraw Hill , New Delhi, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the need, history and principles of quality and TQM	Applying (K3)
CO2	illustrate the principles and strategies of TQM	Applying (K3)
CO3	make use of various tools and techniques of quality management	Analyzing (K4)
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	30	30	20			100
CAT3	25	45	30				100
ESE	20	30	35	15			100

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

18GEE01 - FUNDAMENTALS OF RESEARCH

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)**

18CHE18 - PROCESS INSTRUMENTATION

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	PE	3	0	0	3

Preamble	This course will able to 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", 2nd Edition, Academic Press, United States of America, 2015.

REFERENCE BOOKS:

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	discuss 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)**

18CHE19 - INDUSTRIAL WASTE WATER TREATMENT

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	PE	3	0	0	3

Preamble	To promote understanding of basic and advanced concepts in Industrial waste water treatment technologies	
Unit – I	**Sources and Types of Industrial Waste Water:**	**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 waste water 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 Waste Water 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	**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, United States of America, 2011.

REFERENCE BOOKS:

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	acquire the knowledge in Sources and types of Industrial Wastewater	Understanding (K2)
CO2	apply the principles of physical and chemical unit operations in waste water treatment	Understanding (K2)
CO3	explain the Biological waste water treatment applied in industries	Understanding (K2)
CO4	discuss the advanced wastewater treatment techniques used in industries	Understanding (K2)
CO5	acquire knowledge of various Effluent Treatment Plants and their operations	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	1	2				3						3	2
CO3	3	1	2				3						3	2
CO4	3	2	2				3					1	3	3
CO5	3	2	2				3					1	3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	35	65					100
CAT2	30	70					100
CAT3	30	50	20				100
ESE	30	50	20				100

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

18CHE20 - CORROSION TECHNOLOGY

Programme & Branch	B.Tech. & Chemical Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	PE	3	0	0	3

Preamble	To gain knowledge on the principles of corrosion, its testing methods, control measures in specific environments and its impact on country's economy.	
Unit - I	**Types of Corrosion and Testing:**	**9**
Basic principles of corrosion and its control: Forms of corrosion, Uniform, Galvanic, Crevice, Pitting, Inter-granular, Selective leaching, Erosion, Stress corrosion. Hydrogen Blistering and Embrittlement, Cracking, Cavitation and their Fracture Mechanics. Corrosion testing: Classification, Purpose, Material and Specimen, Surface preparation, Measuring and Weighing. Exposure techniques: Duration – Planned interval test; NACE test methods, Slow-Strain-Rate test, Linear Polarization, AC Impedance method.		
Unit - II	**Corrosion Prevention Methods:**	**9**
Corrosion inhibitors, Electroplated coatings, Conversion coatings, Anodizing, Hot dipping, Spray metal coatings, Zinc coating by alloying, 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.

REFERENCE BOOKS:

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	comprehend the different types of corrosion and their testing methods	Understanding (K2)
CO2	understand corrosion protection methods for applications in chemical process industries	Applying (K3)
CO3	comprehend the corrosion in specific environments and its control	Understanding (K2)
CO4	understand corrosion control methods in industrial applications and case studies	Applying (K3)
CO5	get acquainted with corrosion in section and management practices and impact of corrosion in nations economy	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2											2	1
CO2	2	2											3	1
CO3	2	2											3	1
CO4	3	2											2	1
CO5	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	25	55	20				100
CAT3	15	65	20				100
ESE	20	65	15				100

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

18CHE21 - 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 cylindroconical 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, Hydrocyclones.		
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.

REFERENCE BOOKS:

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	understand the sources, beneficiation, sampling methodologies in mineral processing	Understanding (K2)
CO2	discuss various comminution and solid screening techniques	Understanding (K2)
CO3	explain the aspects of gravity concentration techniques	Understanding (K2)
CO4	exemplify the importance of froth flotation in ore processing	Understanding (K2)
CO5	describe 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	3	2									2	
CO2	3	2	3	2									2	
CO3	3	2	3	2									2	
CO4	3	2	3	2									2	
CO5	3	2	3	2									2	

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

ASSESSMENT PATTERN - THEORY

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

18MBE49 - ENTREPRENEURSHIP DEVELOPMENT

(Common to All BE/BTech Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	Engineering Economics and Management	8	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)**

18CHO01 - POLYMER TECHNOLOGY
(Offered by Department of Chemical Engineering)

Programme & Branch	All BE/BTech branches except Chemical Engineering branch	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	This course highlights the importance, properties and production of various polymers	
Unit - I	**Introduction:**	**9+3**
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+3**
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+3**
Polyethylene- poly propylene- polystyrene-polymethylmethacrylate - 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+3**
X-ray diffraction- Microscopic technique-Light scattering- SEM- Spectroscopic methods- IR,NMR- Thermal analysis-DSC, DTA and TGA.		
Unit - V	**Introduction to Plastics:**	**9+3**
Anti-oxidants and stabilizers- polymer additives- fillers- plasticizers-colorants- Moulding methods-Injection-compression- transfer and blow moulding- Processing techniques- Calendaring- casting- extrusion-thermoforming- foaming.		

