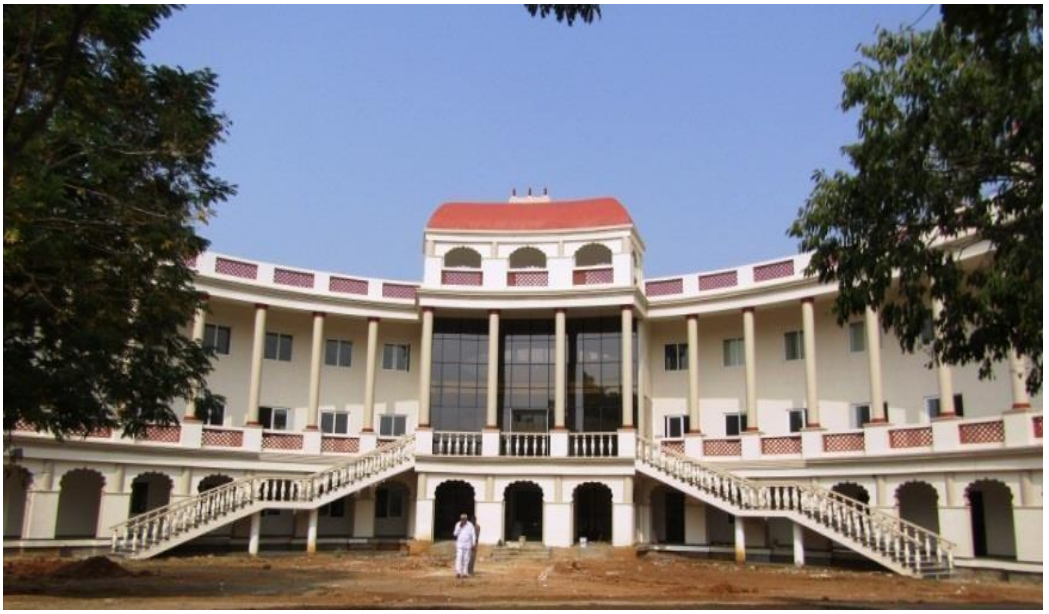
ACADEMIC REGULATIONS
&
CURRICULUM

Applicable to the students admitted from the Academic Year 2024-25 Onwards



CHEMICAL ENGINEERING
B. Tech. Program

MAHARAJ VIJAYARAM GAJAPATHI RAJ COLLEGE OF ENGINEERING
(Autonomous)

(Approved by AICTE, New Delhi, and permanently affiliated to JNTUGV, Vizianagaram,

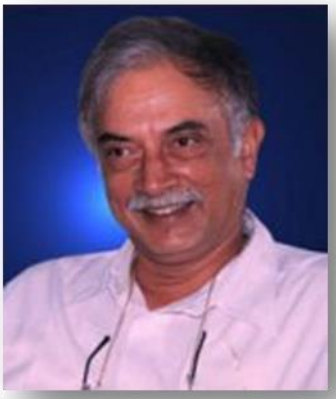
Listed u/s 2(f) & 12(B) of UGC Act 1956)

Vijayaram Nagar Campus, Chintalavalasa, Vizianagaram-535005, Andhra Pradesh.

The visionaries

Late Dr. P V G Raju
Raja Saheb of Vizianagaram
Founder Chairman-MANSAS
Ex-Minister for Education and Health, Govt. of AP
Ex Member of Parliament

Late Dr. P. Anand Gajapathi Raju
Ex-Chairman-MANSAS
Ex-Minister for Education and Health
Govt. of AP.
Ex-Member of Parliament.



P. Ashok Gajapathi Raju
Chairman-MANSAS
Ex-Union Minister for Civil Aviation,
Govt. of India.
Ex-Minister for Finance,
Govt. of AP

Academic Regulations (R24M) for B. Tech (Regular-Full time)

(Effective for the students admitted into I year from the Academic Year **2024-25** onwards)

1. Award of the Degree

Award of the B.Tech. Degree if he/she fulfils the following:

(i) Pursues a course of study for not less than four academic years and not more than eight academic years. However, for the students availing Gap year facility this period shall be extended by two years at the most and these two years would in addition to the maximum period permitted for graduation (Eight years).

(ii) Registers for **160** credits and secures all **160** credits.

2. Award of B.Tech. degree with Honors

1. A student will be declared eligible for the award of the B.Tech degree with Honors if he/she fulfills the following:
   (i) Student secures additional **18** credits fulfilling all the requisites of B.Tech program i.e., **178** credits.
   (ii) Registering for Honors is optional.
   (iii) Honors is to be completed simultaneously with B.Tech. program.

2. Students, who fail to fulfill all the academic requirements for the award of the degree within eight academic years from the year of their admission, forfeit their seat in B.Tech. course and their admission stands cancelled.
   This clause shall be read along with clause 1 (a) (i).

3. Admissions

Admission to the B. Tech Program shall be made subject to the eligibility, qualifications and specialization prescribed by the A.P. State Government/University from time to time. Admissions shall be made either based on the merit rank obtained by the student in the common entrance examination conducted by the A.P. Government/University or any other order approved by the A.P. Government/University, subject to reservations as prescribed by the Government/University from time to time.

4. Program related terms

Credit: A unit by which the course work is measured. It determines the number of hours of instruction required per week. One credit is equivalent to one clock hour of teaching (Lecture/Tutorial) or two clock hours of practical work/field work per week.

Credit definition:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credit
2 Hrs. Practical (Lab) per week	1 credit

a) **Academic Year**: Two consecutive (one odd + one even) semesters constitute one academic year.

b) **Choice Based Credit System *(CBCS):*** The CBCS provides a choice for students to select from the prescribed courses.

5. Semester/Credits:

i. A semester comprises 90 working days and an academic year is divided into two semesters.

ii. The summer break term is for Six /eight weeks during which a student has the opportunity to pursue Internship/ apprenticeship/work-based vocational education and training. This is intended to meet the mandatory requirement of a student to carry out 2-credit Community Project and Mini Project modules. This is especially helpful for students who wish to exit after two semesters or four semesters of study.

iii. Regular courses may also be offered during the summer on a fast-track mode to enable students to do additional courses or complete backlogs in coursework. The student will have the option to repeat the course inclusive of continuous assessment.

iv. The institution can decide on the courses to be offered in the summer term depending on the availability of faculty and the number of students.

6. Structure of the Undergraduate Program:

All courses offered for the undergraduate program (B.Tech.) are broadly classified as follows:

S. No.	Category	Breakup of Credits (Total 160)	Percentage of total credits
1.	Engineering Major	81	50.625
2.	Extended Open Elective Cluster (EOEC)	29	18.125
3.	Generic Engineering Stream	20	12.5
4.	Ability Enhancement Courses (AEC)	6	3.75
5.	Value Added Courses (VAC)	6	3.75
6.	Skill Enhancement Courses (SEC)	8	5
7.	Projects	10	6.25
	Total	**160**	**100**

7. Course Classification:

All subjects/courses offered for the undergraduate program in Engineering & Technology (B.Tech. degree programs) are broadly classified as follows:

Course Category	Course Modules	Total Credits
Professional Core	• 16 Professional Core Theory Mandatory of 3 credits each **16 * 3 credits = 48 credits** • 5 Professional Core Elective Theory of 3 credits each **5 * 3 credits = 15 credits** • 6 Professional Core Lab of 2 credits each **6 * 2 credits = 12 credits** • Projects (Mini & Major) **(2 + 8) credits = 10 credits** • Department specific module (SEC) = **2 credits**	**87**
Basic Sciences	• M-I and M-II **2 * 3 credits = 6 credits** • Physics + Lab **(3 + 1) credits = 4 credits** • Chemistry + Lab **(3 + 1)credits = 4 credits** • Department Specific Math oriented courses **2 * 3 credits = 6 credits**	**20**
Humanities	• **AEC** (Language Proficiency = 2 credits; Env. Studies = 2 credits; Community Project = 2 credits) • **VAC** (E & HV = 2 credits; Constitutional values/ Rights = 2 credits; Health & Wellness =2 credits) • **SEC** (Quantitative Problem Solving = 2 credits)	**14**
Engineering Sciences/Professional Sciences	**EOEC-Extended Open Elective Cluster** • 6 Theory Mandatory modules. **6 * 3 credits = 18** credits • 1 Theory Elective module. **1 * 3 credits = 3** credits • 4 Lab/practice modules. **4 * 2 credits = 8** credits, which is an elective cluster where students can choose from multiple clusters which they can opt for as secondary skill with total of **29 credits**. • Procedural Programming + Lab **(3 +1) credits = 4** credits • Computer Aided Engineering Drawing **= 2** credits • Engineering Workshop **= 2** credits • Office tools & Social Media Etiquette **= 2** credits	**39**
		160
Honors	Optional For Honors (In Professional Core Area as a deep dive into Professional Elective Cluster) **4 Modules * 4 credits = 16 credits**	**16**
	4 Year Honors Degree	**176**

8. Programme Pattern

i. Total duration of the B. Tech (Regular) Program is four academic years of 8 semesters.
ii. A semester comprises 90 working days and an academic year is divided into two semesters.
iii. There will be an Induction Program before the commencement of the First Semester for the newly admitted students in order to provide orientation and acclimatization to the college campus and professional learning environment. Several activities such as physical activity, creative arts, universal human values, literary, proficiency modules, lectures by eminent people, visits to local areas, familiarization to the departments, innovation activities etc., form part of the Induction Program.
v. Value Added Courses (VAC) like Health & Wellness, Constitutional Rights/Values, Ethics and Human Values are mandatory credit courses for all the undergraduate students.
vi. Ability Enhancement Courses (AEC) like Language Proficiency, Environmental Studies and Community Project are mandatory credit courses for all the undergraduate students.
vii. Skill Enhancement Courses (SEC) like Office Tools & Social Media Etiquette, Engineering Workshop, Quantitative Problem Solving Techniques and Departmental Specific Module are mandatory credit courses for all the undergraduate students.
viii. Undergraduate degree with Honors is offered as an option for the students having good academic record.
xvi. College shall assign a faculty advisor/mentor after admission to a group of students from same department to provide guidance in courses registration/ career growth / placements / opportunities for higher studies/ GATE/ other competitive exams etc.

9. Evaluation Process

- The performance of a student in each semester shall be evaluated subject wise with a maximum of 100 marks for 3 credit theory subjects, 50 Marks for 2 credit theory courses and 100 marks for practical subjects. Community Project and Mini Project shall be evaluated for 50 marks while Main Project work shall be evaluated for 200 marks.
- A student has to secure not less than 35% of marks in the semester end examination and a minimum of 40% of marks in the sum total of the Continuous Assessment (CA) and Summative Assessment (SA) marks taken together for the theory, practical, design, drawing subject or project etc.

THEORY COUSES

Assessment Method	Marks
Continuous Assessment (CA)	40
Summative Assessment (SA)	60
Total	**100**

i. For theory subject, the distribution shall be 40 marks for Continuous Assessment and 60 marks for the Summative Assessment.

ii. For practical subject, the distribution shall be 40 marks for Continuous Assessment and 60 marks for the Summative Assessment.

a) Continuous Assessment (5- unit/3 Credit courses)

i. Continuous Assessment, which is evaluated for 40 Marks is divided into 2 parts: Periodic Assessment (PA) examinations for 25 Marks and Teacher Assessment (TA) for 15 Marks. There shall be two Periodic Assessment (PA) examinations each of 25 marks during a semester. The weighted average in 80/20 ratio will be taken for 25 marks. The duration of exam is 90 minutes. The PA question paper contains 3 long answer questions with internal choice. Each Long answer question carries 7 marks. (3 * 7M = 21 marks). This will be scaled up to 25 marks)

ii. The first PA examination shall be conducted on Units I & II with either/or type question from each unit and the second PA examination shall be conducted on Units III, IV and V with either/or type question from each unit.

iii. The Teacher Assessment (TA) for 15 marks shall be based on assignments/projects/presentations /surprise tests/quizzes which the concerned course owner/subject teacher shall design. The TA methodology shall be approved upfront by the Board of Studies and the same shall be informed to the students at the beginning of the semester itself.

The weighted average in 80/20 ratio is calculated in the following manner. For example:

Marks obtained in first PA exam	: 25
Marks obtained in second PA exam	: 20
Final PA Marks: (25x0.8) + (20x0.2)	= 24

If the student is absent for any one PA examination, the final PA semester marks shall be arrived at by considering 80% weightage to the marks secured by the student in the appeared examination and zero to the other. For example:

Marks obtained in first PA:	Absent
Marks obtained in second PA:	25
Final PA Marks: (25x0.8) + (0x0.2)	=20

Final Continuous Assessment marks shall be evaluated as follows:

CA = Final PA + TA

b) Summative Assessment - Evaluation Pattern for 5-Unit/3-Credit courses

Summative Assessment examination of 3-credit theory subjects shall have the following pattern:

- The SA will be conducted for 60 Marks (**180 minutes**)
- Question Paper contains two parts: Part – A is for 50 Marks and Part – B is for 10 Marks.
- **In Part – A**, there shall be one question from each of the 5 units (with either/or choice) which will be evaluated for 10 marks each
- **In Part – B**, there will be 1 question of 10 marks (with either/or choice) that may be a case study or comprehensive examination treating the course as one complete whole.

c) Continuous Assessment (5-unit/2 Credit courses)

For a 2-credit theory course, Continuous Assessment is evaluated for 20 Marks and shall only include the Periodic Assessment (PA) examination. There will be no Teacher Assessment component for these courses. There shall be two PA examinations each of 20 marks. The weighted average in 80/20 ratio will be taken for 20 marks. The duration of exam is **90 minutes**. The PA question paper contains 3 long answer questions with internal choice. Each Long answer question carries 6 marks. (3 * 6M = 18 marks. This will be scaled up to 20 marks)

d) Summative Assessment – Evaluation Pattern for 5-Unit/2-Credit courses

Summative Assessment examination of 2-credit theory courses shall have the following pattern:

- The Examination will be conducted for 30 Marks (5 * 6 Marks).
- Question Paper contains 5 questions (with either/or choice), one from each unit.
- The duration of exam is for **120 minutes**.

PRACTICAL COURSES

Assessment Method	Marks
Continuous Assessment (CA)	40
Summative Assessment (SA)	60
Total	**100**

a) For practical subjects, there shall be a Continuous Assessment during the semester for 40 marks and Summative Assessment for 60 marks.

b) The CA shall include 2 components: Day-to-day work evaluated for 25 marks and Pre-Summative Assessment examination evaluated for 15 marks. Day-to-day work in the laboratory shall be evaluated by the concerned laboratory teacher based on the regularity/record/viva and the Pre-Summative Assessment Examination shall be conducted before the end of the semester.

c) The SA shall be evaluated for 60 marks, conducted by the concerned laboratory teacher and a senior expert in the subject from the same domain.

d) The Summative Assessment laboratory examination shall be conducted for **120 minutes** and assessment includes:

- Knowledge on Principles/concepts/Procedure: 20 Marks
- Experimental design /work, Results-Interpretation and analysis: 30 marks
- Viva voce: 10 marks.

e) Computer Aided Engineering Drawing – Evaluation Pattern

Assessment Method	Marks
Continuous Assessment (CA)	40
Summative Assessment (SA)	60
Total	**100**

a) The CA shall include 2 components: Day-to-day work evaluated for 25 marks and Pre-Summative Assessment examination evaluated for 15 marks. Day-to-day work shall be evaluated by the concerned subject teacher based on the reports/submissions prepared in the class. The Pre-Summative Assessment examination pattern shall consist of 3 questions (either/or type) of 5 marks each.

b) The Summative Assessment examination shall be evaluated for 60 marks, conducted by the concerned teacher and a senior expert in the subject from the same domain.

c) The question paper shall contain 3 questions (with either/or choice). Each question will be of 20 marks (5 marks for free hand drawing and list of commands and 15 marks for final drawing prepared in AutoCAD). A student shall answer all questions.

f) Computer Aided Geometric Design and Assembly Lab – Evaluation Pattern

Assessment Method	Marks
Continuous Assessment (CA)	40
Summative Assessment (SA)	60
Total	**100**

1. The CA shall include 2 components: Day-to-day work evaluated for 25 marks and Pre-Summative Assessment examination evaluated for 15 marks. Day-to-day work shall be evaluated by the concerned subject teacher based on class reports and submissions. The pre-summative examination question paper consists of two questions: one on modeling & drafting and one on assembly & drafting. Each question carries 5 marks. Student must answer both questions. And the remaining 5 marks are allocated for viva-voce.

2. The SA examination shall be evaluated for 60 marks, conducted by the concerned teacher and a senior expert in the subject from the same or related department.

3. The SA examination question paper consists of two questions: one on modeling & drafting and one on assembly & drafting. Each question

carries 25 marks (divided into 5 marks for free hand drawing & procedure and 20 marks for final drawings (modeling/ assembly/ drafting). Student must answer both questions and the remaining 10 marks are allocated for viva-voce.

10. Community Project: There will be a summer break of 4 to 6 weeks at the end of each academic year to provide opportunity to students to engage in internships with industry/government agencies/NGO etc. These internships are intended to give exposure to the students through Community Projects and Mini Projects.

- A student shall identify and provide a solution to the problem relevant to society.

- A student shall engage at least 30 hours on community project. Community project shall be evaluated internally for 50 marks by Project Review Committee (PRC). PRC comprising of HoD, Two senior faculty and guide shall review the progress.

11. Mini Project:

- A student shall undergo internship (Physical/Virtual) for a period of 4 weeks and provide solution to the problem relevant to Industry/ Modern tool during the vacation after VI semester and submit comprehensive report/certificate (For virtual internship) issued by external agencies.

- The recommended Virtual Internships offered by external agencies/regulating bodies like AICTE/APSCHE etc, conversions and appropriate grades/marks are to be approved by the BoS at the beginning of the semester.

- Mini project shall be evaluated internally for 50 marks by Project Review Committee (PRC). PRC shall prepare rubrics for assessment.

12. Skill Enhancement Course:

Skill Enhancement Course is assessed for 100 marks, of which, 40 marks for internal assessment and 60 marks for semester end examination.

Assessment Method	Marks
Continuous Internal	40
Semester End Examination	60
Total	100

Continuous Internal Assessment : (40 Marks)
Continuous assessment : 20 Marks
Internal test : 20 Marks

The end examination shall be evaluated for 60 marks, conducted by the concerned course teacher and a senior expert in the subject from the same department.

Procedure	: 20 Marks
Experimental work & Results	: 30 marks
Viva voce	: 10 marks.

The student shall be given an option to choose either the skill courses being offered by the college or to choose a certificate course (Minimum 30 hours) being offered by industries / Professional bodies or any other accredited bodies. If a student chooses to take a Certificate Course offered by external agencies, the credits shall be awarded to the student upon producing the Course Completion Certificate from the agency. A committee shall be formed at the level of the college to evaluate the grades/marks given for a course by external agencies and convert to the equivalent marks/grades.

The recommended courses offered by external agencies, conversions and appropriate grades/marks are to be approved by the BoS at the beginning of the semester.

If a student prefers to take a certificate course offered by external agency and approved by BoS, the department shall mark attendance of the student for the remaining courses in that semester excluding the skill course in all the calculations of mandatory attendance requirements upon producing a valid certificate as approved by the BoS.

Evaluation pattern for Quantitative Problem Solving Techniques :

The Course is assessed for 100 marks, of which, 40 marks for internal assessment and 60 marks for semester end examination.

Assessment Method	Marks
Continuous Internal	40
Semester End Examination	60
Total	100

Continuous Internal Assessment : (40 Marks)

Continuous assessment	: 20 Marks
Internal test	: 20 Marks

The end examination shall be evaluated for 60 marks, conducted by the concerned course teacher and a senior expert in the subject from the same department.