Lecture:45, Tutorial:15, Total:60

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.

REFERENCE BOOKS:

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 moulding plastics	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	3											
CO2	3	1	3											
CO3	3	1	3											
CO4	3	2	3											
CO5	3	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	30	55	15				100
CAT3	15	60	25				100
ESE	15	65	20				100

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

18CHO02 - INTRODUCTION TO DRUGS AND PHARMACEUTICALS TECHNOLOGY
(Offered by Department of Chemical Engineering)

Programme & Branch	All BE/BTech branches except Chemical Engineering branch	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	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 -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.

REFERENCE BOOKS:

1. Arthur Owen Bentley, "Text book of Pharmaceutics", 8th Edition, All India Traveller Book Seller, New Delhi, 2002.
2. Banker G.S. and Rhodes C.T, "Modern Pharmaceutics", 4th 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								
CO2	3					1								
CO3	2					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	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)**

18CHO03 - BIO ENERGY RESOURCES
(Offered by Department of Chemical Engineering)

Programme & Branch	All BE/BTech branches except Chemical Engineering branch	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	1	0	4

Preamble	This course will able to help students to gain knowledge in the available Bio energy resources and the present conversion techniques.	
Unit - I	**Principles of Biomass Combustion:**	**9+3**
The role of Biomass in the Energy mix, Biomass and Environment, Biomass Production, Photosynthetic Efficiency, Bio-residues for power generation, Plantation residues, Liquid Bio-fuels and waste land utilization. Routes for conversion of Bio-wastes. Properties influencing combustion, Ultimate analyses of Biomass, Heat of combustion and Heat of Formation, Gas composition at high Temperature, the flame temperature, Theoretical versus measured flame temperature, Biomass and Fossil fuel properties, combustion of solid bio-fuel and Emissions, Burn rate of solid fuels, Large combustion systems, Gaseous emissions from solid fuel combustion devices		
Unit – II	**Bio-methanation:**	**9+3**
Introduction, Conversion process, Characteristics of liquid industrial Effluents, Liquid bio-methanation reactors, Performance of systems. Biodegradability, Raw materials for biogas production and their characteristics. Conversion Principles, Fermented Slurry as Fertilizer.		
Unit - III	**Biomass Gasification and Pyrolysis:**	**9+3**
Introduction, Basic Principles, The Thermochemistry of Gasification, Approaches to the gasification process, Flame Propagation through Packed beds, Biomass Feed size and tar, Cooling and cleaning strategies, Particulates, Tars and gasification Efficiency. Liquid Effluents and Water treatment in gasification systems. Slow and Fast Pyrolysis, Thermal applications-Decentralized power generation.		
Unit - IV	**Bio refinery:**	**9+3**
Introduction, First generation Alcohol, First-Generation Biodiesel, Biochemical process for second-Generation fuel, Gasification for second –Generation technology, The Fischer Tropsch process for second generation fuels, Combining various routes, Greenhouse gas Emissions, Hydro and Super –critical gasification		
Unit - V	**Urban solid waste and recent conversion Techniques:**	**9+3**
Solid wastes, Large –scale reactors, Conversion Technologies, Performance of the conversion systems, Stirling Engines, Thermoelectrics, Algae, Direct Carbon and Microbial Fuel Cells, Hydrogen from Biomass.		

Total:45

TEXT BOOK:

1. Mukunda H.S., "Understanding clean energy and Fuels from biomass", 1st Edition, Wiley India Pvt. Ltd., New Delhi, 2012.

REFERENCE BOOKS:

1. Nijaguna B.T., "Biogas Technology", 1st Edition, New Age International, India, 2002.
2. Lijun Wang, "Sustainable bioenergy production", 1st Edition, CRC Press, United State of America, 2014.
3. Sunggyu Lee, Shah Y.T., "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	understand the production of biomass and combustion of biofuel emissions.	Understanding (K2)
CO2	illustrate the conversion process of biomethanation.	Understanding (K2)
CO3	describe the principles of gasification process and types of pyrolysis.	Understanding (K2)
CO4	explain the biochemical process for first and second generation fuels.	Understanding (K2)
CO5	elaborate the recent conversion technologies used for solid wastes	Understanding (K2)

Mapping of COs with POs and PSOs

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

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

ASSESSMENT PATTERN - THEORY

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

18CHO04 - FUNDAMENTALS OF NANOSCIENCE AND NANOTECHNOLOGY
(Offered by Department of Chemical Engineering)

Programme & Branch	All BE/BTech branches except Chemical Engineering branch	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	1	0	4

Preamble	This course will able to help students to gain knowledge in preparation and application of nanomaterials	
Unit - I	**Introduction to Nanotechnology:**	**9+3**
History of nanotechnology and its different perspective, definition and classification of nanomaterials , nanoscale, different types of nano-oxides, electronic phenomenon in nanostructures, optical absorption in solids, quantum structure.		
Unit - II	**Methods of Preparation of Nanomaterials:**	**9+3**
Nanomaterial synthesis, physical approaches - arc discharge method, laser ablation, aerosol synthesis, inert gas condensation, high energy ball milling, chemical vapour deposition , chemical approaches – hydrothermal method ,micro emulsion method, sol-gel synthesis, microwave method, sonochemical process, co-precipitation.		
Unit - III	**Characterization and Properties:**	**9+3**
Scanning Electron Microscope (SEM),Energy Dispersive X-ray Analysis(EDX), Transmission Electron Microscope(TEM),Scanning Tunneling Microscope(STM) ,Atomic Force Microscope (AFM), methods of sample preparation. Properties of nano materials - Properties – mechanical, optical , electrical , magnetic , electrochemical		
Unit - IV	**Applications of Nano material:**	**9+3**
Applications of Nano materials – Medical applications, energy sector, Nanocatalysts, communication applications, nano foods, Environmental applications		
Unit - V	**Nanostructures:**	**9+3**
Nanocomposites, nanofillers, high performance materials nanocomposies, polymer, nanoclays, nanowires, nanotubes, nanoclusters etc. Smart materials, self-assembly of materials, safety issues with nanoscale powders.		

Total:45

TEXT BOOKS:

1. Shah M.A. and Tokeer Ahmad, "Principles of Nanoscience and Nanotechnology", 1st Edition, McGraw Hill Book Co., New Delhi, 2010, for Units I, II, III & IV.
2. Charles P. Poole, Jr. Frank J. Owens, "Introduction to Nanotechnology", 1st Edition, Wiley, New Delhi, 2006 for Unit V.

REFERENCE BOOK:

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	acquire knowledge in history and basics of nanotechnology	Understanding (K2)
CO2	explain the methods used for the preparation of nanomaterials	Understanding (K2)
CO3	understand the different characterization techniques for characterization of nano materials and discuss their properties	Understanding (K2)
CO4	discuss the applications of nano materials in various sectors	Understanding (K2)
CO5	elaborate the concept of nanostructured materials and safety measures in handling nanopowder	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	3											
CO2	3	1	3											
CO3	3	1	3											
CO4	3	2	3											
CO5	3	2	3											
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	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)**

18CHO05 - ENZYME ENGINEERING

(Offered by Department of Chemical Engineering)

Programme & Branch	All BE/BTech branches except Chemical Engineering branch	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	OE	3	0	0	3

Preamble	This subject focuses on the introduction to enzymes and gives an overview of kinetics, production, immobilization, fermentation process and its industrial applications.	
Unit - I	**Enzymes and Kinetics:**	**9**
Classification of enzymes; Principle of enzymatic catalysis;Enzyme kinetics-Factors affecting the enzyme activity- Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, L.B Plot, Turnover number, Kcat. Kinetics of Enzyme Inhibition.		
Unit - II	**Enzyme Production:**	**9**
Extraction of crude enzyme from plant, animal and microbial source; Purification of enzymes by the help of different methods. Methods of characterization of enzymes; criteria of purity. Unit of enzyme activity -definition and importance. Development of enzyme assays.		
Unit - III	**Enzyme Immobilization:**	**9**
Immobilization Type: Adsorption, Matrix entrapment, Encapsulation, Cross linking, Covalent binding and their examples; Advantages and disadvantages of different immobilization techniques. Structure & stability of immobilized enzymes, kinetic properties of immobilized enzymes- partition effect, diffusion effect.		
Unit - IV	**Large Scale Production:**	**9**
Fermentation using continuously stirred aerated tank bioreactors. Mixing power correlation. Determination of volumetric mass transfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration on oxygen transfer rate, heat transfer and power.		
Unit - V	**Industrial Applications of Enzymes:**	**9**
Industrial Enzymes in:Dairy, Bread making, Starch processing, Brewing; Bioethanol production and other fermentation processes; Thermophilic enzymes, amylases, lipases, proteolytic enzymes in Meat and Leather industry, Cellulose degrading enzymes in Paper and Pulp industry; Metal degrading and pollutant degradation. Biosensors		

Total:45

TEXT BOOKS:

1. Nicolas C. Price and Lewis Stevens, "Fundamentals of enzymology: Cell and Molecular Biology of Catalytic Proteins", 3rd Edition, Oxford University Press, United States of America, 2000 for Unit I.
2. Young JeYoo, Yan Feng, Yong Hwan Kim Camila Flor J. Yagonia, "Fundamentals of Enzyme Engineering", 1st Edition, Springer Inc, United Kingdom, 2017 for Units II, III, IV & V.