Objective Test (MCQs, 50 Questions, each one mark)	: 50 Marks
Viva voce	: 10 marks.

13. Main Project Work:

The 4th Year of study comprises only self-study courses giving opportunity to students to spend one full year as an intern at various organizations (government/private) in pursuance of his/her career aspiration. The student is also expected to complete the Main Project during this period. At the end of the year, the candidate shall submit the main project report and may also include a certificate of internship.

The project report shall be evaluated with an external examiner. The total marks for project work is **200 marks** and the distribution shall be **80 marks** for continuous assessment and **120 marks** for summative assessment. The supervisor assesses the student for 40 marks (Report: 20 marks, Seminar: 20 marks). At the end of the semester, all projects shall be showcased at the department for the benefit of all students and staff and the same is to be evaluated by the departmental Project Review Committee consisting of supervisor, a senior faculty and HOD for 40 marks. The external evaluation of Project Work is a Viva-Voce Examination conducted in the presence of internal examiner and external examiner and is evaluated for 120 marks.

The college shall facilitate and monitor the student main project/internship programs. Completion of the main project is mandatory. If any student fails to complete the main project, he/she will not be eligible for the award of degree. In such cases, the student shall repeat and complete the main project.

14. Massive Open Online Courses (MOOCs):

- It is recommended to register and complete minimum two courses through MOOCs approved by the BoS. A student can pursue courses other than core through MOOCs. A student is not permitted to register and pursue core courses through MOOCs.

- The student shall register for the (Minimum of 12 weeks) courses offered by SWAYAM/NPTEL as Program elective/Open elective with the approval of the BoS. The Head of the Department shall appoint one mentor for each MOOC. The student has to submit the pass certificate issued by SWAYAM/NPTEL after completion of the course.

- Students who have qualified in the proctored examinations conducted through MOOCs platform can apply for credit transfer as specified and are exempted from appearing internal as well as external examination (for the specified equivalent credit course only) conducted by the Institution.

  Necessary amendments in rules and regulations regarding adoption of MOOC courses would be proposed from time to time.

15. Academic Bank of Credits (ABC)

The Institution is part of the Academic Bank of Credits (ABC) initiative to promote increased opportunity of mobility for a student (as per NEP 2020). As such,

i. A student, upon joining the institution, will become part of the ABC.

ii. All credits earned by the students in the institution as well as through MOOCs will be reflected in his/her account in the ABC

iii. The student will be able to avail transfer of credits earned from other institutions to his account as per the regulations of UGC/AICTE/JNTUGV declared from time to time.

16. Guidelines for offering Honors

The objective of introducing B.Tech.(Honors) is to facilitate the students to choose additionally the specialized courses of their choice and build their competence in a specialized area in the UG level. The program is a best choice for academically excellent students having good academic record and interest towards higher studies and research.

i. Honors is introduced in the curriculum of all B. Tech. programs offering a major degree and is applicable to all B.Tech (Regular and Lateral Entry) students admitted in Engineering & Technology.

ii. A student shall earn additional 18 credits for award of B.Tech.(Honors) degree from same branch/department/discipline registered for major degree. This is in addition to the credits essential for obtaining the Undergraduate degree in Major Discipline.

iii. A student is permitted to register for Honors and is allowed to take maximum of two subjects per semester pertaining to the Honors.

iv. Separate class work and timetable of the courses offered under Honors program shall be arranged.

v. Courses that are used to fulfill the student’s primary major may not be double counted towards the Honors. Courses with content substantially equivalent to courses in the student's primary Major may not be counted towards the Honors.

vi. Students can complete the courses offered under Honors either in the college or in online platforms like SWAYAM with a minimum duration of 12 weeks for a 3-credit course satisfying the criteria for credit mobility. If the courses under Honors are offered in conventional mode, then the teaching and evaluation procedure shall be similar to regular B. Tech courses.

vii. A student registered for Honors shall pass in all subjects that constitute the requirement for the Honors degree program. No class/division (i.e., second class, first class and distinction, etc.) shall be awarded for Honors degree program.

viii. If a student drops or is terminated from the Honors program, the additional credits so far earned cannot be converted into open or core electives; they will remain extra. However, such students will receive a separate grade sheet mentioning the additional courses completed by them.

ix. The Honors will be mentioned in the degree certificate as Bachelor of Technology (Honors) in XYZ. For example, B.Tech. (Honors) in Mechanical Engineering.

Enrolment into Honors:

i. Students of a Department/Discipline are eligible to opt for Honors program offered by the same Department/Discipline.

ii. The enrolment of student into Honors is based on the CGPA obtained in the major degree program. CGPA shall be taken up to IV semester in case of regular and Lateral entry students. Students having 7 CGPA without any backlog subjects will be permitted to register for Honors.

iii. Transfer of credits from Honors to regular B. Tech degree and vice-versa shall not be permitted.

iv. An honor is to be completed simultaneously with a Major degree program.

Registration for Honors:

i. The eligible and interested students shall apply through the HOD of his/her parent department. The whole process should be completed within one week before the start of every semester. Selected students shall be permitted to register the courses under Honors.

ii. The selected students shall submit their willingness to the principal through his/her parent department offering Honors. The parent department shall maintain the record of student pursuing the Honors.

iii. The students enrolled in the Honors courses will be monitored continuously. An advisor/mentor from parent department shall be assigned to a group of students to monitor the progress.

iv. There is no fee for registration of subjects for Honors program offered in offline at the respective institutions.

17. Attendance Requirements:

i. A student shall be eligible to appear for the external examinations if he/she acquires a minimum 75% of attendance in aggregate of all the subjects.

ii. Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester may be granted.

iii. Students whose shortage of attendance is not condoned in any semester are not eligible to take their end examination of that class and their registration shall stand cancelled.

iv. A student will not be promoted to the next semester unless he satisfies the attendance requirements of the present semester. They may seek readmission for that semester from the date of commencement of class work.

v. If the learning is carried out in blended mode (both offline & online), then the total attendance of the student shall be calculated considering the offline and online attendance of the student.

vi. Given the extensive scope for learning in blended mode, a student can seek consideration of time spent online or on course projects in lieu of attendance. The college academic committee will arbiter engagement of students on a case-to-case basis where a student falls short of the requisite attendance.

vii. For induction program attendance shall be maintained as per AICTE norms.

18. Promotion Rules:

A student shall be promoted from IV semester to V semester if he fulfills the minimum attendance requirement (75%) and academic requirement of 40% of credits (any decimal fraction should be rounded off to lower digit) up to either III semester or IV semester from the following examinations irrespective of whether the candidate takes the examination or not.

- Two regular and Two supplementary examinations of I semester
- Two regular and One supplementary examinations of II semester
- One regular examination and One supplementary examination of III semester
- One regular examination of IV semester.

A student shall be promoted from VI semester to VII semester if he fulfills the minimum attendance requirement (75%) and academic

requirement of 40% of credits (any decimal fraction should be rounded off to lower digit) up to either V Semester or VI semester from the following examinations irrespective of whether the candidate takes the examination or not.

- Three regular and Three supplementary examinations of I semester
- Three regular and Two supplementary examinations of II semester
- Two regular and Two supplementary examinations of III semester
- Two regular and One supplementary examinations of IV semester
- One regular and One supplementary examination of V semester
- One regular examination of VI semester.

19. Grading:

As a measure of the student's performance, a 10-point Absolute Grading System using the following Letter Grades and corresponding percentage of marks shall be followed:
After each course is evaluated for 100 marks, the marks obtained in each course will be converted to a corresponding letter grade as given below, depending on the range in which the marks obtained by the student fall.

Structure of Grading of Academic Performance

Range in which the marks in the subject fall	Grade letter	Grade points
≥ 90	A+ (Outstanding)	10
≥ 80 and < 90	A (Excellent)	9
≥ 70 and < 80	B (Very Good)	8
≥ 60 and < 70	C (Good)	7
≥ 50 and < 60	D (Average)	6
≥ 40 and < 50	E (Pass)	5
< 40	F (Fail)	0
Absent	Ab (Absent)	0

A student obtaining Grade "F" or Grade "Ab" in a subject shall be considered failed and will be required to reappear for that subject when it is offered the next supplementary examination.

Computation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

The Semester Grade Point Average (SGPA) is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.,

$$SGPA = \Sigma (C_i \times G_i)/\Sigma C_i$$

where, C_i is the number of credits of the i^{th} subject and G_i is the grade point scored by the student in the i^{th} course.
The Cumulative Grade Point Average (CGPA) will be computed in the same manner considering all the courses undergone by a student over all the semesters of a program, i.e.,

$$CGPA = \Sigma (C_i \times S_i) / \Sigma C_i$$

where "S_i" is the SGPA of the ith semester and C_i is the total number of credits up to that semester.

Both SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

While computing the SGPA the subjects in which the student is awarded Zero grade points will also be included.

Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale.

Letter Grade: It is an index of the performance of students in a said course. Grades are denoted by the letters A^+, A, B, C, D and F.

Award of Class:

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of B. Tech. Degree, he/she shall be placed in one of the following four classes:

Class Awarded	CGPA Secured
First Class with Distinction	≥ 7.0 (Without any supplementary appearance)
First Class	≥ 6.0 and < 7.0
Second Class	≥ 5.0 and < 6.0
Pass Class	≥ 4.0 and < 5.0

Note: Students who have written supplementary examinations to fulfil the credit requirement will not be awarded First Class with Distinction. For such students the highest degree that is awarded will be First Class Only.

CGPA to Percentage conversion Formula = CGPA x 10

20. With–holding of Results

If the candidate has any dues not paid to the institution or if any case of indiscipline or malpractice is pending against him/her, the result of the candidate shall be withheld in such cases.

21. Multiple Entry / Exit Option

With NEP setting in, the theme is we will need to give different entry-exit options for students and a possibility to tailor a 4-year course or even a 3-year exit degree to suit their interests and requirements.

- Exit-Entry at each year of study through the entire 4-year duration.
- Possible multiple Degree Options with different Credit requirements that provide an option to a student to pick an option that best suits his/her interests and requirements.

Note: Four Year undergraduate program (FYUP) with or without Honors is the most recommended exit. But if for some unavoidable reasons, a student needs to exit at the end of Year I, Year II, Year III, the following would be the respective exit requirements with a tentative certificate/ diploma/ degree defined.

Year of Exit	Degree	Credits Required to be Earned During Course Work	Exit Extra Credits (Crash Course & Exam)	Total Credits
End of Year I	Office Tools Certificate (Or something equivalent as determined by Affiliating University)	40	6	46
End of Year II	Diploma in Discipline 1 (Or something equivalent as determined by Affiliating University)	88	8	96
End of Year III	Bachelor in Vocational Sciences in **Discipline1** (Or something equivalent as determined by Affiliating University)	136	0	136
End of Year IV (Without Honors)	Bachelor of Technology in **Discipline 1**) (Or something equivalent as determined by Affiliating University)	160	0	160

Year of Exit	Degree	Credits Required to be Earned During Course Work	Exit Extra Credits (Crash Course & Exam)	Total Credits
End of Year IV (With Honors)	Bachelor of Technology with Honors in **Discipline 1**) (Or something equivalent as determined by Affiliating University)	176	0	176

Note: The exit extra credits at Year II and Year III would essentially come from critical courses as determined by BoS from the following semester.

(a) Exit Policy:

The students can choose to exit the four-year program at the end of first/second/third year.

i) **UG Certificate in (Field of study/discipline)** - Program duration:
First Year (first two semesters) of the undergraduate program, 40 credits followed by an additional exit 6 credit bridge course. The 6 extra credits would be to make the certificate self-sufficient, with one 3-Credit Course on Taxation and one 3-Credit Course on Accounting that would help the candidates acquire job-ready competencies required to enter the workforce.

ii) **UG Diploma (in Field of study/discipline)** - Program duration:
First two years (first four semesters) of the undergraduate program, 88 credits followed by an additional exit of 8-credit bridge course with 2 Integrated 4 Credit courses in Major with 3+1 Theory and Lab distribution administrated as a Crash course in 1 month which would help the candidates acquire job-ready competencies required to enter the workforce.

iii) **Bachelor of Science (in Field of study/discipline) i.e., B.Sc. Engineering in (Field of study/discipline)-** Program duration:
First three years (first six semesters) of the undergraduate program, 120 credits.

(b) Entry Policy:

Modalities on multiple-entry by the student into the B.Tech. program will be provided in due course of time.

Note: The institution shall resolve any issues that may arise in the implementation of Multiple Entry and Exit policies from time to time and shall review the policies in the light of periodic changes brought by UGC, AICTE, State government and the affiliating univeristy.

22. Transitory Regulations

Discontinued, detained or failed candidates are eligible for readmission as and when the semester is offered after fulfillment of academic regulations. Candidates who have been detained for want of attendance or not fulfilled academic requirements or who have failed after having undergone the course in earlier regulations or have discontinued and wish to continue the course are eligible for admission into the unfinished semester from the date of commencement of class work with the same or equivalent subjects as and when subjects are offered, subject to Section 2 and they will follow the academic regulations into which they are readmitted.

Candidates who are permitted to avail Gap Year shall be eligible for re-joining into the succeeding year of their B.Tech from the date of commencement of class work, subject to Section 2 and they will follow the academic regulations into which they are readmitted.

23. Medium of Instruction:

The medium of instruction of the entire B.Tech undergraduate program in Engineering & Technology (including examinations and project reports) will be in English only.

24. Student Transfers:

Student transfers shall be as per the guidelines issued by the Government of Andhra Pradesh and the University from time to time.

25. General Instructions:

a. The academic regulations should be read as a whole for purpose of any interpretation.
b. Malpractices rules-nature and punishments are appended.
c. Where the words "he", "him", "his", occur in the regulations, they also include "she", "her", "hers", respectively.
d. In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the institution is final.
e. The institution may change or amend the academic regulations or syllabi at any time and the changes or amendments shall be made applicable to all the students on rolls with effect from the dates notified by the institution.
f. In the case of any doubt or ambiguity in the interpretation of the guidelines given, the decision of the Head of the institution is final.

* * *

Regulations for MALPRACTICES during the conduct of examinations

	Nature of Malpractices/Improper conduct	Punishment
1.a	If the candidate possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination) - **FIRST TIME** (whether copied or not)	Expulsion from the examination hall and cancellation of the performance in that subject only. • To keep the CC footage of the act as an evidence. • To obtain a statement from student and get it authorized by observer and Chief superintendent.
1.b	If the candidate possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination) - **SECOND TIME**(whether copied or not)	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations, project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. • To keep the CC footage of the act as an evidence. • To obtain a statement from student and get it authorized by observer and Chief superintendent.
1.c	If the candidate possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination) - **REPITITION OF THE ABOVE ACT** (After second time and whether copied or not)	Nature of punishment to be given for the improper conduct shall be as per the recommendations of the committee. • The committee comprising of Principal, Vice principal, Chief superintendent, Controller of Examinations and HoD to discuss and initiate the action to be taken and recommend. • To keep the CC footage of the act as evidence. • To obtain a statement from student and invigilator and authorized by Chief superintendent.
2.a.	If the candidate gives assistance or guidance or receives it from any other candidate orally or by any other body language methods.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. • To keep the CC footage of the act as an evidence.

2.b	If the candidate communicates through cell phones / through any other means with any candidate or persons in or outside the exam hall in respect of any matter. (i) If the communication is with the person(s) who belongs to our college.	Confiscation of the mobile or electronic gadgets involved and Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations, project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. • To obtain all relevant proofs of evidence from the Mobile/ gadgets and handing over of the same to the candidate. • To keep the CC footage of the act as evidence. • To obtain a statement from student and invigilator and authorized by observer and Chief superintendent.
	(ii) If the communication is with the person(s) outside the campus or people who are not related to our college.	Confiscation of the mobile or electronic gadgets involved and Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations, project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. • To obtain all relevant proofs of evidence from the Mobile/ gadgets and handing over of the same to the candidate. • To keep the CC footage of the act as evidence. • To obtain a statement from student and invigilator and authorized by observer and Chief superintendent. • The person(s) involved should be handed over to the police and a case is registered against him.
3.	If the candidate impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate, who has been impersonated, shall be cancelled in all the subjects of the examination (including practical's and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider/candidate not on rolls, he will be handed over to the police and a case is registered against him.

		• To constitute a committee comprising of Principal, Vice principal, Chief superintendent, Observer, Controller of Examinations and HoD to discuss and initiate the above action with documented proofs. • To keep the CC footage of the act as an evidence. • To obtain a statement from student, invigilator, subject expert and authorized by observer and Chief Superintendent.
4	If the candidate mishandles the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination. Also, if the answer script is mutilated / damaged disturbing the shape, of the script, answers, the bar code intentionally.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester. In addition to the above punishment, a committee shall be constituted and recommends appropriate punishment for the improper conduct. • To keep the CC footage of the act as an evidence. • To Obtain a statement from student and invigilator and authorized by observer and Chief superintendent.
5.	Uses objectionable, abusive or offensive language in the Examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject only. • To Obtain a statement from student and invigilator and get it authorized by Observer and Chief superintendent.
6.	Refuses to obey the orders of the Chief Superintendent/ACE/ any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them. • To constitute a committee comprising of Principal, Vice principal, Chief superintendent, Observer, Controller of Examinations and HoD to discuss and initiate the above action with documented proofs • To keep the CC footage of the act as an evidence. • To Obtain a statement from student and invigilator and authorized by observer and Chief superintendent.

7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. • To constitute a committee comprising of Principal, Vice principal, Chief superintendent, Observer, Controller of Examinations and HoD to discuss and initiate the above action. • To keep the CC footage of the act as an evidence. • To Obtain a statement from student and invigilator and authorized by observer and Chief superintendent.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. • To constitute a committee comprising of Principal, Vice principal, Chief superintendent, Observer, Controller of Examinations and HoD to discuss and initiate the above action with documented proofs • To keep the CC footage of the act as an evidence. • To obtain a statement from student and invigilator and authorized by observer and Chief superintendent. • The candidate shall be handed over to Police and register a case.
9.	If a student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	If the student belongs to our college: Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester. The candidate is also debarred and forfeits the seat.

		Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them. • To constitute a committee comprising of Principal, Vice principal, Chief superintendent, Observer, Controller of Examinations and HoD to discuss and initiate the above action. • To keep the CC footage of the act as an evidence. • To Obtain a statement from student and invigilator and authorized by observer and Chief superintendent.
10	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester. • To keep the CC footage of the act as an evidence(If any). • To obtain a statement from invigilator and any others as witness authorized by observer and Chief superintendent.
11	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations. • To Obtain a statement from Valuer / Chief Valuer authorized by Spot Coordinator and Controller of Examinations.

* * *

Ragging

Salient Features

- **Ragging within or outside any educational institution is prohibited.**
- **Ragging means doing an act which causes or is likely to cause Insult or Annoyance of Fear or Apprehension or Threat or Intimidation or outrage of modesty or Injury to a student**

	Imprisonment upto		Fine Upto
Teasing, Embarrassing and Humiliation	 **6 Months**	+	**Rs. 1,000/-**
Assaulting or Using Criminal force or Criminalintimidation	 **1 Year**	+	**Rs. 2,000/-**
Wrongfully restraining or confining or causing hurt	 **2 Years**	+	**Rs. 5,000/-**
Causing grievous hurt, kidnapping or Abducts or rape or committing unnaturaloffence	 **5 Years**	+	**Rs. 10,000/-**
Causing death or abetting suicide	 **10 Months**	+	**Rs. 50,000/-**

In Case of Emergency CALL TOLL FREE NO. : 1800 - 425 – 1288

LET US MAKE MVGR A RAGGING FREE CAMPUS

ABSOLUTELY SAY NO TO RAGGING

1. Ragging is prohibited as per Act 26 of A.P. Legislative Assembly, 1997.
2. Ragging entails heavy fines and/or imprisonment.
3. Ragging invokes suspension and dismissal from the College.
4. Outsiders are prohibited from entering the College and Hostel without permission.
5. Girl students must be in their hostel rooms by 7.00 p.m.
6. All the students must carry their Identity Cards and show them when demanded
7. The Principal and the Wardens may visit the Hostels and inspect the rooms any time.