REFERENCE BOOK:

1. Trevor Palmer and Philip Bonner, "Enzymes : Biochemistry, Biotechnology and Clinical Chemistry", 2nd Edition, Woodhead Publishing, United Kingdom, 2001.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Classify enzymes and elaborate the principles of catalysis and enzyme kinetics	Understanding (K2)
CO2	Describe the enzyme production, purification, characterisation and assay	Understanding (K2)
CO3	Outline the immobilization of enzymes	Understanding (K2)
CO4	Elaborate the large scale fermentation process using bioreactors	Understanding (K2)
CO5	Apply enzyme science in its industrial 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	3	3											
CO2	3	1	3											
CO3	3	1	3											
CO4	3	3	3											
CO5	3	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)**

18CHO06 - NUCLEAR ENGINEERING
(Offered by Department of Chemical Engineering)

Programme & Branch	All BE/BTech branches except Chemical Engineering branch	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	OE	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. Kenneth Shultis J., Richard E. Faw, "Fundamentals of Nuclear Science and Engineering", 3rd Edition, CRC Press, United States of America, 2016.

REFERENCE BOOKS:

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	discuss the fundamentals 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	deduce various fission reactors and its economics	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	2	1												
CO2	2	1												
CO3	2	1												
CO4	2	1												
CO5	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	90					100
CAT2	5	95					100
CAT3	5	95					100
ESE	10	90					100

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

18CHO07 - FERTILIZER TECHNOLOGY
(Offered by Department of Chemical Engineering)

Programme & Branch	All BE/BTech branches except Chemical Engineering branch	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	OE	3	0	0	3

Preamble	This course offers an insight into the fundamentals and applications 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; 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(NO3)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 and 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 CO2 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 of Biofertilizers, Nitrogen fixing biofertilizers, Phosphate-solubilizing biofertilizers, Preparation of a biofertilizers		

Total:45

TEXT BOOK:

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

REFERENCE BOOKS:

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	discuss the classification and functions of various fertilizers	Understanding (K2)
CO2	discuss the production of other nitrogen based fertilizers	Understanding (K2)
CO3	explain the manufacturing techniques of Ammonia and Urea	Understanding (K2)
CO4	elaborate the production of phosphate based fertilizers	Understanding (K2)
CO5	illustrate the functions 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	1												
CO2	3	1												
CO3	3	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	10	90					100
CAT2	5	95					100
CAT3	5	95					100
ESE	10	90					100

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

18MAO01 - MATHEMATICAL FOUNDATIONS OF MACHINE LEARNING

(Offered by Department of Mathematics)

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

Preamble	To impart the basic knowledge in linear algebra, decomposition of matrices, continuous optimization, linear regression and support vector machines which provide the foundations for machine learning and deep learning.	
Unit - I	**Vector Spaces:**	**9+3**
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**
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**
Parameter Estimation – Maximum Likelihood estimation – Bayesian linear regression – Bayesian parameter estimation of Gaussian distribution, Support Vector Machines: Introduction – Margin and support vectors – 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", 9th Edition, John Wiley and Sons, New Delhi, 2011 for Units I, II, III.
2. Deisenroth M.P., Faisal A.A. and Ong C.S., "Mathematics for Machine Learning", 1st Edition, Cambridge University Press, 2019 for Units IV, V.

REFERENCES:

1. David C. Lay, Steven R. Lay and Judith McDonald, "Linear Algebra and its Applications", 5th Edition, Pearson Education, New Delhi, 2016.
2. Ethem Alpaydin, "Introduction to Machine Learning(Adaptive Computation and Machine Learning series)", 4th Edition, MIT Press, USA, 2020.
3. Duda R.O., Hart E. and Stork D.G., "Pattern Classification", 2nd Edition, John Wiley and Sons, New Delhi, 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	use the concept of inner product space and decompose the given matrix by means of orthonormal vectors.	Applying (K3)
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.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1												
CO2	3	1												
CO3	3	2												
CO4	3	3	1	1	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	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)**

18MAO02 - GRAPH THEORY AND ITS APPLICATIONS

(Offered by Department of Mathematics)