ACADEMIC REGULATIONS (R24) FOR B.TECH. (LATERAL ENTRY SCHEME)

(Effective for the students getting admitted into II year through Lateral Entry Scheme from the Academic Year **2024-2025** onwards)

1. Award of the Degree

(a) Award of the B.Tech. Degree / B.Tech. Degree with a Minor if he/she fulfils th following:

(i) Pursues a course of study for not less than three academic years and not more than six academic years. However, for the students availing Gap year facility this period shall be extended by two years at the most and these two years would in addition to the maximum period permitted for graduation (Six years).

(ii) Registers for 120 credits and secures all 120 credits.

(b) **Award of B.Tech. degree with Honors**

A student will be declared eligible for the award of the B.Tech. with Honors if he/she fulfils the following:

(i) Student secures additional 18 credits fulfilling all the requisites of a B.Tech. program i.e., 120 credits.

(ii) Registering for Honors is optional.

(iii) Honors is to be completed simultaneously with B.Tech. programme.

2. Students, who fail to fulfil the requirement for the award of the degree within six consecutive academic years from the year of admission, shall forfeit their seat.

3. Minimum Academic Requirements

The following academic requirements have to be satisfied in addition to the requirements mentioned in item no.2

i. A student shall be deemed to have satisfied the minimum academic requirements and earned the credits allotted to each theory, practical, design, drawing subject or project if he secures not less than 35% of marks in the end examination and a minimum of 40% of marks in the sum total of the mid semester evaluation and end examination taken together.

ii. A student shall be promoted from VI semester to VII semester if he fulfills the minimum attendance requirement (75%) and academic requirement of 40% of credits (any decimal fraction should be rounded off to lower digit) up to either V Semester or VI semester from the following examinations irrespective of whether the candidate takes the examination or not.

- Three regular and Three supplementary examinations of I semester
- Three regular and Two supplementary examinations of II semester
- Two regular and Two supplementary examinations of III semester
- Two regular and One supplementary examinations of IV semester
- One regular and One supplementary examination of V semester
- One regular examination of VI semester.

iii. And in case if student is already detained for want of credits for particular academic year, the student may make up the credits through supplementary exams of the above exams before the commencement of IV year I semester class work of next year.

4. Course Pattern

i) The entire course of study is three academic years on semester pattern.

ii) A student eligible to appear for the end examination in a subject but absent at it or has failed in the end examination may appear for that subject at the next supplementary examination offered. iii) When a student is detained due to lack of credits/shortage of attendance the student may be re-admitted when the semester is offered after fulfilment of academic regulations, the student shall be in the academic regulations into which he/she is readmitted.

5. All other regulations as applicable for B. Tech. Four-year degree course (Regular) will hold good for B. Tech. (Lateral Entry Scheme).

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R24-MVGR
COURSE STRUCTURE AND CURRICULUM
B.TECH (Regular/Honors)-CHEMICAL ENGINEERING
(Applicable from the academic year 2024-25 onwards)

I Semester

S. No	Course Code	Course Title	L	T	P	Credits
1	R24MCHYT001	Chemistry	3	0	0	3
2	R24MMATT001	Linear Algebra and Differential Equations	3	1	0	3
3	R24MMATT002	Multi Variables and Vector Calculus	3	1	0	3
4	R24MCHYL001	Chemistry Lab	0	0	2	1
5	R24MCIVT001	Environmental Studies	2	0	0	2
6	R24MENGT001	Language Proficiency	2	0	0	2
7	R24MSCSL001	Office Tools and Social Media Etiquette	0	0	3	2
8	R24MENGT002	Constitutional Values	2	0	0	2
9	R24MMECW001	Engineering Workshop	1	0	2	2
	Total Credits					**20**

Semester II

S. No	Course Code	Course Title	L	T	P	Credits
1	R24MPHYT001	Physics	3	0	0	3
2	R24MMATT003	Probability and Statistics and Numerical Methods	3	1	0	3
3	R24MCHET001	Material Science and Engineering	3	1	0	3
4	R24MSCST001	Procedural Programming	3	0	0	3
5	R24MMECD001	Computer Aided Engineering Drawing	1	0	2	2
6	R24MPHYL001	Physics Lab	0	0	2	1
7	R24MSCSL002	Procedural Programming Lab	0	0	2	1
8	R24MENGT003	Health and Wellness	2	0	0	2
9	R24MENGT004	Ethics and Human Values	2	0	0	2
	Total Credits					**20**

Semester III

S. No	Course Code	Course Title	L	T	P	Credits
1	R24MCHET002	Fluid Mechanics for Chemical Engineers	3	0	0	3
2	R24MCHET003	Chemical Process Calculations	3	0	0	3
3	R24MCHET004	Mechanical Unit Operations	3	0	0	3
4	R24MCHET005	Chemical Technology	3	0	0	3
5	R24MCSCT001	Data Structures	3	0	0	3
6	R24MCSCT002	Operating Systems	3	0	0	3
7	R24MCHEL001	Fluid Mechanics for Chemical Engineers Lab	0	0	3	2
8	R24MCHEL002	Mechanical Unit Operations Lab	0	0	3	2
9	R24MCSCL001	Data Structures Lab	0	0	3	2
	Total Credits					**24**

IV Semester

S. No	Course Code	Course Title	L	T	P	Credits
1	R24MCHET006	Process Heat Transfer	3	0	0	3
2	R24MCHET007	Chemical Engineering Thermodynamics	3	0	0	3
3	R24MCHET008	Chemical Reaction Engineering-I	3	0	0	3
4	R24MCHET009	Mass Transfer-I	3	0	0	3
5	R24MCSCT003	Python Programming	3	0	0	3
6	R24MCSCT004	Database Management Systems	3	0	0	3
7	R24MCHEL003	Process Heat Transfer Lab	0	0	3	2
8	R24MCHEL004	Chemical Reaction Engineering Lab	0	0	3	2
9	R24MCSCL002	Python Programming Lab	0	0	3	2
Total Credits						**24**

V Semester

S. No	Course Code	Course Title	L	T	P	Credits
1	R24MCHET010	Transport Phenomena	3	0	0	3
2	R24MCHET011	Chemical Reaction Engineering-II	3	0	0	3
3	R24MCHET012	Mass Transfer-II	3	0	0	3
4	R24MCHET013	Process Instrumentation	3	0	0	3
5	R24MCHETXXX	DSC-E1	3	0	0	3
6	R24MCSCT005	Software Engineering	3	0	0	3
7	R24MCHEL005	Mass Transfer Lab	0	0	3	2
8	R24MCSCL003	Database Management Systems Lab	0	0	3	2
9	R24MCHEP001	Community Project	0	0	2	2
Total Credits						**24**

VI Semester

S. No	Course Code	Course Title	L	T	P	Credits
1	R24MCHET014	Process Modelling and Simulation	3	0	0	3
2	R24MCHET015	Process Dynamics and Control	3	0	0	3
3	R24MCHET016	Plant Design and Economics for Chemical Engineers	3	0	0	3
4	R24MCSCT006	OOP with JAVA	3	0	0	3
5	R24MCHETXXX	DSC E2	3	0	0	3
6	R24MCHETXXX	DSC E3	3	0	0	3
7	R24MCHEL006	Process Control and Simulation Lab	0	0	3	2
8	R24MCSCL004	OOP with JAVA Lab	0	0	3	2
9	R24MMATT007	Quantitative Problem Solving Techniques	2	0	0	2
Total Credits						**24**

VII Semester

S. No	Course Code	Course Title	L	T	P	Credits
1	R24MCHET017	Basic Environmental Engineering and Pollution Abatement (Self-Study/MOOCS)	3	0	0	3
2	R24MCHETXXX	DSC E4 (Self-Study/MOOCS)	3	0	0	3
3	R24MCHETXXX	DSC E5 (Self-Study/MOOCS)	3	0	0	3
4	R24MCHEP002	Mini Project	0	0	2	2
5	R24MCHEL007	Industrial Safety Training/Training in Pharmaceutical industries/ASPEN PLUS	0	0	3	2
Total						**13**

VIII Semester

S. No	Course Code	Course Title	L	T	P	Credits
1	R24MCSCT007	Computer Networks	3	0	0	3
	R24MCSCT008	Artificial Intelligence: Principles and Techniques	3	0	0	
	R24MCSCT009	OOAD and Design Patterns	3	0	0	
2	R24MCHEP003	Major-Dissertation/Academic Project-Major	0	0	16	8
Total Credits						**11**

B.Tech. (Regular/HONORS) Total Credits: 160 /178

DEPARTMENT ELECTIVE COURSES

Specialization-1: Advanced Chemical Engineering

Type of Course	Course Code	Course Title	Semester
DSC-E1	R24MCHET021	Petroleum Refining	V
DSC-E2	R24MCHET022	Biochemical Engineering	VI
DSC-E3	R24MCHET023	Industrial Safety and Hazards Management	VI
DSC-E4	R24MCHET024	Physico-chemical processes for wastewater treatment	VII
DSC-E5	R24MCHET025	Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems	VII

Specialization-2: Bioprocess Technologies

Course Code	Type of Course	Course Code	Semester
DSC-E1	R24MCHET026	Fluidization Engineering	V
DSC-E2	R24MCHET022	Biochemical Engineering	VI
DSC-E3	R24MCHET027	Chemical Process Utilities	VI
DSC-E4	R24MCHET028	Advanced Reaction Engineering	VII
DSC-E5	R24MCHET029	Chemical Process Intensification	VII

Specialization-1: Advanced Chemical Engineering

S. No	Course Code	Course Title	L	T	P	Credits	Sem
1	R24MCHEHT01	Process Equipment Design	3	0	0	3	VI
2	R24MCHEHT02	Computational Methods in Chemical Engineering	3	0	0	3	VI
3	R24MCHEHT03	Process Integration	3	0	0	3	VII
4	R24MCHEHT04	Optimization of Chemical Processes	3	0	0	3	VII
5	R24MCHEHT05	Membrane Technology	3	0	0	3	VIII
6	R24MCHEHT06	Hydrogen Energy: Production, Storage, Transportation And Safety	3	0	0	3	VIII
Total Credits						**18**	

Specialization-2: Bioprocess Technologies

S. No	Course Code	Course Title	L	T	P	Credits	Sem
1	R24MCHEHT07	Industrial Biotechnology	3	0	0	3	VI
2	R24MCHEHT08	Biomass Conversion And Biorefinery	3	0	0	3	VI
3	R24MCHEHT09	Biological process design for wastewater treatment	3	0	0	3	VII
4	R24MCHEHT10	Bioreactor Design and Analysis	3	0	0	3	VII
5	R24MCHEHT11	Thermal Processing of Foods	3	0	0	3	VIII
6	R24MCHEHT12	Polymer Reaction Engineering	3	0	0	3	VIII
Total Credits						**18**	

EXTENDED OPEN ELECTIVE CLUSTER

Business Management Cluster(BMC) (for CSE/IT/CSIT/AIML/DS/ICB)							
Type of Course	**Course Code**	**Course Title**	**Sem**	**Type of Course**	**Course Code**	**Course Title**	**Sem**
EOEC-T1	R24MBMCT001	Financial Management	III	EOEC-L1	R24MMECL001	Computer Aided Geometric Design and Assembly Lab	III
EOEC-T2	R24MMECT013	Leadership and Team Management	III	EOEC-L2	R24MBMCL001	Financial Accounting Lab	IV
EOEC-T3	R24MMECT020	Product Lifecycle Management	IV	EOEC-L3	R24MBMCL002	Digital Engineering Lab	V
EOEC-T4	R24MBMCT002	Quality Management	IV	EOEC-L4	R24MBMCL003	Business Analytics Lab	VI
EOEC-T5	R24MBMCT003	Entrepreneurship	V				
EOEC-T6	R24MMECT018	Business Analysis	VI				
EOEC - E1 (Self-Study/MOOCs)	R24MBMCT004	Strategic Management	VIII				
	R24MBMCT005	Digital Marketing					
	R24MMECT017	Logistics and Supply Chain Management					

R24

Computer Science Cluster(CSC) (for MEC, ECE, EEE, CIV and CHE) (Not for CSE/IT/CSIT/AIML/DS/ICB)							
Type of Course	**Course code**	**Course Title**	**Sem**	**Type of Course**	**Course Code**	**Course Title**	**Sem**
EOEC-T1	**R24MCSCT001**	Data Structures	III	EOEC-L1	**R24MCSCL001**	Data Structures Lab	III
EOEC-T2	**R24MCSCT002**	Operating Systems	III	EOEC-L2	**R24MCSCL002**	Python Programming Lab	IV
EOEC-T3	**R24MCSCT003**	Python Programming	IV	EOEC-L3	**R24MCSCL003**	Database Management Systems Lab	V
EOEC-T4	**R24MCSCT004**	Database Management Systems	IV	EOEC-L4	**R24MCSCL004**	OOP with JAVA Lab	VI
EOEC-T5	**R24MCSCT005**	Software Engineering	V				
EOEC-T6	**R24MCSCT006**	OOP with JAVA	VI				
EOEC-E1 Selfstudy /Moocs	**R24MCSCT007**	Computer Networks	VIII				
	R24MCSCT008	Artificial Intelligence: Principles and Techniques					
	R24MCSCT009	OOAD and Design Patterns					

I SEMESTER

R24MCHYT001	CHEMISTRY (Common to All Branches)					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Basics of 10 + 2 Chemistry	**3**	**0**	**0**	**3**

Course Objective

This course aims to help students

- To gain the comprehensive understanding of polymers and green chemistry
- To gain knowledge in electrochemistry, spectroscopic techniques and molecular machines.
- To get insight on phenomena of material deterioration and develop understanding on control and protective techniques.

Course Outcomes

After completing this course, the students will be able to

1	Classify macromolecules as materials such as polymers, rubbers and make use of these materials as good engineering materials with improved properties. **(BL4)**
2	Apply fundamentals of electrochemistry and electro analytical techniques and judge a suitable storage device for desired engineering applications. **(BL5)**
3	Choose certain spectroscopic techniques for analysis of compounds and explain the behaviour of materials as molecular switches. **(BL5)**
4	Classify various types of material deterioration phenomena and identify suitable control and protective techniques. **(BL4)**
5	Explain the principles of green chemistry and develop understanding on nanomaterials and harnessing of solar energy. **(BL5)**
6	Choose suitable material, analytical technique for identification, analysis and develop an understanding on material use, protection and energy storage. **(BL6)**

SYLLABUS

Unit I	**HIGH POLYMERS**	**8 hr**

Introduction – Stereospecific Polymers; Types of Polymerizations – Co-ordination polymerization - Zieglar – Natta Catalysis – Mechanism; Plastics –Types - Thermoplastics – Thermosets –Differences; Preparation, Properties and Applications of –PVC - Teflon – Bakelite – Nylon; Rubbers – Natural - Synthetic –Vulcanization; Preparation, properties and applications of - BUNA – S, Thiokol rubber; Fiber Reinforced Plastics – Introduction - Types of FRP – Aramids – Kevlar and Nomex; Conducting polymers - Introduction – Classification – Intrinsic and extrinsic – Applications.

Unit II	**ELECTROCHEMISTRY AND ITS APPLICATIONS**	**8 hr**

Introduction - Electrode Potential – Measurement of electrode potential - Electrochemical series**;** Expression for electrode potential – Electrochemical cell – EMF of the cell**;** Storage devices – Classification – Primary – Leclanché cell**;** Secondary - Solid state battery / Lithium-ion battery**;** Flow Cells - Fuel cells – Hydrogen – Oxygen fuel cell, Methanol – Oxygen fuel cell - Solid Oxide Fuel Cells**;** pH Metry**;** Conductometry**;** Potentiometry - Principle – Applications.

Unit III	**SPECTROSCOPY AND MOLECULAR SWITCHES**	**8 hr**

Introduction to spectroscopy - Electromagnetic radiation**;** Classification – Absorption and Emission spectroscopy**;** Laws of Absorption – Derivation of Beer – Lambert's law – Significance**;** UV – Visible Spectroscopy - 1 – Introduction – Principle**;** UV – Visible Spectroscopy – 2 - Instrumentation (block diagram) – Applications**;** Infra – Red Spectroscopy - 1 – Introduction to Infra - Red Spectroscopy – Principle**;** Infra – Red Spectroscopy – 2 - Instrumentation (block diagram) – Applications**;** Molecular switches - NOR and NOT logic gate operators - Characteristics - Rotaxanes and

Catenanes as artificial molecular machines.		
Unit IV	**CORROSION**	**8 hr**
Chemical Corrosion – Mechanism - Pilling Bed worth rule**;** Electrochemical Corrosion - Mechanism - Difference between dry and wet corrosion - Galvanic series**;** Types of Corrosion - Differential aeration corrosion, galvanic corrosion, pitting corrosion, waterline corrosion and stress corrosion**;** Factors influencing rate of corrosion - Metal-based factors and Environment based factors; Corrosion control Methods – Proper design, Use of Pure metal, Use of Alloy**;** Cathodic protection – Sacrificial Anodic protection method – Impressed current cathodic protection method- Use of Inhibitors**;** Protective coatings - Types - Metal Coatings – Anodic - Galvanizing and Cathodic Coating – Tinning**;** Passivation and Pourbaix diagram - Pourbaix diagram.		
Unit V	**CONCEPTS OF GREEN CHEMISTRY, NANO CHEMISTRY AND SOLAR ENERGY**	**8 hr**
Green Chemistry - Introduction - Principles of Green Chemistry**;** Applications – Any green two reactions**;** Nanomaterials - Introduction – Classification**;** Synthesis of Nano material by Top down and bottom-up approach**;** CVD Method – Sol gel method – Synthesis of iron oxide nano particles**;** Carbon nano tubes – Introduction - Classification – Applications**;** Harnessing of Solar Energy – Construction and Working of PV Cell**;** Solar collectors – Concentrating.		
LEARNING RESOURCES		
TEXT BOOKS:		
1	Jain and Jain, *Engineering Chemistry*, 17th ed. New Delhi, India: Dhanpat Rai Publications, 2015.	
2	S.S. Dara, *Text Book of Engineering Chemistry*, 12th ed. New Delhi, India: S. Chand, 2006.	
3	Y. Bharathi Kumari, *Text Book of Engineering Chemistry*, For JNTU R23 Hyderabad, India: VGS Publications, 2023	
REFERENCE BOOKS:		
1	T. F. Yen, *Chemistry for Engineers*, London, U.K.: Imperial College Press, 2008.	
2	S. K. Chawla, *Engineering Chemistry*, latest ed. New Delhi, India: Dhanpat Rai & Co., 2017.	

Bloom's level - Units catchment articulation matrix

CO	Blooms levels	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL4	×				
CO2	BL5		×			
CO3	BL5			×		
CO4	BL4				×	
CO5	BL5					×
CO6	BL6	×	×	×	×	×

R24MMATT001	LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS (Common to all branches)					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Basic Calculus and Matrices	**3**	**1**	**0**	**3**

Course Objective

To equip the students with standard concepts and tools of mathematics to handle various real-world problems and their applications.