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	OE	3	1	0	4

Preamble	To develop rigorous logical thinking and analytical skills by graph theoretic concepts which helps for solving real time engineering problems in networks, computer architecture, compiling techniques, model checking, artificial intelligence, software engineering, expert systems, software/hardware correctness problem.	
Unit - I	**Graphs:**	**9+3**
Introduction – Definition – Types of graphs – Degree of vertex – Walk, path and cycle – Isomorphism – Connected graph – Hamiltonian graph – Euler graph – Digraph – 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 – Tree traversal.		
Unit - III	**Graph Coloring:**	**9+3**
Vertex coloring – Chromatic number – Chromatic partitioning – Independent sets – Chromatic polynomial – Matching – Covering – Four color problem (statement only) – Simple applications.		
Unit - IV	**Basic Algorithms:**	**9+3**
Shortest paths – Shortest path algorithms: Dijkstra's algorithm – Warshall's algorithm – Minimum Spanning tree – Minimal spanning tree algorithms: Prim's algorithm – Krushkal's algorithm – Optimal assignment – Kuhn and Munkres algorithm – Travelling salesman problem: Two optimal algorithm – Closest Insertion Algorithm.		
Unit - V	**Network Flows and Applications:**	**9+3**
Flows and cuts in networks - Max-flow Min-cut Theorem – Algorithms: Flow Augmenting Path – Ford-Fulkerson Algorithm for Maximum Flow – Edmonds and Karp algorithm.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall, New Delhi, 2010.

REFERENCES:

1. Douglas B.West, "Graph Theory", 2nd Edition, Prentice Hall, New Delhi, 2017.
2. Jonathan L. Gross & Jay Yellen, "Graph Theory and its Applications", 2nd Edition, CRC Press, New York, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the types of graphs and illustrate isomorphism on graphs.	Understanding (K2)
CO2	use the concepts and properties of different types of trees in data structures.	Applying (K3)
CO3	estimate the chromatic partition, chromatic polynomial and matching of a given graph.	Applying (K3)
CO4	apply various graph theoretic algorithms to communication and network problems.	Applying (K3)
CO5	identify the maximal flow in network by means of algorithms.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1											
CO2	3	1												
CO3	3	1												
CO4	3	2	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	30	60				100
ESE	10	30	60				100

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

18MAO03 - NUMBER THEORY AND CRYPTOGRAPHY

(Offered by Department of Mathematics)

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	OE	3	1	0	4

Preamble	To provide the skills for applying various number theoretic algorithms, congruences, primality tests in cryptography and network security and impart knowledge of basic cryptographic techniques.	
Unit - I	**Divisibility Theory and Canonical Decompositions:**	**9+3**
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+3**
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+3**
Introduction – Functions τ and σ– Mobius function – Greatest integer function – Euler's Phi function – Euler's theorem – Properties of Euler's function – Applications to Cryptography.		
Unit - IV	**Primality Testing and Factorization:**	**9+3**
Primality testing: Fermat's pseudo primality test – Solvay-Strassen test – Miller-Rabin test – Fibonacci test – Lucas test – Integer factorization: Trial division – Pollard's Rho method – Quadratic sieve method.		
Unit - V	**Classical Cryptographic Techniques:**	**9+3**
Introduction – Substitution techniques – Transposition techniques – Encryption and decryption – Symmetric and asymmetric key cryptography – Steganography.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Thomas Koshy, "Elementary Number Theory with Applications", 2nd Edition, Academic Press, Elsevier, USA, 2007 for Units I, II, III.
2. William Stallings, "Cryptography and Network Security: Principles and Practice", 7th Edition, Pearson Education, New Delhi, 2019 for Units IV, V.

REFERENCES:

1. Ivan Niven, Herbert S. Zukerman & Hugh L. Montgomery, "An Introduction to the Theory of Numbers", Reprint Edition, John Wiley & Sons, New Delhi, 2008.
2. Bernard Menezes, "Cryptography and Network Security", 1st Edition, Cengage Learning India, New Delhi, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand various the concepts of divisibility and canonical decompositions.	Understanding (K2)
CO2	obtain knowledge in theory of congruences and solution of linear congruences.	Applying (K3)
CO3	use different number theoretic function suitably in cryptography.	Applying (K3)
CO4	apply various Primality test and factorisation algorithms to network security problems.	Applying (K3)
CO5	identify 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)**

18MAO04 - ADVANCED LINEAR ALGEBRA

(Offered by Department of Mathematics)

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	OE	3	0	0	3

Preamble	To provide the skills for applying 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 dependence and independence – Basis and dimension – Row space, Column space and Null Space – Rank and nullity.		
Unit - III	**Inner Product Space:**	**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	**Eigenvalues and Eigenvectors:**	**9**
Definition – Orthogonal Diagonalization – Quadratic forms – Quadratic surfaces – Singular value decomposition – Applications.		