Course Outcomes

After completing this course, the students will be able to

1	Solve system of equations by Direct methods. **(BL3)**
2	Make use of Linear Algebra techniques to find higher powers and inverse of Matrices. **(BL3)**
3	Solve first order differential equations and make use of them to deal with real word problems like law of cooling, growth, and decay. **(BL3)**
4	Solve the higher order differential equations to make use of them to deal with real word problems. **(BL3)**
5	Make use of Laplace transforms to solve initial value problems. **(BL3)**
6	Formulate Mathematical models and estimate appropriate physical quantities. **(BL6)**

SYLLABUS

Unit I	**LINEAR ALGEBRA-1**	**8 hr**

Rank; Consistency criteria; Non homogeneous systems; Homogeneous systems; Characteristic equation; Eigen values; Eigen vectors; Properties.

Unit II	**LINEAR ALGEBRA-2**	**8 hr**

Cayley-Hamilton Theorem; Higher powers; Matrix polynomials; Inverse of Matrix; Diagonalization; Quadratic forms (QF); Canonical forms (CF); Reduction of QF to CF.

Unit III	**FIRST ORDER DIFFERENTIAL EQUATIONS & APPLICATIONS**	**8 hr**

Linear Differential Equations (DE); Solving Linear DE; Bernoulli's DE; Solving Bernoulli's DE; Exact DE; Non-exact DE; Newton's law of cooling; laws of natural growth and decay.

Unit IV	**HIGHER ORDER DIFFERENTIAL EQUATIONS**	**8 hr**

Homogeneous linear differential equations (DE)-1; Homogeneous linear DE -2; Non homogeneous linear DE (e^{ax}); Non homogeneous linear DE $(sin\, ax\ /\ cos\, ax)$; Non homogeneous linear DE (x^k); Non homogeneous linear DE $\left(e^{ax}\, v(x)\right)$; Particular integrals; Method of variation of parameters.

Unit V	**LAPLACE TRANSFORMS**	**8 hr**

Laplace transform (LT) of elementary functions-1; LT of elementary functions-2; LT using elementary properties-1; LT using elementary properties-2; Inverse LT (Partial Fractions); Convolution theorem; Initial value problems (IVP); Solving IVP.

LEARNING RESOURCES

TEXT BOOKS:

1	B.S.Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.
2	T.K.V. Iyengar et al, Engineering Mathematics, S. Chand Publishers, Revised edition.

REFERENCE BOOKS:

1	Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.
2	B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3	T. Veerarajan, Higher Engineering Mathematics, Tata McGraw-Hill, 2008.

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL 3	x				
CO2	BL 3		x			
CO3	BL 3			x		
CO4	BL 3				x	
CO5	BL 3					x
CO6	BL 6	x	x	x	x	x

R24MMATT002	MULTI VARIABLES AND VECTOR CALCULUS (Common to all branches)					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Basic Calculus	**3**	**1**	**0**	**3**

Course Objective

To equip the students with standard concepts and tools of mathematics to handle various real-world problems and their applications.

Course Outcomes

After completing this course, the students will be able to

1	Test for maxima and minima for functions of several variables. (**BL6**)
2	Evaluate double and triple integrals of functions of several variables in two and three dimensions. (**BL5**)
3	Interpret the physical meaning of different operators such as gradient, curl and divergence. (**BL5**)
4	Estimate the work done against a field, circulation and flux using vector calculus. (**BL6**)
5	Solve the partial differential equations by various methods. (**BL3**)
6	Formulate Mathematical models and estimate appropriate physical quantities. (**BL6**)

Unit I	**MULTIVARIABLE CALCULUS**	**8 hr**

Partial derivative; Total derivative; Chain rule; Taylor's Series for functions of two variables; Maclaurin's series; Jacobian and its properties; Maxima and minima; Lagrange's method of undetermined multipliers.

Unit II	**MULTIPLE INTEGRALS**	**8 hr**

Double integrals; Double integrals over a region; Double integrals in polar co-ordinates; Change of order; Change of variables in double integrals; Triple integrals; Change of variables; Applications of double and triple integrals.

Unit III	**VECTOR DIFFERENTIATION**	**8 hr**

Gradient; Normal vector to the surface; Angle between surfaces; Directional derivative; Divergence; Solenoidal vector; Curl of a vector; Irrotational vector.

Unit IV	**VECTOR INTEGRATION**	**8 hr**

Line integral; Circulation; Work done; Surface integral; Volume integral; Green's theorem; Gauss divergence theorem; Stokes theorem (without proofs).

Unit V	**PARTIAL DIFFERENTIAL EQUATIONS (PDE)**	**8 hr**

Formation of PDE (Eliminating arbitrary constants); Formation of PDE (Eliminating arbitrary functions); Lagrange's Linear PDE-1; Lagrange's Linear PDE-2; Homogeneous Linear PDE; Homogeneous Linear PDE (e^{ax+by}); Homogeneous Linear PDE (sin or cos $(ax+by)$); Homogeneous Linear PDE ($x^m y^n$).

LEARNING RESOURCES

TEXT BOOKS:

1	B.S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.
2	T.K.V. Iyengar et al, Engineering Mathematics, S. Chand Publishers, Revised edition

REFERENCE BOOKS:

1	Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.
2	B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3	T. Veerarajan, Higher Engineering Mathematics, Tata McGraw-Hill, 2008.

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL 6	x				
CO2	BL 5		x			
CO3	BL 5			x		
CO4	BL 6				x	
CO5	BL 3					x
CO6	BL 6	x	x	x	x	x

R24MCHYL001	CHEMISTRY LAB (Common to All Branches)					
	Total Contact Hours	**28 (P)**	**L**	**T**	**P**	**C**
	Pre-requisite	**Basics of 10 + 2 Chemistry**	**0**	**0**	**2**	**1**

Course Objective: This course aims to help students,	
To verify the fundamental concepts with experiments	
Course Outcomes: After completing this course, the students will be able to	
1	Determine total hardness, dissolved oxygen, strength of acid in a lead acid battery, using volumetric analysis
2	Explain conductometric, potentiometric, pH metric titrations and colorimetric determinations.
3	Explain the synthesis of a polymer, nanomaterials.

List of Experiments

1. Determination of HCl using sodium carbonate.
2. Determination of Strength of an acid in Pb-Acid battery.
3. Determination of Iron (II) using potassium dichromate.
4. Determination of Hardness of a groundwater sample.
5. Determination of Dissolved oxygen in ground water sample.
6. Potentiometric titration of Fe (II) with potassium dichromate.
7. Condcutometric titration of Strong acid VS Strong base.
8. Condcutometric titration of Weak acid VS strong base.
9. pH metric titration of strong acid and strong base.
10. Determination of percentage of Iron in Cement sample by colorimetry.

Additional Experiments

1. Preparation of nanomaterials by precipitation method.
2. Preparation of Bakelite.
3. Determination of Cell constant of a conductivity cell.

Advanced Design Experiments

1. Determination of viscosity of polymer solution using survismeter.
2. Measurement of 10Dq by spectrophotometric method.

TEXTBOOKS

1. A.I. Vogel, "Quantitative Chemical Analysis," 6th ed. Boston, MA, USA: Cengage Learning, 2000.
2. D. A. Day and A. L. Underwood, Quantitative Chemical Analysis. Upper Saddle River, NJ, USA: Prentice Hall, 1991.
3. K. Mukkanti, Practical Engineering Chemistry. Hyderabad, India: B.S. Publications, 2009.

REFERENCE BOOKS:

1. J. Cherukui, Laboratory Manual of Engineering Chemistry-II, VGS Techno Series, 2012.
2. Department of Chemistry, MVGR College of Engineering, Laboratory Manual.

R24MCIVT001	ENVIRONMENTAL STUDIES					
	Total Contact Hours	28 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	NIL	**2**	**0**	**0**	**2**

Course Objective

This course aims to impart a deep understanding of environmental processes, climate change, biodiversity, ecosystem functionality, and lifestyle impacts. Equipped with this knowledge, students will advocate for climate mitigation and combat climate change effectively.

Course Outcomes: After completing this course, the students will be able to apply and articulate

1. The roles of knowledge of biodiversity, ecosystem functionality, and resources in tackling pollution and environmental laws. (BL3)
2. The concepts of carbon cycle, climate systems, and microclimate and their connection to weather patterns and climate policies. (BL3)
3. The concepts of greenhouse gases, paleoclimate, energy balance, water cycle, and atmospheric motion and their role in climate systems. (BL3)
4. The knowledge of ocean, cryosphere, biosphere interactions and their influence on climate regulation. (BL3)
5. Sustainable practices such as energy and water conservation to promote environmental protection and resource efficiency. (BL3)

SYLLABUS

Unit I	**INTRODUCTION TO ENVIRONMENTAL STUDIES**	**5 hr**

Biodiversity and ecosystem functionality – Natural resources – Environmental pollution – Environmental episodes – Environmental legislation

Unit II	**INTRODUCTION TO CLIMATE CHANGE**	**5 hr**

Carbon cycle – Earth's Climate System – Weather and Climate – Understanding Microclimate - Policy initiatives to Combat Climate Change

Unit III	**SCIENCE BEHIND THE CLIMATE CHANGE – 1**	**5 hr**

Greenhouse gas effect - Paleoclimate - Energy Balance - Water Cycle – Atmospheric motion

Unit IV	**SCIENCE BEHIND THE CLIMATE CHANGE – 2**	**5 hr**

Ocean changes - Cryosphere dynamics – Volcanoes - Biosphere and climate regulation - Mitigation strategies

Unit V	**LIFESTYLE FOR ENVIRONMENT**	**5 hr**

Sustainability Challenges - Save Energy - Save Water - Reduce waste - Healthy Lifestyles

LEARNING RESOURCES

TEXTBOOKS:

1. E. Bharucha, *Textbook of Environmental Studies for Undergraduate Courses*, 2nd ed. Hyderabad, India: Universities Press, 2012.
2. A. Schmittner, *Introduction to Climate Science*. Corvallis, OR: Oregon State University, 2018. [Online]. Available: https://open.oregonstate.education/ climatechange/

REFERENCE BOOKS:
1. R. T. Wright and D. F. Boorse, *Environmental Science: Toward a Sustainable Future*, 13th ed. Boston, MA: Pearson, 2017.
2. United Nations Development Programme, *Climate Box. An interactive learning toolkit on climate change*. New York, NY, 2018.
3. J.K. Arora, B.K. Tyagi, K.S. Bath, R. Bal, and S.S. Ladhar, *Activity Book on Climate Change*. Punjab State Council for Science & Technology, 2022.
ADDITIONAL REFERENCE MATERIAL
1. Mission Life for Environment (https://missionlife-moefcc.nic.in/Download-Creatives-Save-Energy.php?id=MTE=)
ONLINE COURSES
1. Climate Change Science, IISc Bangalore, https://nptel.ac.in/courses/120108558
2. The Literature of Climate Crisis, Uni. of Hyderabad, https://nptel.ac.in/courses/109106733
3. Climate change: Extreme Events: IISER Bhopal https://nptel.ac.in/courses/105106707

BLOOM'S LEVEL - UNITS CATCHMENT ARTICULATION MATRIX

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL3	X				
CO2	BL3		X			
CO3	BL3			X		
CO4	BL3				X	
CO5	BL3					X

R24MENGT001	LANGUAGE PROFICIENCY					
	Total Contact Hours	28 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	---	**2**	**0**	**0**	**2**

Course Objective

The student will be able to apply the concepts of comprehension, Interpretation and structured presentation in varied contexts and demonstrate skilled communication.

Course Outcomes

1	Demonstrate the skill to comprehend, analyze and interpret information. (**BL 3**)
2	Demonstrate the skill of structured thinking. (**BL 3)**
3	Demonstrate Competency to summarize and paraphrase content in different materials. (**BL 3)**
4	Demonstrate application of the skills of presentation in writing and speaking, meeting the requirement of the concept of constructive presentation. (**BL 3**)
5	Demonstrate understanding of the nuances in group communication. (**BL3)**

SYLLABUS

Unit I	**VOCABULARY ENRICHMENT**: Understanding the meaning of a word by identifying the context – The technique; presenting an idea using a set of words; Vocabulary mind mapping; word choice & Connotation. Collocations. Understanding Jargon.	**5 hr**
Unit II	**THE ART OF READING**: Understanding the process of reading; Reading an article and assimilating the rhetoric; Skimming & scanning a piece of text; Reading fiction to understand writer's perspective; The art of analyzing and appreciating a literary text.	**5 hr**
Unit III	**LISTENING & COMPREHENDING:** Understanding the process of listening**;** Watching travel documentaries to master the technique of active listening; making a brochure; watching a film and drafting a review; watching interviews of successful entrepreneurs and sharing the take–away concepts/ideas**;** Watching documentaries on 'Engineering marvels' and sharing impressions.	**5 hr**
Unit IV	**WRITING FOR COMMUNICATION**: Basics in writing**;** The technique of persuasion; genres of writing - Narrative writing, descriptive writing, expository writing; nuances of Journal writing; Letter Writing & its etiquette**.** Email writing & etiquette.	**5 hr**
Unit V	**EXPRESSING ONESELF**: Introducing oneself; Ted talk and the concept of structured presentation; Case debates on contemporary problems; open discussions on different perspectives of living – Adventures, society & life, science & religion, sports, cinema. Dialogues & language experimentation-Staging skits on relevant social themes.	**5 hr**

REFERENCE BOOKS:	
1	Seely, John. *Oxford guide to effective Writing and Speaking*. Oxford Press. 2022.
2.	Atkins, Ros. *The art of explanation.* Wildfire publications. 2023.
WEB RESOURCES:	
1. www.purdueowl.com 2. www.voanews.com 3. www.learningenglish.vn 4. www.prowritingaid.com 5. www.eslcafe.com 6. www.5minutesenglish.com 7. www.livinglanguage.com 8. www.newsinlevels.com	

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL3	X				
CO2	BL3		X			
CO3	BL3			X		
CO4	BL3				X	
CO5	BL3					X

R24MSCSL001	OFFICE TOOLS AND SOCIAL MEDIA ETIQUETTE					
	Total Contact Hours	42 (P)	**L**	**T**	**P**	**C**
	Pre-requisite	-	**0**	**0**	**3**	**2**

Course Objective

- To get hands-on exposure to office automation software.
- To perform basic data analysis tasks using spreadsheets.
- To practice methods of social media etiquette and digital wellbeing.

Course Outcomes

After completing this course, the students will be able to

1	Create documents and letters for professional communication.
2	Analyze and interpret data and provide effective visualization.
3	Create presentations and slideshows.
4	Practice various mechanisms of social media etiquette.

LIST OF EXPERIMENTS

1	Create a simple document containing tables, images, smart art and flowchart symbols. Apply various font styles, sizes, designs, bullet points and page layouts.
2	Create a document containing hyperlinks, equations, symbols and charts. Apply various header and footer formats, bookmarks and macros.
3	Create a document with citations, bibliography, table of figures, cross-reference and index.
4	Create a simple presentation with various layouts, background design, fonts and geometric shapes with different effects
5	Create a presentation with transitions, animations with timings and audio files.
6	Create a presentation with hyperlinks to internal slides, external files and language translator.
7	Create a spreadsheet using numerical data and perform various mathematical, statistical and engineering operations using built-in formulae.
8	Create a spreadsheet using text data and perform Text operations like search, replace, concatenate, trim etc.; use Date format to perform various Date & Time operations.
9	Create a spreadsheet using numerical data which is imported from real time datasets and perform visualization using graphs, pivot charts etc.
10	Create a spreadsheet using all available data formats and perform data migration, validation and consolidation.
11	Create digital profile on LinkedIn and observe patterns of a professional profile. Follow influential people from technology and software domain.
12	Create a social media profile on any latest platform following social media etiquette and mark a professional digital footprint.

LEARNING RESOURCES

ONLINE COURSES

1	https://books.libreoffice.org/en/
2	https://www.w3schools.com/googlesheets/
3	https://support.microsoft.com/en-us/training
4	https://www.office.com/
5	https://www.google.com/docs/about/
6	https://workspace.google.com/products/sheets/
7	https://in.linkedin.com/
8	https://www.rd.com/list/social-media-etiquette/

R24MENGT002	CONSTITUTIONAL VALUES					
	Total Contact Hours	28 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	….	**2**	**0**	**0**	**2**

Course Objective

The course aims at creating awareness regarding different provisions enshrined in the Constitution and makes students understand the concept of Fundamental Rights.

Course Outcomes

1	Demonstrate understanding of the principles of the Constitution of India. **(BL 3)**
2	Demonstrate understanding of Constitutional values. **(BL 3)**
3	Demonstrate understanding of Fundamental Rights and their relevance. **(BL 3)**
4	Demonstrate understanding of the role of Judiciary in the interpretation and protection of Fundamental Rights. **(BL 3)**
5	Demonstrate understanding of the role of institutions like National Human Rights Commission in the protection of Fundamental Rights. **(BL 3)**

SYLLABUS

Unit I	Constitution & Democracy; Understanding the spirit of Indian Constitution; Constitutional Values – social, economic and political Justice; Liberty in thought, expression, belief, faith and worship, equality before law, Fraternity.	**5 hr**
Unit II	Interpretation of Articles 14 -31: Right to equality (Articles 14 - 18); Right to freedom (Articles 19-22); Right against exploitation (Articles 23-24).	**5 hr**
Unit III	Right to freedom of Religion (Articles 25-28); Cultural and educational Rights (Articles 29-30).	**5 hr**
Unit IV	Right to Life and personal liberty (Article 21); Right to constitutional remedies (Article 32).	**5 hr**
Unit V	Role of Judiciary and other institutions in the protection of Fundamental Rights; Case Studies.	**5 hr**

LEARNING RESOURCES

REFERENCE BOOK:

1	Durga Das Basu, et al., *Introduction to the Constitution of India*, Lexis Nexis, 2022.

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL3	X				
CO2	BL3		X	X	X	X
CO3	BL3		X	X	X	X
CO4	BL3		X	X	X	X
CO5	BL3					X

R24MMECW001	ENGINEERING WORKSHOP					
	Total Contact Hours	14 (L) + 28 (P)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**1**	**0**	**2**	**2**

Course Objective	
To familiarize students with different useful trades widely used in day- today practice.	
Course Outcomes	
Student able to	
1	Identify various trades and perform related work at a preliminary level.
2	Select and use proper tools for the different tasks
3	Address troubleshoots in real-life and get rid of dependency.
4	Ability to design and model different prototypes using different trades
5	Demonstrate the safety practices to be applied on different trades
Module 1	**Carpentry shop** 1.1. Introduction to various types of wood such as Teak, Mango, Sheesham, etc. (Demonstration and their identification). 1.2. Demonstration, function and use of commonly used hand tools. Care, maintenance of tools and safety measures to be observed. Job I Marking, sawing, planning and chiselling & their practice 1.3. Introduction to various types of wooden joints, their relative advantages and uses. Preparation of half lap joint, Preparation of Mortise and Tenon Joint 1.4.Safety precautions in carpentry shop. 1.5 Hands on experience in carpentry for making duster. 1.6 Hands on experience in carpentry for making day-today used products and wood requirement.
Module 2	**Plumbing:** 2.1. Introduction to plumbing tools, common materials used in plumbing. 2.2. Description and demonstration of simple operations in plumbing 2.3.Care, Safety precautions and maintenance of plumbing tools and setup. 2.4 Design a plumbing layout for domestic applications. 2.5 Address trouble shootings in basic plumbing emergencies.(Spindle replacement in taps, water tap replacement, leakage of a tap)
Module 3	**House wiring – 3** 3.1 Study, demonstration and identification of common electrical materials such as wires, cables, switches, fuses, PVC Conduits. 3.2 Study of electrical safety measures and demonstration about use of protective devices such as fuses, and relays including earthing. 3.3 Selection of wires (color code) and identification of electrical components in house hold. 3.4 House wiring for specific requirement from main panel and usage of multimeter. 3.5 Load calculation given connected utilities and cost estimation
Module 4	**Fabrication – 4:** 4.1 Introduction to welding 4.2. Description about fabrication peripherals such as protection shield, welding machine types, electrode nomenclature. 4.3. Safety measures in welding practice 4.4 Fabrication of an useful component/ product using different weld joints.
Module 5	**Assembly and Disassembly:** 5.1 Introduction to machine parts, tools and accessories used for assembly and disassembly of a machine 5.2. Functions of all parts and their importance

	5.3 Care and safety precautions during the work. 5.4 Assembly and disassembly of automobile (Replacement of vehicle tyre) 5.5 Assembly and disassembly of mechanical unit (machine).
LEARNING RESOURCES	
TEXT BOOKS:	
1	K.C. John, *Mechanical workshop practice*, second edition, PHI learning, 2010.
2	Bruce J. Black, *Workshop Processes, Practices and Materials*, Routledge publishers, 5th Edn. 2015.
3	B.S. Raghuwanshi, *A Course in Workshop Technology Vol I. & II,* , Dhanpath Rai & Co., 2015 & 2017.
REFERENCE BOOKS:	
1	S. K. Hajra Choudhury, Hajra Choudhury, A K, Roy, Nirjhar, Bhattacharya, S C. *Elements of Workshop Technology, Vol. I*, 14th edition, Media Promoters and Publishers, Mumbai. 2007.
2	H. S. Bawa, *Workshop Practice*, Tata-McGraw Hill, 2004.
3	Soni P.M. & Upadhyay P.A, *Wiring Estimating, Costing and Contracting;* Atul Prakashan, 2021.
ADDITIONAL REFERENCE MATERIAL	
1	https://mrcet.com/downloads/hs/EWS-ITWS%20%20LAB%20MANUAL.pdf
2	https://sjce.ac.in/wp-content/uploads/2018/04/Workshop-Laboratory-Manual.pdf
3	https://manavrachna.edu.in/latest/virtual-lab-workshop-for-first-year-engineering-students-mru/

II SEMESTER

R24MPHYT001	PHYSICS					
	Total Contact Hours	42(L)	**L**	**T**	**P**	**C**
	Pre-requisite	Higher Secondary School Physics	**3**	**0**	**0**	**3**

Course Objective

To bridge the gap between the Physics in school at 10+2 level and UG level engineering courses by introducing the learners to domains like crystallography, light wave phenomena, coherent radiation, quantum etiquettes, and magneto-dielectric materials.

Course Outcomes

After completion of the course, the students will be able to

1	**Examine** the crystallographic phase of the unknown specimen by using X-ray diffraction method. (**BL4**)
2	**Categorize** the dielectric polarization mechanisms, and **classify** the magnetic material for an intended application. (**BL4**)
3	**Analyze** the intensity variation of light due to interference, diffraction and polarization. (**BL4**)
4	**Analyze** the production of laser in the given medium; and **categorize** the optic fiber for envisioned communication requirements. (**BL4**)
5	Deduce the quantized aspects of a particle in a potential box; **analyze** the semiconductor carrier concentrations, and **inspect** their type by using the Hall effect. (**BL4**)
6	**Elaborate** the crystallographic phase, magneto-dielectric physiognomies, optical phenomena, and the essentials of photonics, quantum confinement effects, and the rudiments of semiconductor band model. (**BL6**)

SYLLABUS

Unit I	**CRYSTAL PHYSICS**	**8 hr**

Space Lattice- Unit cell- Crystal systems; Bravais lattices; Atomic packing fraction- Simple Cubic- BCC- FCC structures; Diamond cubic structure- Calculation of lattice constant; Crystal planes- Directions- Miller indices; Distance between successive h k l planes; X-ray Diffraction- Bragg's law; Powder X-ray diffraction method- Applications.

Unit II	**MAGNETIC AND DIELECTRIC MATERIALS**	**8 hr**

Magnetic dipole moment – Permeability- Magnetization- Atomic origin of magnetism; Dia, Para, Ferro, Anti-ferro and Ferrimagnetic materials; Hysteresis- Soft and Hard magnetic materials; Dielectric constant- Displacement Vector- Dielectric polarization – Relation between the electric vectors; Electronic polarization; Ionic polarization- Orientation polarization (Qualitative); Internal field in dielectrics; Clasius-Mossotti relation in dielectrics;

Unit III	**WAVE OPTICS**	**8 hr**

Principle of Superposition- Theory of interference fringes; Interference in thin film- Cosine law; Newton's rings-Applications; Diffraction at a single slit- Intensity distribution; Diffraction at N-parallel slits; Polarization by reflection- Brewester's law; Double refraction; Quarter and Half wave plates

Unit IV	**PHOTONICS**	**8 hr**

Absorption, Spontaneous and Stimulated emission of radiation; Einstein coefficients- Relation between the coefficients; Laser- Characteristics- Applications; Population inversion (3-level)- Components of laser system; Ruby laser- Construction- Working-

Advantages; Optic fiber- Principle- Components of fiber; Numerical aperture- Acceptance angle- Acceptance cone; Classification of optic fiber- Step Index- Graded Index fibers.		
Unit V	**QUANTUM PHYSICS AND SEMICONDUCTORS**	**8 hr**
Matter Wave- de Broglie wavelength of matter wave; Uncertainty principle- Wave function- Physical significance; Schrodinger Time-independent wave equation; Particle in a 1D potential box- Energies and Wave functions; Fermi-Dirac distribution function- Distinction between metals, insulators and semiconductors; Intrinsic semiconductors- Carrier concentration- Fermi level; Extrinsic semiconductors- Carrier concentration; Hall effect		
LEARNING RESOURCES		
TEXT BOOKS:		
1	B.K. Pandey and S. Chaturvedi, *Engineering Physics*, Second edition. Cengage Learning, 2021.	
2	M. N. Avadhanulu, P.G.Kshirsagar and TVS Arun Murthy, *A Text book of Engineering Physics*, Eleventh edition. S.Chand Publications, 2019.	
REFERENCE BOOKS:		
1	Hitendra K. Malik and A.K. Singh, *Engineering Physics*, Second edition. Mc. Graw Hill Publishers, 2017.	
2	M.R. Srinivasan, *Engineering Physics,* Second edition. New Age International Publishers, 2021.	
3	Shatendra Sharma and Jyotsna Sharma, *Engineering Physics*, First edition. Pearson Education, 2018.	
ADDITIONAL REFERENCE MATERIAL:		
1	https://www.youtube.com/watch?v=GQ5XpeS3e3U&list=PLLy_2iUCG87B_Tmfs0y2tR8GNIkyRIKpW	
2	https://archive.nptel.ac.in/courses/112/106/112106227/	
3	https://archive.nptel.ac.in/courses/122/107/122107035/	
4	https://archive.nptel.ac.in/courses/104/104/104104085/ https://archive.nptel.ac.in/courses/115/107/115107095/	
5	https://archive.nptel.ac.in/courses/115/101/115101107/ https://archive.nptel.ac.in/courses/108/108/108108122/	

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL4	X				
CO2	BL4		X			
CO3	BL4			X		
CO4	BL4				X	
CO5	BL4					X
CO6	BL6	X	X	X	X	X

R24MMATT003	PROBABILITY AND STATISTICS AND NUMERICAL METHODS (CIV, MEC & CHE)					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Basic calculus and probability	**3**	**1**	**0**	**3**

Course Objective

To equip the students with standard concepts and tools of mathematics to handle various real-world problems and their applications.

Course Outcomes

After completing this course, the students will be able to

1	Analyze and comprehend the properties of different statistical distributions. (**BL4**)
2	Utilize statistical techniques to analyze bivariate data. (**BL3**)
3	Test a hypothesis concerning means and proportions for large samples. (**BL6**)
4	Solve algebraic and transcendental equations and use numerical techniques for interpolation. (**BL3**)
5	Apply Numerical methods to solve initial value problems and do numerical integration. (**BL3**)
6	Formulate Mathematical models and estimate appropriate physical quantities. (**BL6**)

SYLLABUS

Unit I	**RANDOM VARIABLES & PROBABILITY DISTRIBUTIONS**	**8 hr**

Discrete Random Variable; Discrete Probability Distribution; Expectation of Discrete random variable; Continuous random variable; Continuous probability distribution; Normal distribution; Probabilities of normal variable; Parameters of normal variable.

Unit II	**STATISTICAL METHODS**	**8 hr**

Fitting of Linear Curve-1; Fitting of Linear Curve-2; Fitting of Parabola; Fitting of Exponential Curve; Fitting of Power Curve; Correlation-1; Correlation-2; Regression.

Unit III	**SAMPLING DISTRIBUTIONS AND TESTING OF HYPOTHESIS (LARGE SAMPLES)**	**8 hr**

Sampling Distribution of Means with replacement; Sampling Distribution of Means without replacement; Confidence interval for means; Confidence interval for proportions; Testing of Hypothesis for single mean; Testing of Hypothesis for two means; Testing of Hypothesis for single proportion; Testing of Hypothesis for two proportions.

Unit IV	**NUMERICAL METHODS-1**	**8 hr**

Bisection Method; Regula-Falsi Method; Newton-Raphson Method; Finite Differences and Symbolic operations; Newton Forward interpolation-1; Newton Forward interpolation-2; Newton Backward interpolation; Lagrange's interpolation.

Unit V	**NUMERICAL METHODS-2**	**8 hr**

Trapezoidal rule-1; Trapezoidal rule-2; Simpson’s 1/3 rule; Simpson’s 3/8 rule; Taylor's Series method; Euler's method; Runge-Kutta method of 2^{nd} order; RK method of 4^{th} order.

LEARNING RESOURCES

TEXT BOOKS:

1	RE Walpole, SL Mayeres & K May, Probability and Statistics for Engineers & Scientists, 3/e, Pearson Publishers
2	T.K.V. Iyengar et al, Probability and Statistics, S. Chand Publications, Revised edition.
3	B.S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.

REFERENCE BOOKS:

1	Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011
2	B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill New

	Delhi, 11th Reprint, 2010
3	T. Veerarajan, Higher Engineering Mathematics, Tata McGraw-Hill, 2008

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL 4	x				
CO2	BL 3		x			
CO3	BL 6			x		
CO4	BL 3				x	
CO5	BL 3					x
CO6	BL 6	x	x	x	x	x

R24MCHET001	MATERIAL SCIENCE AND ENGINEERING					
	Total Contact Hours	42 (L)	L	T	P	C
	Pre-requisite	Nil	3	1	0	3

Course Objectives:	
1	To establish a broad knowledge base on the structure and properties of materials for solving engineering problems.
2	To analyze the phase diagrams for different systems.
3	To select suitable engineering materials for various Engineering applications.
Course Outcomes: After completing this course, the student will be able to,	
1	Analyze the Structure of materials at different levels using the principles of crystal geometry (BL-4)
2	Identification of phase diagrams and reactions, including single component and binary systems (BL-4)
3	Evaluate phase transformations, including nucleation, solidification, allotropic transformations, and their impact on material properties. (BL-5)
4	Analyze and suggest the heat treatment process such as annealing, normalizing, hardening, and surface hardening to modify material properties. (BL-4)
5	Compare the properties ferrous metals and non-ferrous metals in engineering contexts. (BL-4)
6	Develop the ability to select appropriate materials for specific engineering applications. (BL-6)

SYLLABUS

Unit I	**Introduction to Materials**	**8 hr**

Introduction and Classification of Engineering Materials, Crystal Geometry; Bravais Lattices; Miller Indices; X-Ray Diffraction, Bragg's Law, The Powder Method, Atomic Bonding.

Unit II	**Phase Diagram**	**8 hr**

Phase rule, Single component systems, Binary phase diagrams, Lever rule, Copper-Zinc Phase Diagram, Iron-Carbon Phase Diagram, Eutectic and Peritectic Reactions, Solid Solutions.

Unit III	**Phase Transformations**	**8 hr**

Nucleation & growth, solidification, Allotropic transformation, cooling curve for pure iron, Iron carbon equilibrium diagram, Isothermal transformations (TTT Curves), Precipitation Hardening, Martensitic Transformation.

Unit IV	**Heat Treatment**	**8 hr**

Annealing, Normalizing, Hardening, Martempering, Austempering, Hardenability, Quenching and Tempering, Surface Hardening Methods.

Unit V	**Typical Engineering Materials**	**8 hr**

Ferrous metals, Non-ferrous metals, Aluminium and its alloys, Copper and its alloys, Lead and its alloys, Tin, Zinc and its alloys, Alloys for high temperature service, Composite Materials.

LEARNING RESOURCES

TEXT BOOK:

1	Raghavan V, Materials Science and Engineering – A First Course, Third edition., Prentice Hall of India Pvt. Ltd., New Delhi, 1996.
2	William D. Callister Jr., David G. Rethwisch, Materials Science and Engineering: An Introduction, Tenth edition, John Wiley & Sons Inc., 2018.
3	Hajra Choudhury S.K., Material Science and Processes, Second edition, Indian Book Distributing Co., 1982.

REFERENCE BOOKS:

1	Manas chanda, Science of Engineering Materials Vol. 1 &2; First edition, McMillan Company of India Ltd,1981

2	Van Valck H.L., Elements of Material Science, Second edition, Addision – Wesly Publishing Company, New York, 1964.
3	William F. Smith, Javad Hashemi, Ravi Prakash, Material Science and Engineering, Fifth edition, McGraw Hill Education, 2017.

Bloom's level and Units catchment articulation matrix

CO	Blooms L	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
CO 1	BL 4	X				
CO 2	BL 4		X	X		
CO 3	BL 5			X		
CO 4	BL 4				X	
CO 5	BL 4		X			X
CO 6	BL 6	X	X	X	X	X

R24MSCST001	PROCEDURAL PROGRAMMING					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	-	**3**	**0**	**0**	**3**

Course Objective

To develop proficiency in procedural programming using C through fundamental concepts, control structures, arrays, pointers, structures, and file handling.

Course Outcomes

After completing this course, the students will be able to

1	**Apply** the basics of software, hardware, number systems, and programming concepts to write simple C programs. **(BL3)**
2	**Implement** decision-making and control structures like if-else, switch, loops, and unconditional statements in C programs. **(BL3)**
3	**Analyze** and **manipulate** arrays and strings, and **design** modular programs using functions and recursion. **(BL4)**
4	**Utilize** pointers for dynamic memory allocation, pointer arithmetic, and complex data structure manipulation in C programs. **(BL3)**
5	**Construct** and **manage** complex data structures like structures and unions, and **develop** file handling operations in C. **(BL6)**
6	**Design** and **develop** comprehensive C programs by integrating various programming concepts to solve complex problems using procedural programming techniques. **(BL6)**

SYLLABUS

Unit I	**INTRODUCTION TO PROGRAMMING**	**8 hr**

Software, hardware, Number Systems (Binary, Hexadecimal, Octal, Decimal); Algorithms, pseudo code; Flowcharts, Program development steps; Structure of c program with example;

Tokens, Basic data types; Operators Arithmetic, logical, relational, bitwise; ternary, increment /decrement, special operators, assignment; Built-in Input/output Functions, Expressions, type casting.

Unit II	**SELECTION AND CONTROL STATEMENTS**	**8 hr**

Two way selection statements if, if-else with examples; Nested if with examples; Multiway selection statements - switch with examples; Nested switch with examples, else if ladders with examples;

Iterative statements while, do-while with examples; for loop with examples; Nested loops with examples; Un conditional statements; break, continue, goto with examples

Unit III	**INTRODUCTION TO ARRAYS AND STRINGS, MODULAR PROGRAMMING THROUGH FUNCTIONS**	**8 hr**

Array Definition, Declaration and accessing of 1D array; Declaration and accessing of integer 2D array; 2D array applications: matrix addition, multiplication; String definition, declaration and accessing of strings with examples;

Function Definition, prototype, declaration and accessing with examples; Parameter passing mechanisms with examples, Scope and Extent of Variables; Storage classes auto, static, Register and extern with examples; Definition of recursion, types of recursion (direct and indirect) Solving problems using recursive approach like finding factorial, Fibonacci series, Towers of Hanoi.

Unit IV	**POINTERS AND DYNAMIC MEMORY ALLOCATION**	**8 hr**

Definition of pointers, declaration, initialization, Pointer arithmetic; Representing 1D array using pointers with examples; Representing 2D arrays using pointers with examples; Pointer to pointer, constant pointers with examples, Pointer to constant variable, void pointer, generic pointer with examples;

Pointers to Functions; Difference between static and dynamic memory allocation, Dynamic memory allocation using built-in functions (malloc (), calloc ()) ; Dynamic memory allocation using built-in functions (realloc (), free ()) ; Dangling pointer and unreferenced memory problem

Unit V	**STRUCTURES, UNIONS AND FILE HANDLING**	**8 hr**

Structure definition, declaration, initialization and accessing structure members; Nested structures with examples, arrays of structures; Pointer to structures with examples, Self-Referential structures; Unions, Bitfields, typedef with examples; Concept of a file and file modes, Formatted I/O; File handling functions; fopen (), fclose (), fscanf (), fprintf (); Random access files handling functions, command line arguments ; Text files, Binary files, Differences between text and Binary files, fread (), fwrite ()	
LEARNING RESOURCES	
TEXTBOOKS:	
1	Brian W Kernighan and Dennis M Ritchie, *The C programming Language*, Second Edition, Pearson, 2015.
2	Pradip Dey, Manas Ghosh, *Programming In C*, 2nd Edition, Oxford Higher Education, 2011.
REFERENCE BOOKS:	
1	Dr Reema Thareja, *Programming in C*, Third Edition, Oxford Press, 2023.
2	Byron Gottfried, *Programming with C*, Third Edition. Schaums Outlines Series, 2017.
3	Ajay Mittal, *Programming in C - A Practical Approach*, Pearson, 2010.
ONLINE COURSES	
1	https://mvgrce.codetantra.com
2	www.netacad.com

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL3	X				
CO2	BL3		X			
CO3	BL4			X		
CO4	BL3				X	
CO5	BL6					X
CO6	BL6	X	X	X	X	X

R24MMECD001	COMPUTER AIDED ENGINEERING DRAWING					
	Total Contact Hours	14 (T) + 28 (P)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**1**	**0**	**2**	**2**

Course Objective: To enable the students to learn various concepts of engineering graphics using the CAD tool.

Course Outcomes

1	Sketch the two-dimensional drawings using draw, modify, and annotation commands in CAD software
2	Draw the projections and solve the problems in projections of points, lines, planes & solids.
3	Create orthographic projections and isometric projections and create composite solids using CAD software.

SYLLABUS:

Module 1:

Overview of CAD Software:

Computer technologies that impact graphical communication, Demonstrating knowledge of CAD software such as The Menu System, Toolbars, Command window, and Status Bar.

Set up the drawing page and the printer, Scale settings, setting up of units and drawing limits, standards for annotations, and 3D Modeling.