Total: 45

TEXT BOOK:

1. Howard Anton & Chris Rorres, "Elementary Linear Algebra", 11th Edition, John Wiley & Sons, USA, 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", 8th Edition, Jones & Barlett Learning, USA, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	use the concepts of matrices and vectors in the solution of a system of linear equations.	Applying (K3)
CO2	understand the concepts of vector spaces.	Understanding (K2)
CO3	understand the concept of inner product space and decompose the given matrix by means of orthonormal vectors.	Understanding (K2)
CO4	transform the system from one dimension to another and represent the pertinent linear transformation in matrix form.	Applying (K3)
CO5	apply the knowledge of quadratic forms and techniques of singular value decomposition for problems arising in power/control system analysis, signals and 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	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	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)**

18MAO05 - OPTIMIZATION TECHNIQUES

(Offered by Department of Mathematics)

Programme & Branch	All Engineering and Technology Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	OE	3	0	0	3

Preamble	To provide the skills for solving the real time engineering problems involving linear, non-linear, transportation and assignment problems and also impart knowledge in project management and game theoretic concepts.	
Unit - I	**Linear Programming:**	**9**
Introduction – Formulation of Linear Programming Problem – Advantages of Linear Programming methods – Limitations of Linear Programming models – Standard form of LPP – Graphical Method – Simplex Method – Artificial variable techniques – Big M Method.		
Unit - II	**Transportation Problem:**	**9**
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.		
Unit - III	**Assignment Problem and Theory of Games:**	**9**
Assignment Problem: Mathematical model of Assignment problem – Hungarian Method – Unbalanced assignment problem. Theory of Games: Two-person zero-sum game – Pure strategies - Game with mixed strategies – Rules of Dominance – Solution methods: Algebraic method – Matrix method – Graphical method.		
Unit - IV	**Project Management:**	**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. Kanti Swarup, Gupta P.K. & Man Mohan, "Operation Research", 14th Edition, Sultan Chand & Sons, New Delhi, 2014.

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	formulate and solve linear programming problems.	Applying (K3)
CO2	apply transportation 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	5	10	85				100
CAT2	5	10	85				100
CAT3	5	10	85				100
ESE	5	10	85				100

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

18PHO01 - THIN FILM TECHNOLOGY
(Offered by Department of Physics)

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

Preamble	This course aims to impart the essential knowledge on deposition, characterization and application of thin films in various engineering fields, and also provides motivation towards innovations.	
Unit - I	**Theories and models of thin film growth:**	**9+3**
Introduction - Theories of thin film nucleation: Impingement, Adsorption and Thermal accommodation - The capillarity model - The atomistic models - Structural consequences of thin film nucleation - The four stages of film Growth - The incorporation of defects during growth.		
Unit - II	**Vacuum technology:**	**9+3**
Principle and working of vacuum pumps: Roots 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, UV-vis spectroscopy, Four probe resistivity – Applications (qualitative): Thin film resistors, Thin film capacitors, Thin film diodes, Thin film transistors, 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", McGraw Hill Inc., 1970 for Units I,II,III, IV.
2. Zhang S., Li L. and Kumar A., "Materials Characterization Techniques", CRC Press, 2009 for Unit V.

REFERENCES:

1. Ohring M., "Material Science of Thin Films", Academic Press, 1992.
2. Goswami A., "Thin Film Fundamentals", New Age International Pvt. Ltd., 2003.
3. Chopra K.L., "Thin Film Phenomena", McGraw Hill Inc., 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	20	40	40				100
CAT3	20	35	45				100
ESE	20	40	40				100

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

18PHO02 - STRUCTURAL AND OPTICAL CHARACTERIZATION OF MATERIALS

(Offered by Department of Physics)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	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 - Destructive and non-destructive techniques - Crystalline materials - Reciprocal lattice - Theory of X-ray diffraction - Powder and Single crystal X-ray diffraction: Instrumentation, XRD pattern, Systematic procedure for structure determination, Particle size determination, Strain calculation - Applications of X ray diffraction measurements.		
Unit - II	**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 - III	**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 Gun - Field Emission Scanning electron microscope - Merits of Transmission electron microscope.		
Unit - IV	**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 - V	**Ultra Violet and 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 for Units I,II,III,IV.
2. Banwell C.N., "Fundamentals of Molecular Spectroscopy", Tata McGraw-Hill Publications, New Delhi, 2007 for Unit V.

REFERENCES:

1. Holt D.B. and Joy D.C., "SEM micro characterization of semiconductors", Academic Press, New Delhi, 1989.
2. Willard H.H., Merritt L.L., John A. Dean and Settle F.A., "Instrumental Methods of Analysis", 7th Edition, CBS Publishers and Distributors, New Delhi.
3. Elton N. Kaufman, "Characterization of Materials (Volume1&2)", Wiley-Interscience, 2003.