Module 2:

Introduction to Orthographic Projections: Projections of points, straight lines, planes and simple solids

Module 3:

Development of surfaces of simple solids, isometric views, Conversion of isometric views to orthographic views. And create complex compound solids in CAD

List of Exercises

1	Creation of simple 2-D geometries
2	Creation of complex 2-D geometries & Engineering Curves –Generic method for Conic sections
3	Engineering Curves – Cycloids & Involutes
4	Orthographic Projection of Points
5	Projection of lines in simple positions and inclined to one plane
6	Projection of lines inclined to both planes
7	Projection of planes is simple and inclined to one plane
8	Projection of planes inclined to both planes
9	Projection of solids simple positions
10	Development of simple Solids (Prisms, Pyramids, Cylinder & Cone)
11	Conversion of orthographic views to isometric views
12	Modeling of complex 3D geometries and their conversion to orthographic views

LEARNING RESOURCES

TEXT BOOKS:

1	N. D. Bhatt, *Engineering Drawing*, Charotar Publishing House, 2016.
2	Dhananjay Jolhe, *Engineering Drawing with an Introduction to AutoCAD*, Tata McGraw Hill, 2017

REFERENCE BOOKS:	
1	K.L. Narayana and P. Kannaiah, *Engineering Drawing*, Tata McGraw Hill, Third Edition, 2013.
2	M.B.Shah and B.C. Rana, *Engineering Drawing*, Pearson Education Inc., 2009.
ADDITIONAL REFERENCE MATERIAL	
1	https://nitc.ac.in/imgserver/uploads/attachments/Ed__5c3343c5-c3f9-468a-b114-8f33556810b4_.pdf

R24MPHYL001	PHYSICS LAB					
	Total Contact Hours	28 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Higher Secondary School Physics	**0**	**0**	**2**	**1**

Course objectives

- To complement the classroom learning with laboratory experiments.
- Calibration of instruments like travelling-microscope, spectrometer, cathode-ray-oscilloscope, magnetometer, etc. and to make precise measurements.
- Understand the physical principles involved in the conduct of experiment and measure the relevant experimental variables.
- Apply the analytical techniques and graphical analysis to experimental data and draw necessary conclusions.
- Prepare a concise and clear technical report to communicate his/her experimental understanding.

Course outcomes

After completion of course, the students will be able to

1	Interpret the given XRD pattern to analyze crystallographic phase of the given unknown specimen.
2	Conduct experiments to reconnoitre the interference and diffraction patterns of light.
3	Find the signature variation of magnetic field due to current, and the specifics of magneto-dielectric materials.
4	Estimate the wavelength of coherent radiation, the coercing parameter of optic fiber, and the perpetual aspects of a semiconductor diode.
5	Measure the elastic modulus of the material and determine the unknown fork frequency.

LIST OF EXPERIMENTS

1	Determination of the lattice constant and crystallographic phase of the unknown by using XRD patterns.
2	Determination of the Hysteresis energy loss of a ferromagnetic material by forming B-H curve.
3	Find the signature variation of magnetic field along the axis of a current carrying circular coil- Stewart and Gee's Method.
4	Determination of radius of curvature of a given plano-convex lens by forming Newton's rings.
5	Determination of thickness of the object by forming parallel interference fringes
6	Determination of the wavelength of spectral lines by using a plane transmission grating in normal incidence configuration.
7	Determination of wavelength of the Laser by using a diffraction grating.
8	Determination of numerical aperture and acceptance angle of the optic fiber.
9	Determination of energy gap of the semiconductor p-n junction diode.
10	Plot the I/V characteristics of Zener diode under forward and reverse conditions.

ADDITIONAL EXPERIMENTS

1	Determination of dielectric constant of solid dielectric.
2	Determination of rigidity modulus of the of the material of the wire- Torsional pendulum
3	Determination of frequency of the electrical vibrator- Melde's experiment

LEARNING RESOURCES

TEXT BOOK:

1	C.S. Robinson and Dr. Ruby Das, *A Textbook of Engineering Physics Practical*,

	First edition. Laxmi Publications Pvt. Ltd., 2016.
REFERENCE BOOK:	
1	S. Balasubramanian and M.N. Srinivasan, *A Textbook of Practical Physics*, First edition. S. Chand Publishers, 2017
ADDITIONAL REFERENCE:	
1	www.vlab.co.in

R24MSCSL002	PROCEDURAL PROGRAMMING LAB					
	Total Contact Hours	28 (P)	**L**	**T**	**P**	**C**
	Pre-requisite	-	**0**	**0**	**2**	**1**

Course Objective

To get practical exposure to the Structured Programming with hands-on experience in laboratory for solving real world problems using C

Course Outcomes

After completing this course, the students will be able to

1	Students will write and execute simple C programs, demonstrating understanding of basic input/output operations and program structure.
2	Students will use various operators and control structures to perform decision-making and repetitive tasks.
3	Students will declare, initialize, and perform operations on one-dimensional and multi-dimensional arrays, as well as handle string operations.
4	Students will define, call, and pass parameters to functions, including recursive functions, to solve problems in a modular and efficient manner.
5	Students will use pointers for dynamic memory allocation, manipulate structures and unions, and perform file operations for reading and writing data in text and binary formats.

LIST OF EXPERIMENTS

1	Week-1: Introduction to Programming with operators **1.** Write a C program to print "Hello, World!" and understand the structure of a basic C program. **2.** Write a C program to demonstrate the use of basic I/O statements (printf, scanf) **3.** Write a C program for calculating the sum of two numbers.
2	Week-2: Expressions and Operators 1. Write a C program to finding the maximum of three numbers using conditional operator. **2.** Write a C Program to convert temperature from Celsius to Fahrenheat and vice versa **3.** Write a C Program to to calculate simple and compound interest
3	Week 3: Selection Statements **1.** Write a C program to find the largest of three numbers using if-else statements. **2.** Write a program to demonstrate the use of switch-case statements to perform arithmetic operations based on user choice. **3.** Write a program to demonstrate the use of else-if ladder to grade student marks.
4	Week-4: Loops **1.** Write a C program to print sum of the digits of the given number. **2.** Write a C program to print the Fibonacci series up to n terms using a for loop. **3.** Write a C program to check the given number is a palindrome or not. **4.** Write a C program to calculate the factorial of a number using a while loop.
5	Week-5: Nested Loops and branching **1.** Write a C program to print a pyramid patterns using nested loops. **2.** Write a C program to print prime numbers between 1 to 100 **3.** Write a C program to demonstrate the use of break and continue statements within loops.
6	Week 6: Arrays **1.** Write a C program to find the sum of all elements in a 1D array. **2.** Write a C program to read and print the 2D Array elements in a

	matrix form. **3.** Write a C program to perform matrix addition using 2D arrays. **4.** Write a C program to find the transpose of a given matrix.
7	Week-7: String Handling **1.** Write a program to demonstrate string operations (copy, concatenate, compare, length) using built-in functions. **2.** Write a C program to count the number of vowels in a string. **3.** Write a C program to concatenate two strings without using the library function strcat.
8	Week-8: Functions **1.** Write a program to define and use a function to find the sum of two numbers. **2.** Write a C program to check the given number is prime or not using a function. **3.** Demonstrate passing of an array to a C function.
9	Week-9: Recursive Functions **1.** Write a recursive program to generate Fibonacci series. **2.** Write a C program to find the GCD of two numbers using a recursive function. **3.** Write a C Program to find the nCr value for the two positive numbers where n > r using recursion.
10	Week-10: Pointers & Dynamic Memory Allocation **1.** Write a program to demonstrate pointer arithmetic. **2.** Write a program to use pointers to access elements of an array. **3.** Write a program to dynamically allocate memory for an array using malloc and calloc. **4.** Write a program to demonstrate the use of realloc and free for dynamic memory allocation.
11	Week-11: Structures & Unions **1.** Write a program to define, declare, and access members of a structure. **2.** Write a program to demonstrate the use of nested structures. **3.** Write a C program to store and display student information using structures.
12	Week-12: File Handling **1.** Write a program to demonstrate file handling functions (fopen, fclose, fscanf, fprintf). **2.** Write a program to read and write data to a binary file using fread and fwrite. **3.** Write a C program to simulate copy command using command line arguments.
LEARNING RESOURCES	
TEXTBOOKS:	
1	Brian W Kernighan and Dennis M Ritchie, *The C programming Language*, Prentice Hall.
2	Pradip Dey, Manas Ghosh, *Programming In C*, Oxford Higher Education.
REFERENCE BOOKS:	
1	Dr Reema Thareja, *Programming in C*, Third Edition, Oxford Press
2	Byron Gottfried, *Programming with C*, Schaums Outlines Series, Third Edition.
3	Ajay Mittal, *Programming in C - A Practical Approach*, Pearson
ONLINE COURSES	
1	https://www.tutorialspoint.com/learn_c_by_examples

R24MENGT003	HEALTH & WELLNESS					
	Total Contact Hours	28 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	-	**2**	**0**	**0**	**2**

Course Objective

This course aims to help students grasp the significance of a healthy diet, yoga, and stress management techniques in fostering their overall well-being.

Course Outcomes

After completing this course, the students will be able to

1	Demonstrate understanding of the current ways of living and develop a plan of action that promotes overall well-being. (**BL 3**)
2	Demonstrate Understanding of the importance of nutrition, a balanced diet and scheduled sleeping hours for maintaining a healthy lifestyle **(BL3)**
3	Demonstrate Understanding of the use of yoga as a holistic tool in improving physical and mental health **(BL3)**
4	Demonstrate Understanding of various stress management techniques for better physical and mental health **(BL3)**
5	Demonstrate Understanding of the importance of Emotional intelligence in the aspects of stress relief, general health and social wellness **(BL3)**

SYLLABUS

Unit I	**INTRODUCTION TO HEALTH AND WELLNESS AND WELLNESS PLANNING**	**5 hrs**

Understanding Health and Wellness as holistic concepts encompassing Physical, Mental, Emotional, Social and environmental well-being – need to develop personalized wellness plans, set goals, and track progress toward a healthier lifestyle.

Unit II	**HEALTHY LIFESTYLE CHOICE**	**5 hr**

Examine topics such as sleep, hygiene, substance abuse prevention, and the impact of lifestyle choices on health.

Unit III	**HOLISTIC WELLNESS: INTRODUCTION TO YOGA**	**5 hr**

Explore the interconnectedness of physical, mental, and emotional health and the importance of balance by introducing Yoga

Unit IV	**EMOTIONAL INTELLIGENCE AND STRESS MANAGEMENT**	**5 hr**

Regulation and management of feelings and emotions effectively-
Methods of stress management include unhooking; Acting on Your Values, Being Kind, Making Room for deep breathing, Taking a break; Making time for hobbies; Talking about your problems and Meditation.

Unit V	**SELF-CARE**	**5 hr**

Formulate practical self-care routines and strategies to maintain optimal physical and mental health, encompassing a holistic approach that addresses physical, emotional, intellectual, social, spiritual, and environmental well-being.

LEARNING RESOURCES

TEXTBOOKS:

1	B.K.S. Iyengar, *Yoga The Path to Holistic: The Definitive Step-by-step Guide,* DK Publishers, 2021.
2	C. Gopalan, B. V. Rama Sastri, S. C. Balasubramanian, *Nutritive value of Indian foods (NVIF),* National Institute of Nutrition, India, 2023.
3	ICMR-*National Institute of Nutrition, Short summary report of nutrient requirements for Indians,* 2020.
4	Emily Attached & Marzia Fernandez*, Mental Health Workbook,* 2021.

REFERENCE BOOKS:

1	C. Nyambichu & Jeff Lumiri, *Lifestyle Diseases: Lifestyle Disease*

	Management, 2018.
2	Nashay Lorick, *Mental Health Workbook for Women: Exercises to Transform Negative Thoughts and Improve Well-Being,* 2022.
3	Angela Clow & Sarah Edmunds, *Physical Activity and Mental Health*, 2013.
ADDITIONAL REFERENCE MATERIAL	
1	B.K.S. Iyengar, *Light on Yoga: The Classic Guide to Yoga by the World's Foremost Authority*, 2006.
2	Claude Bouchard, Steven N. Blair, William L. Haskell, *Physical Activity and Health*, Human Kinetics, 2012.
ONLINE COURSES	
1	http://vikaspedia.in/health/nutrition
2	https://yoga.ayush.gov.in/Yoga-Course/

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL3	X				
CO2	BL2		X			
CO3	BL3			X		
CO4	BL3				X	
CO5	BL2					X

R24MENGT004	ETHICS AND HUMAN VALUES					
	Total Contact Hours	28 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**2**	**0**	**0**	**2**

Course Objective

The course creates awareness regarding the need for the development of a holistic perspective in understanding the nuances of personal, professional and social life. It enables the student to grasp the ethical principles that govern human existence.

Course Outcomes

After completing this course, the students will be able to

1	Demonstrate Understanding of the relevance of the concepts of Self - Exploration and Natural Acceptance in day-to-day life to achieve continuous happiness and prosperity. (**BL 3**)
2	Demonstrate Understanding of the impact of trust and respect as foundational values in human relationships to achieve comprehensive human goals. (**BL 3)**
3	Demonstrate Understanding of the relevance of ethical theories and their applications in societal living. (**BL3**)
4	Demonstrate Understanding of the concept of ethics in engineering practice **(BL 3)**
5	Demonstrate Understanding of the concepts of ethics in the context of understanding global issues pertaining to different fields. (**BL 3)**

SYLLABUS

Unit I	**UNDERSTANDING THE SELF**	**5 hr**

Characteristics of Universal Human Values; Self-Exploration– Meaning and Process; Basic Human Aspirations – Meaning and Basic Requirements for fulfilment; Concept of Human Existence – Conscious and Material Entities; Difference between the Conscious and the Material Entities of Human Existence.

Unit II	**UNDERSTANDING THE FAMILY AND SOCIETY**	**5 hr**

Understanding the importance of harmony in a family; Exploring value of feelings in relationships; Measures to ensure Harmony in the family. Understanding conflict (meaning, types); Dimensions of Human order for harmony in society – Physical, mental, social and spiritual; Universal values of justice, democracy.

Unit III	**ETHICAL THEORIES**	**5 hr**

Professionalism and ethics; Ethical Theories: Golden mean theory, Rights-based theory, Duty-based theory, Utilitarian theory, Kohlberg's Theory. Moral issues; Moral Dilemmas; Types of Inquiries – Normative, Conceptual, factual/descriptive.

Unit IV	**ETHICS AND ENGINEERING**	**5 hr**

Engineering ethics - Social Experimentation; Safety Responsibility and Rights: Engineers as responsible Experimenters, Engineer's Responsibility for Safety, Risk – Benefit Analysis.

Case Studies: The challenger disaster, The Three Mile Island, Fukushima Nuclear Disaster, Bhopal Gas Tragedy, The Titan submersible disaster.

Unit V	**ETHICS AND GLOBAL CONTEXTS**	**5 hr**

Ethics and Global Contexts: Environmental ethics; computer ethics; Business Ethics; Corporate Social responsibility; Code of ethics.

LEARNING RESOURCES

TEXTBOOKS:

1	R R Gaur, R Sangal, G P Bagaria, "*A Foundation Course in Human Values and Professional Ethics*" Excel Books, New Delhi, 2010.

REFERENCE BOOKS:

1	A.N. Tripathi, "*Human Values*", 2nd Edition, New Age International Publishers, 2004.
2	Charles D. Fleddermann, "*Engineering Ethics*", Pearson Education /

	Prentice Hall, New Jersey, 2004.

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL3	X				
CO2	BL3		X			
CO3	BL3			X		
CO4	BL3				X	
CO5	BL3					X

III Semester

R24MCHET002	FLUID MECHANICS FOR CHEMICAL ENGINEERS					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**3**	**0**	**0**	**3**

Course Objectives:

This course will prepare students to make them understand the various properties of fluids and their influence on fluid motion and analyse a variety of problems in fluid statics and dynamics.

Course Outcomes: The student will be able to

1	Interpret various fluid flow models and explain fluid statics & its applications. (BL-5)
2	Explain macroscopic balances for mass, energy and momentum and assess major and minor losses associated to fluid flow in pipes (BL-5)
3	Determine the pressure drop and energy requirement associated to incompressible and compressible fluid flow in pipes (BL-5)
4	Estimate the pressure drop that occurs during fluid flow through packed beds and fluidized beds (BL-5)
5	Select a suitable fluid transport machinery for a particular operation including flow measuring devices (BL-5)
6	Discuss various fluid flow phenomena encountered in chemical engineering applications and determine pressure drop (BL-6)

SYLLABUS

Unit I	**Fluid statics and Fluid flow phenomena**	**8 hr**

Basics on dimensional Analysis, Nature of fluids, hydrostatic equilibrium, applications of fluid statics: U-Tube and Inclined Manometers. Fluid flow phenomena- Rheological properties of fluids, Turbulence, Boundary layers, wake formation.

Unit II	**Fluid Kinematics and Dynamics**	**8 hr**

Basic equation of fluid flow –Mass balance in a flowing fluid- continuity, shell balance for mass flow, Differential momentum balance- Equation of motion, Macroscopic momentum balance, Bernoulli's equation without friction, with friction and pump work, major and minor losses

Unit III	**Flow through pipes and channels**	**8 hr**

Incompressible Newtonian /Non Newtonian Flow in pipes and channels- shear stress and skin friction in pipes, laminar flow & turbulent flow in pipes and channels.

Flow of compressible fluids- Definitions and basic equations, Processes of compressible flow

Isentropic flow through nozzles, adiabatic frictional flow & isothermal frictional flow.

Unit IV	**Flow past immersed objects**	**8 hr**

Drag and Drag coefficient, stagnation point and stagnation pressure, flow through beds of solids, Motion of particles through fluids

Fluidization: Conditions of fluidization, Types of fluidization, Minimum fluidization velocity & applications of fluidization.

Unit V	**Transportation of fluids**	**8 hr**

Transportation fluids- Pipes and fittings, types of valves; Pumps: positive

displacement pumps, and centrifugal pumps, NPSH, Fans, blowers, and compressors; Jet ejectors, Measurement of flowing fluids.	
LEARNING RESOURCES	
TEXT BOOKS:	
1	Unit Operations of Chemical Engineering by W.L.McCabe, J.C.Smith& Peter Harriot,McGraw-Hill, 6th Ed, 2001
REFERENCE BOOKS:	
1	Transport processes and unit operations by Christie J. Geankoplis, PHI.
2	Introduction to Fluid mechanics by R.W. Fox, A.T.McDonald, P.J.Pritchard, JohnWileyand sons-6th edition

Bloom's level and units catchment articulation matrix

CO	Blooms Level	UNIT I	UNIT II	UNIT III	UNIT IV	UNIT-V
CO1	BL5	X				
CO2	BL5		X			
CO3	BL5			X		
CO4	BL5				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCHET003	CHEMICAL PROCESS CALCULATIONS					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**3**	**0**	**0**	**3**

Course Objectives:

This course will prepare students to make analysis of chemical processes through calculations, which need to be performed in the chemical processing operations. The students are introduced to the application of laws and also to formulate and solve material and energy balances in processes with and without chemical reactions.

Course Outcomes

Student will be able to,

1	Determine degree of completion of a chemical reaction (BL-5)
2	Evaluate how pressure and temperature changes influence gas volume in practical scenarios using gas laws. (BL-5)
3	Formulate and solve the material balance calculations for processes with and without chemical reactions. (BL-6)
4	Estimate the energy requirements for Physical and Chemical processes (BL-5)
5	Determine equilibrium compositions in ideal solutions using Raoult's law and read humidity charts (BL-5)
6	Perform material and energy calculations for any given Chemical process (BL-6)

SYLLABUS

Unit I **Fundamental concepts of Stoichiometry** **8 hr**

Mass and Volume relations in chemical reactions, Mole concept, Use of molal quantities, Excess reactants and degree of completion, Basis of calculations, Methods of expressing composition of mixtures and solutions. Density and specific gravity, Specific gravity scales.

Unit II **Ideal Gases and Mixtures** **8 hr**

Kinetic Theory of gases, Application of ideal gas law, gage pressure, Dissociating gases, Mixtures of Ideal gases, Dalton's law, Amagat's law, Average molecular weight, density of gas mixtures, Composition of gases on dry and wet basis, Volume changes with change in compositions, Gases in chemical reactions.

Unit III **Material balance**s **8 hr**

Basic material balance principles, tie substance, Material balance calculations involving mixing, drying, evaporation, extraction, leaching, crystallization Material balance in processes involving chemical reactions, Recycle, bypass and purge calculations.

Unit IV **Energy balances** **8 hr**

Energy balance -Thermophysics: Heat capacity of gases, liquids and solids, Kopp's rule, Heat of fusion and heat of vaporization, Trouton's rule, Kistyakowsky equation.

Energy Balance-Thermochemistry: Heat effects accompanying chemical reactions, Standard heat of reaction, combustion and formation; Hess's law of constant heat summation, adiabatic flame temperature.

Unit V **Vapor Pressure and Solutions-Humidity and Saturation** **8 hr**

Vapor Pressure and Solutions: Vapor pressure and boiling point, vapor pressure of solids, Effect of temperature on vapor pressure (Clausius-Clapeyron equation, Antoine equation), Vapor pressure plots. Vapor pressure of immiscible liquids, Vaporization with superheated steam, Ideal solutions, Raoult's law, Henry's law.

Humidity and Saturation: Saturation, Partial saturation, Humidity, Percent humidity, Dew point, Wet bulb and dry bulb temperature, Enthalpy of humid air, Humidity charts, Adiabatic saturation.

LEARNING RESOURCES	
TEXT BOOKS:	
1	Chemical Process principles, Part-1, Material and Energy balances by Hougen O.A, Watson K.M and Ragatz, R.A. 2nd edition,2010.
2	Basic principles and calculations in Chemical Engineering by Himmelblau, 7th edition,2009.
REFERENCE BOOKS:	
1	Stoichiometry by Bhatt and Vora, 4th edition.
2	Stoichiometry and process calculations K.V.Narayanan and Lakshmikutty, 1st edition.

Bloom's level and-Units catchment articulation matrix

CO	Blooms Level	UNIT I	UNIT II	UNIT III	UNIT IV	UNIT-V
CO1	BL5	X				
CO2	BL5		X			
CO3	BL6			X		
CO4	BL5				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCHET004	MECHANICAL UNIT OPERATIONS					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite		**3**	**0**	**0**	**3**

Course Objectives:

This course aims to equip students with advanced skills in particle technology, mechanical separations, fluid dynamics, filtration, membranes, and agitation/mixing essential for chemical engineering applications.

Course Outcomes: Student will be able to

1	Determine specific property parameters of solids and Select suitable size reduction equipment for various applications. **(BL-5)**
2	Analyze screen sizes, evaluate screen effectiveness, and understand magnetic and electrostatic separation principles and froth flotation processes. (**BL-3)**
3	Differentiate gravity separation and centrifugal separation processes. **(BL-4)**
4	To select a suitable type of filter for filtration of a slurry or a suspension. (**BL-5)**
5	Master principles of liquid agitation (impeller types, power consumption) and solid mixing techniques (**BL-5)**
6	Develop integrated knowledge of different mechanical unit operations for various particle handling systems (**BL-6)**

SYLLABUS

Unit I	**Properties of Particulate Solids and Size reduction**	**8 hr**

Particle shape, Significance of Particle size Analysis, Conveying of solids, Equipment for size reduction, Crushing laws, Crushers & Grinders, Ultra-fine grinders, Cutting machines and Open-closed circuit operation.

Unit II	**Mechanical Separations**	**8 hr**

Screen Analysis, Ideal and actual screens, Capacity and effectiveness of screens, Screening equipment, Magnetic separation, Electrostatic separation, Jigginga and Heavy media separation, Froth floatation process.

Unit III	**Separations based on motion of particles through fluids**	**8 hr**

Flow through beds of solids, Gravity sedimentation process, Equipment for sedimentation, Clarifiers and thickeners, Separations of solids from gases, Separations of solids from liquids, Centrifugal sedimentation, Centrifugal classifiers.

Unit IV	**Filtration**	**8 hr**

Classification of Filtration, Principles of Cake Filtration, Industrial Filters, Rotary drum filter, Filter Aids, Principles of Centrifugal filtration, Types of Membranes, Membrane fouling.

Unit V	**Agitation and mixing of liquids**	**8 hr**

Agitation of liquids, Power consumption in agitated vessels, Purpose of Agitation, Types of impellers, Measures for mixer performance, Mixers for Non-cohesive solids, Mixers for cohesive solids, Mixing index and mixing effectiveness.

LEARNING RESOURCES

TEXT BOOKS:

1	Unit operations of Chemical Engineering, Warren,L., McCabe, Julian C.Smith, Peter Harriot, 7th Edition, McGraw Hill (2008).

REFERENCE BOOKS:

1	Chemical Engineering, vol.-II, J.H.Coulson and Richardson, 5th edition, Elsevier India (2006).
2	Perry's Chemical Engineers Hand Book, Perry Rober H, 8th edition, McGraw Hill (2007).
3	Mechanical Operations for Chemical Engineers, C. M. Narayana and B.C.Bhattacharyya, Khanna Publishers (1992).

Bloom's level and-Units catchment articulation matrix

CO	Blooms Level	UNIT I	UNIT II	UNIT III	UNIT IV	UNIT-V
CO1	BL5	X				
CO2	BL3		X			
CO3	BL4			X		
CO4	BL5				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCHET005	CHEMICAL TECHNOLOGY					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**3**	**0**	**0**	**3**

Course Objectives:

This course aims to equip students with the essential operational skills and technical knowledge required for the installation, monitoring, and maintenance of process instrumentation and control equipment in chemical plants.

Course Outcomes

After completing this course, the students will be able to,

1	Understand and evaluate Soda ash, caustic soda, chlorine gas, and glass manufacturing processes. (BL-5)
2	Understand and evaluate manufacturing processes for valuable chemicals in nitrogen industries. (BL-5)
3	Understand and evaluate manufacturing processes of sulphur and paper industries (BL-5)
4	Understand and evaluate process technologies in polymer industries. (BL-5)
5	Understand and evaluate industrial process technology for extracting and refining vegetable oils, and manufacturing soaps, cements. (BL-5)
6	Develop expertise in evaluating engineering problems in prominent inorganic and organic chemical industries. (BL-6)

SYLLABUS

Unit I	**Chlor Alkali and Glass Industries**	**8 hr**

Basic principles of Unit process and Unit operations in Chemical Industries, Manufacturing of Soda ash by Solvay process and Dual Process, Manufacturing of caustic soda and chlorine by Electrolytic Process, Manufacturing of Glass by Foucault and continuous sheet process, Properties & applications of special glasses, Major engineering problems of Solvay, Dual, Foucault and continuous sheet process

Unit II	**Fuel Gases, Cryogenics, Nitrogen & Fertilizer industries**	**8 hr**

Manufacturing of producer gas, water gas and coke oven gas, Manufacturing of oxygen and nitrogen from Air liquefaction process, Hydrogen Production and Major engineering problems of production of Fuel and Industrial gases, Synthetic ammonia production, Urea Production, Production of Nitric acid and Ammonium nitrate, Production of Ammonium phosphate and complex fertilizers, Major engineering problems in Nitrogenous industries

Unit III	**Sulphur Industries, Industrial Chemicals, and Pulp & Paper Industry**	**8 hr**

Extraction of sulphur by Frasch process, Manufacture of sulphuric acid by contact process, DCDA process. Production of Hydrochloric acid and Magensium compounds, Major engineering problems in Sulfur industries, Production of sulphate and sulphite Pulp, Production of paper –wet process., Major engineering problems in pulp and paper industries

Unit IV	**Petrochemicals and Polymer industries**	**8 hr**

Manufacture of phenols by Toluene oxidation process and Cumene Process, Manufacturing of Formaldehyde resin, Manufacturing of Poly Vinyl chloride, Manufacturing of phenol- formaldehyde resin, Manufacturing of SBR, Applications of Major Petrochemical and Polymer Chemicals, Major engineering problems in Petrochemical & Polymer Industries

Unit V	**Natural Products, Soaps & Detergents, Cement Manufacturing**	**8 hr**

Extraction of vegetable oils and oil hydrogenation process, Soaps and Detergents: Definitions, continuous process for the production of fatty acids and soap, Production of detergents and glycerin, Major engineering problems in Oil, soap and detergent industries, Properties and uses of special types of cement, Manufacturing process of cement, Major engineering problems in Cement

industries	
LEARNING RESOURCES	
TEXT BOOK:	
1	Shreeve's Chemical Process Industries edited by Austin, McGraw-Hill.5th ed.1985.
2	Dryden's Outlines of Chemical Technology, edited by M.Gopal Rao and M.Sittig, 2nd ed. 1973.
REFERENCE BOOKS:	
1	Industrial Chemistry by B.K.Sharma.
2	Hand book of Industrial Chemistry Vol 1&II K.H.Davis& F.S. Berner Edited by S.C.Bhatia, CBS publishers.
3	Austin, G. T., Shreve's Chemical Process Industries, Tata – McGraw Hill Publishers,2012.

Bloom's level and-Units catchment articulation matrix

CO	Blooms L	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
CO 1	BL 5	X				
CO 2	BL 5		X			
CO 3	BL 5			X		
CO 4	BL 5				X	
CO 5	BL 5					X
CO 6	BL 6	X	X	X	X	X

R24MCSCT001	DATA STRUCTURES (Common to all Branches)					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Basic Programming	**3**	**0**	**0**	**3**

Course Objective

Students will get exposure to use data structures such as arrays, linked lists, stacks, queues, trees, graphs, hashing and will be able to select and implement the appropriate data structures to solve the given problem.

Course Outcomes

1	Will be able to **apply** various searching and sorting techniques and **analyze** their time complexities. **(BL3)**
2	Will be able to **apply** Linked Lists and its variants and **utilize** them for various applications. **(BL3)**
3	Will be able to **compare** arrays and Linked Lists and **conclude** which storage structure is appropriate for the given problem/data structure. **(BL4)**
4	Will be able to **develop** novel **solutions** to small scale programming challenges involving data structures such as stacks, queues, trees and graphs.
5	Will be able to recognize scenarios where hashing is advantageous, and **design** hash-based **solutions** for specific problems. **(BL6)**
6	Will be able to collaborate in teams to **design** and implement innovative **solutions** by **choosing** and **combining** the appropriate data structure(s). **(BL6)**

SYLLABUS

Unit I	**INTRODUCTION TO LINEAR DATA STRUCTURES**	**8 hr**

Data Structures- Introduction, need for a data structure, Types of Data Structures; Overview of time and space complexity analysis, asymptotic notations; Recursion- Introduction, Types of recursions; Searching-Linear Search algorithm, Binary Search algorithm, Sorting techniques- Bubble Sort, Selection Sort; Insertion Sort; Quick Sort; Merge Sort.

Unit II	**LINKED LISTS**	**8 hr**

Introduction to Linked List, Variations/Types of Linked Lists, Applications; Single Linked List Operations: creation, insertion; Deletion, Traversal/Search; Circular Linked Lists-Insertion, Deletion, Traversal/Search.

Double Linked Lists and Operations- Creation, Insertion; Deletion, Traversal/Search; Applications of Linked List-Representation of Sparse Matrix using Single Linked List, Representation of Polynomials using Single Linked List; Polynomial Operations (Addition) using Linked List.

Unit III	**STACKS AND QUEUES**	**8 hr**

Introduction to Stack data structures, basic operation, implementation of Stack using array; Stack implementation using Linked Lists, advantages & disadvantages; Applications of Stack: Infix to postfix conversion; postfix expression evaluation, Factorial using Stack.

Introduction to Queue data structures, basic operation, implementation of Queue using array; Queue operations implementation using Linked Lists; Circular Queues using Arrays; Double Ended Queues.

Unit IV	**TREE- BINARY TREE, BINARY SEARCH TREE, BALANCED TREE**	**8 hr**

Tree – Introduction, Types of Trees; Binary Tree – Introduction, Properties, Various ways of representing Binary Tree in memory; Recursive Binary tree traversals, Construction of Binary tree given tree traversals (In-order, Pre-order & In-order, Post-order); Tree applications- Heap(Min/Max)

Binary Search tree operations- Creation, Insertion; Deletion, Traversal/Search; Balanced Binary trees – Introduction, Operations on AVL Trees –Insertion; AVL Tree Deletion, Search.

Unit V	GRAPHS AND HASHING	8 hr
Basic concepts, Representation of Graph using Adjacency Matrix and Adjacency List; Graph Traversals (BFS, DFS); minimum spanning tree using Prim's Algorithm; minimum spanning tree using Kruskal's algorithm Single Source Shortest Distance- Dijkstra's algorithm, transitive closure; Introduction to Hashing, Hash Functions; Collision Resolution Techniques: Open hashing -chaining, Open Addressing- linear probing; quadratic probing, double hashing.		
LEARNING RESOURCES		
TEXT BOOKS:		
1	Mark Allen Weiss, *Data Structures and algorithm analysis in C*, Pearson, 2nd Edition.	
2	Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, *Fundamentals of data structures in C*, Silicon Press, 2008.	
3	Richard F, Gilberg , Forouzan, Cengage, *Data Structures*, 2/e.	
REFERENCE BOOKS:		
1	Algorithms and Data Structures: The Basic Toolbox by Kurt Mehlhorn and Peter Sanders.	
2	C Data Structures and Algorithms by Alfred V. Aho, Jeffrey D. Ullman, and John E. Hopcroft	
3	Problem Solving with Algorithms and Data Structures" by Brad Miller and David Ranum	
4	Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein.	
5	Algorithms in C, Parts 1-5 (Bundle): Fundamentals, Data Structures, Sorting, Searching, and Graph Algorithms" by Robert Sedgewick	
ADDITIONAL REFERENCE MATERIAL		
1	https://www.javatpoint.com/data-structure-tutorial	
2	https://www.programiz.com/dsa	
3	https://www.cs.bham.ac.uk/~jxb/DSA/dsa.pdf	
ONLINE COURSES		
1	https://onlinecourses.nptel.ac.in/noc24_cs45/preview	
2	https://www.coursera.org/learn/data-structures	
3	https://www.coursera.org/specializations/boulder-data-structures-algorithms	

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL3	X				
CO2	BL3		X			
CO3	BL4	X	X	X	X	X
CO4	BL6			X	X	X
CO5	BL6					X
CO6	BL6	X	X	X	X	X

R24MCSCT002	OPERATING SYSTEMS (Common to all Branches)					
	Total Contact Hours	42(L)	**L**	**T**	**P**	**C**
	Pre-requisite	Basics of computer systems	**3**	**0**	**0**	**3**

Course Objective

Students will be able to understand how an operating system manages a computer's hardware resources like CPU, memory, file and storage providing a user-friendly interface to interact with the system, enabling them to grasp the principles of managing a computer system efficiently.

Course Outcomes

1	Students will be able to analyze the diverse structures and functionalities of operating systems to evaluate their impact on computer system performance. (BL-4)
2	Students will be able to explain the different process management related aspects of operating system and will be able to analyze various process scheduling algorithms. (BL-5)
3	Students will be able to perceive the significance of process synchronization and deadlock handling mechanisms in the operating system. (BL-5)
4	Students will be able to compare and analyze the various memory management techniques. (BL-4)
5	Students will be able to explain various file management, storage management, protection and security services offered by the operating system. (BL-5)
6	students will be able to discuss how an operating system manages a computer's hardware resources like CPU, memory, and storage, allowing them to effectively utilize these resources through concepts like process management, memory allocation, file systems. (BL-6)

SYLLABUS

Unit I	**COMPUTER SYSTEM AND OPERATING SYSTEM OVERVIEW**	**8 hr**

Overview Computer System Hardware, What Operating System do? Computer System Organization & Computer System Architecture; OS Functions and Services; The Evolution of OS; Computing Environment; OS System Structure; System Calls and types of system calls; User Operating System Interface, Protection and Security.

Unit II	**PROCESS MANAGEMENT**	**8 hr**

Process description, Process States & Transitions, PCB; Process Scheduling-Scheduling queues, Schedulers, Context Switching; Operations on processes; Multithreading-Motivation, Benefits & Multithreading Models; Process Scheduling-Basic Concepts & Scheduling Criteria; Scheduling Algorithms-Non-Preemptive. (FCFS, SJF & Priority); Scheduling Algorithms-Preemptive (Round Robin & Priority). Multilevel Queue Scheduling, Multilevel-feedback Queue Scheduling.

Unit III	**PROCESS SYNCHRONIZATION AND DEADLOCKS**	**8 hr**

Process Synchronization-Background, The Critical section problem; Software-Based Solution (Peterson’s Solution), Synchronization Hardware; Semaphores-Usage, Implementation; Classical Problems Synchronization-Bounded Buffer, Readers Writer’s problem; Deadlock-System model, Deadlock Characterization; Methods of handling deadlocks, Deadlock Prevention; Deadlock Avoidance; Deadlock Detection, Recovery from Deadlock.