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	make use of the concept of Raman effect and Raman spectroscopy to determine the crystal structure and related structural parameters of materials.	Applying (K3)
CO3	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)
CO4	utilize the concept and phenomenon of quantum mechanical tunneling to interpret the surface image at the atomic level recorded using scanning tunneling microscopy.	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	20	40	40				100
CAT3	20	35	45				100
ESE	20	40	40				100

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

18CYO01 - CORROSION SCIENCE AND ENGINEERING

(Offered by Department of Chemistry)

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

Preamble	Corrosion science and engineering aims to equip the students to have wide range knowledge of corrosion and prevention methods in order to meet the industrial needs.	
Unit - I	**Corrosion and its units:**	**9+3**
Importance of corrosion prevention in various industries: direct and indirect effects of corrosion –free energy and oxidation potential criterion of uniform corrosion –Pilling Bedworth ratio and it consequences –units corrosion rate – mdd (milligrams per square decimeter per day) and mpy (Mils per year) –importance of pitting factor – Pourbaix diagrams of Mg, Al and Fe – and their limitations.		
Unit - II	**Mechanism of Corrosion:**	**9+3**
Localized corrosion: electro chemical mechanism Vs. chemical mechanism – Galvanic corrosion – Area effect in anodic and cathodic metal coatings, Organic coatings of bimetallic systems – prediction using emf Series and Galvanic series – Crevice corrosion – Mechanism of differential oxygenation corrosion – Auto catalytic mechanism of pitting due to crevice or differential oxygenation corrosion – Principles and procedures of cathodic protection: Sacrificial anodes and external cathodic current impression – stray current corrosion.		
Unit - III	**Types of Corrosion:**	**9+3**
Inter-granular corrosion: Stainless steels – cause and mechanism (Cr- Depletion theory) – Weld decay and knife line attack – Stress corrosion and fatigue corrosion – Theory of critical corrosion rate in corrosion fatigue. Cavitation damage – Fretting damage – Atmospheric corrosion – Bacterial corrosion – Marine corrosion –High temperature oxidation of metals – Ionic diffusion through protective oxides.		
Unit - IV	**Kinetics of Corrosion:**	**9+3**
Kinetic aspects of corrosion: Over potential activation and concentration over potentials – Exchange current density – Mixed potential theory – corrosion rates of Fe and Zn in air – free acid – effect of oxidizing agents – Phenomenon of passivation – Theories – effect of oxidizing agents and velocity of flow on passivating metals – effect of galvanic coupling of Fe and Ti respectively with Platinum – Noble metal alloying – anodic protection.		
Unit - V	**Prevention of Corrosion:**	**9+3**
Corrosion in inhibition: Inhibitors of corrosion – passivators, adsorbing inhibitors, V.P. inhibitors. Prevention of galvanic crevice, inter granular, Stress and fatigue corrosion at the design stage and in service conditions – control of catastrophic oxidation and Hydrogen disease -control of Bacterial corrosion – Langelier saturation Index and its uses. Corrosion prevention by Coatings – Surface pre- treatment – Hot dip, diffusion and cladded coatings – Phosphating and its uses.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Winston R. & Uhlig H.H., "Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering", 4th Edition, A John Wiley & Sons Inc. Publication, New Jersey, 2008.

REFERENCES:

1. McCafferty E., "Introduction to Corrosion Science", Springer, New York, 2010.
2. Fontanna, "Corrosion Engineering (Materials Science and Metallurgy Series)", McGraw Hill International Education, Singapore, 2005.
3. Pietro Pedeferri, "Corrosion Science and Engineering", Springer Nature Switzerland AG, Switzerland, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	illustrate the importance of direct and indirect corrosion to familiarize for industrial needs.	Understanding (K2)
CO2	demonstrate the mechanism of different types of corrosion with respect to the environment.	Applying (K3)
CO3	organize the various types and theory of corrosion to understand the corrosion problems.	Applying (K3)
CO4	utilize the theories and kinetics of 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)**

18CYO02 - INSTRUMENTAL METHODS OF ANALYSIS

(Offered by Department of Chemistry)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	BS	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), electron spectroscopy for chemical analysis (ESCA) - UV photo electron spectroscopy (UPS)- 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)- Inductively coupled plasma mass spectroscopy (ICP-MS) - Secondary Ion Mass Spectroscopy (SIMS) 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 titrimetry.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Willard H.H., Merritt L.L., Dean J.A & Settle F.A., "Instrumental Methods of Analysis", 7th Edition, CBS Publishers & Distributors, New Delhi, 2012.

REFERENCES:

1. Chatwal G.R. & Anand Sham K., "Instrumental Methods of Chemical Analysis", 5th Edition, Himalaya Publishing House, Girgaon, Mumbai, 2019.
2. Srivastava A.K. & Jain P.C., "Instrumental Approach to Chemical Analysis", 4th Edition, S Chand and Company Ltd, New Delhi, 2012.
3. Sharma B.K., "Instrumental Method of Chemical Analysis", Krishna Prakashan Media Pvt. Ltd., Meerut, 2014.

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)**

18CYO03 - WASTE AND HAZARDOUS WASTE MANAGEMENT

(Offered by Department of Chemistry)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	BS	3	0	0	3

Preamble	Waste and Hazardous waste management aims to equip the students to have a wide-range knowledge on waste management	
Unit – I	**Solid Waste Management:**	**9**
Solid wastes: Definition, types, sources, classification and composition of solid waste- Solid waste management system – Factors affecting solid waste management system – Solid waste processing technologies – incineration, combustion, stabilization, solidification, chemical fixation, encapsulation, composting, vermicomposting – Energy from waste –Biogasification –Anaerobic digestion, pyrolysis, refuse derived fuels; Landfill leachate and gas management, Landfill bioreactors – Recycling of household and commercial waste, recycling of paper, recycling of tire, recycling of plastics – Health and Environmental effects of Solid Waste – SWM: Indian scenario –Characteristics and quantity of various wastes.		
Unit – II	**Hazardous Waste Management:**	**9**
Hazardous waste Management: Identification and sources – characteristics and categorization – collection, segregation, packaging, labelling, transportation, processing (3R) – risk assessment and waste management treatment and disposal – storage and leak detection – site selection criteria, manifest system and records – Indian scenario – Responsibilities of various authorities. Radioactive Waste Management: Definition, sources, classification, collection, segregation, treatment and disposal.		
Unit – III	**E-Waste and Biomedical Waste Management:**	**9**
E-Waste Management: Definition, sources, classification, collection, segregation, treatment and disposal. Biomedical Waste Management : Types of wastes, major and minor sources of biomedical waste – categories and classification of biomedical waste – hazard of biomedical waste – need for disposal of biomedical waste – waste minimization – waste segregation and labelling – waste handling and collection- Treatment – autoclaving, Incineration, Chemical Disinfection – Disposal – Infection control Practices-status in India.		
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, Electroplating industries, Dairy, Sugar, Paper, distilleries, Steel plants, Refineries, fertilizer, thermal power plants – Wastewater reclamation concepts.		
Unit – V	**Solid Waste Management Legislation:**	**9**
Solid waste management plan – Solid Waste (Management and Handling) Rules, 2000, 2016 and amendments if any – Biomedical Waste (Management and Handling) Rules, 2016; Notification of Ash utilization 1999, 2003, 2009, 2015 and amendments if any – Plastic Waste Management Rules, 2016 – E-Waste Management Rules, 2016 – Bio-Medical Waste Management Rules, 2016 – Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 – Construction and Demolition Waste Management Rules, 2016.		

Total:45

TEXT BOOK:

1. John Pichtel, "Waste Management Practices: Municipal, Hazardous, and Industrial", 2nd Edition, CRC Press, Boca Raton, Florida, 2014 for Unit II, III.
2. Sharma U.C. & Neetu Singh, "Environmental Science and Engineering, Volume 5: Solid Waste Management", 2nd Edition, Studium Press, United State of America, 2017 for Unit I,IV,V.

REFERENCES:

1. VanGuilder & Cliff, "Hazardous Waste Management: An Introduction", Har Cdr Edition, Mercury Learning & Information, Herndon, VA, 2011.
2. Karen Hardt, "Solid Waste Management", 1st Edition, Callisto Reference, Germany, 2018.
3. Majeti Narasimha Vara Prasad, Meththika Vithanage & Anwesha Borthakur, "Handbook of Electronic Waste Management: International Best Practices and Case Studies", 1st Edition, Butterworth-Heinemann, United Kingdom, 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 wastes.	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)**

18GEO01 – 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	5,6,7,8	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)**

18GEO02 – 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	5,6,7,8	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)**

18GEO03 - 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	7	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)**

18GEO04 - 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)**

18GEO05 - 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	**5/6/7/8**	**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, 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, 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)**

18GEO06 - 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	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.	
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)**

18GEO07 - 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	5/6/7/8	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)**

18GEO08 - 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	5/6/7/8	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)**

18GEO09 - 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	5/6/7/8	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)**

18GEO10 - 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	5/6/7/8	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)**

18GEO11 - 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.						

18GEO12 - 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.						