Unit IV	MEMORY MANAGEMENT	8 hr
Background-Basic Hardware, Address Binding, Logical vs Physical; Swapping, Contiguous Memory Allocation; Paging- Basic Method, Hardware; Structure of page tables; Segmentation -Basic Methods, Hardware; Virtual Memory-Background, Demand Paging- Basic Concepts; Page Replacement Algorithm-Basic Page replacement, FIFO, Optimal; Page Replacement Algorithm-LRU, Thrashing-Causes of Thrashing.		
Unit V	**FILE & STORAGE MANAGEMENT, PROTECTION AND SECURITY**	**8 hr**
File Concept-File Attributes, File Operations, File Types; Directory Structure-Overview, Single level, Two level, Tree Structure; File Allocation Methods-Contiguous, Linked, Indexed; Mass Storage-Magnetic Disk, Magnetic Tape, Disk Structure; Disk Scheduling; Goals of Protection, Principals of Protection, Access Matrix, ACL; The Security Problems, Program threats- Trojan, Trap Door, Ransomware; User Authentication-Passwords, Password Vulnerabilities, Encrypted Password, OTP, Bio-Metric.		
LEARNING RESOURCES		
TEXTBOOKS:		
1	Operating systems concepts by Abraham Silberschatz, peter B. Galvin, and Greg Gagne.	
2	Operating systems: Internals and design principles by William Stallings.	
REFERENCE BOOKS:		
1	Modern operating systems by Andrew S. Tanenbaum	
2		
3		
ADDITIONAL REFERENCE MATERIAL		
1	"Operating Systems: Three Easy Pieces" by Remzi H. Arpaci-Dusseau and Andrea C. ArpaciDusseau (Free online book available at: http://pages.cs.wisc.edu/~remzi/OSTEP/)	
2	"Linux Kernel Development" by Robert Love.	
3	"File System Forensic Analysis" by Brian Carrier.	
ONLINE COURSES		
1		
2		
3		

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL4	X				
CO2	BL5		X			
CO3	BL5			X		
CO4	BL4				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCHEL001	FLUID MECHANICS FOR CHEMICAL ENGINEERS LAB					
	Total Contact Hours	42 (P)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**0**	**0**	**3**	**2**

Course Objectives	
This lab enables the student to understand,	
1	Measurement of flow rates, velocity
2	Fluid flow behavior, calculation of pressure losses during the fluid flow through closed conduits
3	Calculation of pressure losses in pipe fittings
4	The characteristics of the pumps
5	The working of flow measurement devices
6	Calculation of pressure losses during the fluid flow through packed beds
7	How to handle and operate different types of Fluid handling equipment.
Course Outcomes: Students will be able to,	
1	Determine velocity, volumetric flow rate and mass flow rate of fluids through conduits.(BL-5)
2	Examine whether flow is laminar or turbulent and calculate pressure loss in straight pipes.(BL-4)
3	Estimate pressure loss in fittings like bends, elbows, sudden contraction and sudden expansion.(BL-6)
4	Interpret the performance of the pump through characteristic curves .(BL-5)
5	Measure the fluid flow rates using flow measuring devices.(BL-5)
6	Test different types of Fluid handling equipment.(BL-6)
LIST OF EXPERIMENTS:	
1	Verification of Bernoulli equation
2	Determination of friction factor for flow through straight pipes of different diameters and study of variation of friction factor with Reynolds number
3	Determination friction losses in pipe fittings
4	Determination of discharge coefficient for venturi meter
5	Determination of discharge coefficient for orifice meter
6	Determination of discharge coefficient in a V-notch
7	Determination of viscosity of the fluid using stokes law.
8	Determination of characteristic curves for centrifugal pumps.
9	Determination of characteristic curves for Reciprocating pumps
10	Pressure drop in a packed bed for different fluid velocities
11	Determination of Pressure drop and bed porosity in a fluidized bed
12	Calibration of Rotameter
LEARNING RESOURCES	
TEXT BOOKS:	
1	Unit Operations of Chemical Engineering by W.L.McCabe, J.C.Smith& Peter Harriot,McGraw-Hill, 6th Ed, 2001
REFERENCE BOOKS:	
1	Transport processes and unit operations by Christie J. Geankoplis, PHI.
2	Introduction to Fluid mechanics by R.W. Fox, A.T.McDonald, P.J.Pritchard, JohnWileyand sons-6th edition

R24MCHEL002	MECHANICAL UNIT OPERATIONS LAB					
	Total Contact Hours	42 (P)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**0**	**0**	**3**	**2**

Course Objectives:	
1	Calculate avg. particle size of a given sample.
2	Operate various size reduction mills and calculate energy requirements in these mills for a given size reduction ratio
3	Estimate the capacity and efficiencies of various screens
4	Evaluate the collection efficiency of cyclone separator
5	Evaluate the operation of filtration techniques
6	Determine percentage recovery of given feed using froth floatation
7	Sort out the various ores using sedimentation techniques
Course Outcomes After successful completion of this lab, the students able to:	
1	Calculate avg. particle size of a given sample. (Arithmetic mean diameter, Mass mean diameter, Volume mean diameter, Volume surface mean diameter, Surface area) **(BL3)**
2	Operate various size reduction mills and calculate energy requirements in these mills for a given size reduction ratio**(BL3)**
3	Estimate the capacity and effectiveness of various screens **(BL5)**
4	Evaluate the collection efficiency of cyclone separator **(BL5)**
5	Operate filter press and calculate the resistances of medium and cake **(BL3)**
6	Determine percentage recovery of given feed using froth floatation **(BL5)**
7	Sort out the various ores using sedimentation techniques **(BL6)**

LIST OF EXPERIMENTS

1. Sieve analysis of a given sample using Rotap sieve shaker
2. To calculate the effectiveness of a given screen for different capacities.
3. To crush the coal in a Primary Jaw Crusher (Blake Jaw Crusher) and determination of average product size and energy consumption for crushing.
4. To determine power consumption required for crushing of a given quantity of material using Roll crusher and compare with the values obtained from crushing laws.
5. To compare open circuit and closed circuit grinding by using Ball mill also to compare energy requirements for crushing in both the cases.
6. Determine particle size from batch sedimentation tests
7. To determine the specific cake resistance and filter medium resistance of slurry in a plate and frame filter press.
8. To study the effect of inlet gas velocity and particle size on collecting efficiency of a cyclone separator.
9. To calculate the percentage recovery of coal from coal-sand mixture using froth floatation cell
10. To grind the coal in attrition mill and determine the average product size and energy consumption for grinding.
11. To grind the coal in a hammer mill and determine the average product size and energy consumption for grinding.

LEARNING RESOURCES

TEXT BOOKS:

1	Unit operations of Chemical Engineering, Warren,L., McCabe, Julian C.Smith, Peter Harriot, 7th Edition, McGraw Hill (2008).

REFERENCE BOOKS:

1	Chemical Engineering, vol.-II, J.H.Coulson and Richardson, 5th edition, Elsevier India (2006).

2	Mechanical Operations for Chemical Engineers, C. M. Narayana and B.C.Bhattacharyya, Khanna Publishers (1992).
3	Perry's Chemical Engineers Hand Book, Perry Rober H, 8th edition, McGraw Hill (2007).

<table>
<tr><td rowspan="3">R24MCSCL001</td><td colspan="6">DATA STRUCTURES LAB
(Common to all Branches)</td></tr>
<tr><td>Total Contact Hours</td><td colspan="2">42 (P)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisite</td><td colspan="2">Basic Programming</td><td>0</td><td>0</td><td>3</td><td>2</td></tr>
<tr><td colspan="8">Course Objective</td></tr>
<tr><td colspan="8">To get hands-on exposure to linear and non-linear data structures and to identify and apply the suitable data structures for the given real-world problem.</td></tr>
<tr><td colspan="8">Course Outcomes</td></tr>
<tr><td>1</td><td colspan="7">Student will be able to implement recursive algorithms and will be able to understand the role of linear data structures in organizing and accessing data efficiently using searching and sorting techniques.</td></tr>
<tr><td>2</td><td colspan="7">Student will be able to implement, and apply linked lists for dynamic data storage, demonstrating understanding of memory allocation.</td></tr>
<tr><td>3</td><td colspan="7">Student will be able to develop programs using stacks to handle recursive algorithms, manage program states, and solve related problems.</td></tr>
<tr><td>4</td><td colspan="7">Student will be able to apply queue-based algorithms for efficient task scheduling and breadth-first traversal in graphs and distinguish between linear queues and circular queues, and apply them appropriately.</td></tr>
<tr><td>5</td><td colspan="7">Student will be able to devise novel solutions to small scale programming challenges involving data structures such as stacks, queues, trees, graphs.</td></tr>
<tr><td>6</td><td colspan="7">Student will be able to recognize scenarios where hashing is advantageous, and design hash-based solutions for specific problems.</td></tr>
<tr><td colspan="8">LIST OF EXPERIMENTS</td></tr>
<tr><td>1</td><td colspan="7">WEEK 1(SEARCH TECHNIQUES)
• Write a C Program to search an element in the given list using Linear Search Technique. (using recursive and non-recursive functions)
Write a C Program to search an element in the given sorted list using Binary Search Technique. (using recursive and non-recursive functions)</td></tr>
<tr><td>2</td><td colspan="7">WEEK 2(SORTING TECHNIQUES)
• Write a C Program using recursive function to sort a given list of integers in ascending order using Bubble Sort Technique.
• Write a C Program using recursive function to sort a given list of integers in ascending order using Quick Sort Technique.
• Write a C Program using recursive function to sort a given list of integers in ascending order using Merge Sort Technique.</td></tr>
<tr><td>3</td><td colspan="7">WEEK 3(LINKED LIST)
• Write a C Program to create a Single linked list and perform basic operations on Single Linked List.</td></tr>
<tr><td>4</td><td colspan="7">WEEK 4 (OTHER VARIANTS OF LINKED LIST)
• Write a C Program to create a Circular linked list and perform basic operations.
• Write a C Program to create a Double linked list and perform basic operations.</td></tr>
<tr><td>5</td><td colspan="7">WEEK 5 (STACKS & APPLICATIONS)
• Write a C Program to implement Stack operations using arrays.
• Write a C Program to implement Stack operations using linked list.
• Write a C Program to implement Infix to postfix conversion using stacks.
• Write a C Program to evaluate the Postfix Expression using stacks.</td></tr>
<tr><td>6</td><td colspan="7">WEEK 6 (QUEUES)
• Write a C Program to implement Queue operations using arrays.
• Write a C Program to implement Queue operations using linked list
• Write a C Program to implement Circular Queue operations.</td></tr>
</table>

7	**WEEK 7 (BINARY TREE)** • Write a C Program to implement Binary Tree Creation. • Write a C Program to implement Recursive Binary Tree Traversals.
8	**WEEK 8 (BINARY SEARCH TREE(BST))** • Write a C Program to implement Binary Search Tree creation. • Write a C program to implement Insertion, Deletion, Search operations on Binary Search Tree.
9	**WEEK 9 (GRAPHS & TRAVERSAL TECHNIQUES)** • Write a C Program to create a Graph (using Adjacency Matrix or Adjacency List). • Write a C Program to implement Graph Traversals -Breadth First Search and Depth First Search.
10	**WEEK 10 (GRAPH APPLICATIONS)** • Write a C Program to implement Prim's & Kruskal's Algorithm for finding Minimum Cost Spanning Tree. • Write a C Program to implement Single Source Shortest Path - Dijkstra's Algorithm.
11	**WEEK 11 (HEAPS)** • Write a C Program to implement Binary Heap (Min Heap or Max Heap).
12	**WEEK 12 (HASHING)** • Write a C Program to implement Collision Resolution Techniques using Linear probing (Open Addressing) Technique using Division method as hash function.
LEARNING RESOURCES	
TEXT BOOKS:	
1	Mark Allen Weiss, *Data Structures and algorithm analysis in C*, Pearson, 2nd Edition.
2	Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, *Fundamentals of data structures in C*, Silicon Press, 2008.
3	Richard F, Gilberg , Forouzan, Cengage, *Data Structures*, 2/e.
REFERENCE BOOKS:	
1	Algorithms and Data Structures: The Basic Toolbox by Kurt Mehlhorn and Peter Sanders.
2	C Data Structures and Algorithms by Alfred V. Aho, Jeffrey D. Ullman, and John E. Hopcroft
3	Problem Solving with Algorithms and Data Structures" by Brad Miller and David Ranum
4	Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein.
5	Algorithms in C, Parts 1-5 (Bundle): Fundamentals, Data Structures, Sorting, Searching, and Graph Algorithms" by Robert Sedgewick
ADDITIONAL REFERENCE MATERIAL	
1	https://www.javatpoint.com/data-structure-tutorial
2	https://www.programiz.com/dsa
3	https://www.cs.bham.ac.uk/~jxb/DSA/dsa.pdf
ONLINE COURSES	
1	https://onlinecourses.nptel.ac.in/noc24_cs45/preview
2	https://www.coursera.org/learn/data-structures
3	https://www.coursera.org/specializations/boulder-data-structures-algorithms

IV Semester

R24MCHET006	PROCESS HEAT TRANSFER					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Fluid Mechanics	**3**	**0**	**0**	**3**

Course Objectives:

Heat transfer occurs in many unit operations across a variety of processes in the chemical, petrochemical, power, and pharmaceutical industries. Understanding the fundamentals that govern heat transfer is the key to designing equipment involving heat exchange. This course introduces students to the fundamental aspects and quantification of different modes of heat transport. The course aims to help students apply these fundamentals in typical engineering applications (such as heat exchangers, evaporators, boiling, and condensation), eventually leading to the design of relevant industrial units.

Course Outcomes
On completion of the course the students should be able to,

1	Evaluate rate of heat transfer by conduction for one dimensional steady and transient heat flow through various geometries (BL-5)
2	Evaluate the convective heat transfer coefficient for various flows in internal and external configurations without phase change (BL-5)
3	Estimate condensation heat transfer coefficient-compare different regimes of pool boiling and evaluate the radiative heat exchange between different black and grey surfaces (BL-5)
4	Evaluate heat exchanger performance using LMTD or ε-NTU methods (BL-5)
5	Appraise the construction details-characteristics and maintenance of various types of heat exchangers and assess the performance of evaporators (BL-5)
6	Design various process heat exchange equipment using the principles of heat transfer (BL-6)

SYLLABUS

Unit I	**Heat transfer by Conduction**	**8 hr**

Heat transfer by conduction in solids: Fourier's law, thermal conductivity, steady state heat conduction in plane & composite structures-wall; cylinder; spheres; Critical radius of insulation; Equation for one-dimensional unsteady state heat conduction-Lumped heat capacity systems.

Unit II	**Heat transfer by Convection without phase change**	**8 hr**

Regimes of heat transfer in fluids, thermal boundary layer; heat transfer by forced convection in laminar flow; heat transfer by forced convection in turbulent flow; analogy between transfer of momentum and heat-Reynolds and Colburn analogies, Dimensionless numbers in heat transfer and their significance; Natural convection from vertical shapes and horizontal planes.

Unit III	**Heat transfer by Convection with phase change and Radiation heat transfer**	**8 hr**

Heat transfer from condensing vapours-drop wise and film wise condensation; derivation and practical use of Nusselt equation; Heat transfer to boiling liquids, pool boiling of saturated liquid, maximum flux and critical temperature drop.
Nature of thermal radiation, black body radiation, Laws of black body radiation; view factors; radiation between surfaces; radiation shields.

Unit IV	**Introduction to Heat Exchanger Design**	**8 hr**

Double pipe heat exchanger, counter current and parallel current flows; overall heat transfer coefficient, fouling factors; logarithmic mean temperature difference (LMTD method); LMTD correction factor in multi pass heat exchangers; heat exchanger effectiveness (NTU method).

Unit V	**Heat exchange equipment and Evaporators**	**8 hr**

Classification of Heat exchangers; Shell & tube heat exchangers and types; condensers, Reboilers, Plate & Frame heat exchangers, extended surface

equipment; choice of tube-side fluid; factors affecting heat exchangers performance. Evaporators: Performance of tubular evaporators; area calculations for single effect evaporators; Multiple effect evaporators, methods of feeding.	
LEARNING RESOURCES	
TEXT BOOKS:	
1	W.L. McCabe, J. C. Smith & P. Harriot, *Unit Operations of Chemical Engineering*, 7th ed., McGraw-Hill, 2005
2	J. P.Holman, *Heat Transfer*, 10th ed., McGraw Hill, 2009
3	Y.V.C.Rao, *Heat Transfer*, University Press, 1st ed., 2002
REFERENCE BOOKS:	
1	B. K. Dutta, *Heat Transfer Principles and Applications*, 2nd ed., PHI, 2009
2	D.Q. Kern, *Process Heat Transfer*, 1st ed., McGraw-Hill Publications, 1950
3	N. Ozisik, *Basic approach to Heat Transfer*, 1st ed., McGraw-Hill, 1985
4	P. L. E. Sissom, *Schaum's Outlines of Heat Transfer,* 2nd ed., McGraw-Hill publications, 2005
ONLINE RESOURCES	
1.	https://archive.nptel.ac.in/courses/103/105/103105140/
2.	https://archive.nptel.ac.in/courses/103/101/103101137/
3.	https://archive.nptel.ac.in/courses/103/103/103103031/

Bloom's level and units catchment articulation matrix

CO	Blooms Level	UNIT I	UNIT II	UNIT III	UNIT IV	UNIT-V
CO1	BL5	X				
CO2	BL5		X			
CO3	BL5			X		
CO4	BL5				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCHET007	CHEMICAL ENGINEERING THERMODYNAMICS					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	---	**3**	**0**	**0**	**3**

Course Objectives:

To introduce the principles of chemical engineering thermodynamics and illustrate their applications in the design of chemical process plants.

Course Outcomes
On completion of the course the students should be able to,

1	Determine heat and work associated with a process by using 1st law of thermodynamics for a flow and non-flow process (BL 4)
2	Determine whether a process takes place or not using second law of thermodynamics also demonstrating proficiency in applying property relations and Maxwell's equations (BL 4)
3	Develop fundamental equations that govern the estimation of pure fluids properties and solution properties. (BL 5)
4	Develop the Models for the excess Gibbs energy and equations for Property changes of mixing (BL5)
5	Evaluate equilibrium conversion using rigorous thermodynamic and Van't Hoff methods (BL 5)
6	Evaluate heat and work requirements in thermodynamic processes and Compute compositions of reacting systems in different phases at equilibrium. (BL6)

SYLLABUS

Unit I	**First law of thermodynamics and Volumetric Properties of Pure Fluids**	**8 hr**

First law of thermodynamics and Energy balance for closed systems, Equilibrium and Thermodynamic state, Reversibility, Mass and energy balance for open systems, Phase rule and its applications, PVT behaviour of pure substances, Virial Equation of State and its applications, Cubic equation of state: Vander walls EOS, RK EOS, Theorem of corresponding states.

Unit II	**Second law of thermodynamics and Thermodynamic Properties of Fluids**	**8 hr**

Statements of the second law of thermodynamics, applications of second law to heat engines and heat pumps, Concept of Entropy and its calculation, Entropy changes for an ideal gas, Third law of thermodynamics, Property relations for homogeneous phases, Maxwell relations, Enthalpy and Entropy as a function of Temperature and Pressure, Internal energy as a function of P, Internal energy as a function of T and V.

Unit III	**Solution Thermodynamics: Theory**	**8 hr**

Concept of Residual properties, Calculation of residual properties from Virial EOS, Fundamental property relation, Chemical potential as a criterion for phase equilibrium, Partial properties, Ideal gas mixtures Properties, Fugacity for pure species, Fugacity coefficient for species in solutions, Generalized correlations for Fugacity coefficient.

Unit IV	**Solution Thermodynamics: Applications**	**8 hr**

The ideal solutions, Excess properties, Activity Coefficient, Excess Gibbs energy, Models for the excess Gibbs energy (Margules equations), Models for the excess Gibbs energy (Vanlaar equations), Models for the excess Gibbs energy (Wilson equations), Property changes of mixing.

Unit V	**Chemical Reaction Equilibria**	**8 hr**
The reaction coordinate, Application equilibrium criterion to chemical reactions, The standard Gibb's energy change and the equilibrium constant, Effect of temperature on equilibrium constants, Relation of equilibrium constants to composition, Equilibrium conversion for single reactions, Phase rule and Duhem's theorem for reacting systems		
LEARNING RESOURCES		
TEXT BOOK:		
1	Introduction to chemical engineering thermodynamics by J.M. Smith, H.C. Van Ness and M.M. Abbott, 7th ed. McGraw Hill, 2005.	
2	A Text book of chemical engineering thermodynamics by K.V. Narayanan. PHI, 2001.	
REFERENCE BOOKS:		
1	Chemical Engineering Thermodynamics, Rao Y.V.C., Universities Press (India) Pvt. Ltd.,1997	
2	Chemical and Process Thermodynamics, BG Kyle, 3rd Edition, Phi Learning, 2008	
3	Introductory Chemical Engineering Thermodynamics, J. Richard Elliott, Carl T. Lira, 2nd Edition, Prentice Hall, 2012	
4	Koretsky, M.D., Engineering and Chemical Thermodynamics, 2nd edition, John Wiley & Sons, 2004.	

Bloom's level and units catchment articulation matrix

CO	**Blooms Level**	**UNIT I**	**UNIT II**	**UNIT III**	**UNIT IV**	**UNIT-V**
CO1	BL4	X				
CO2	BL4		X			
CO3	BL5			X		
CO4	BL5				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCHET008	CHEMICAL REACTION ENGINEERING-I					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**3**	**0**	**0**	**3**

Course Objectives:

Provide knowledge of different types of reactions, reaction rate and its dependency on various parameters, Compare various reactors and choose right kind of reactor for single and multiple reactions.

Course Outcomes

After the completion of the course will be able to

1	Estimate the reaction kinetics of homogeneous chemical reactions **(BL-5)**
2	Analyze the batch reactor kinetic data of various types of reactions for both at constant volume and variable volume conditions. **(BL-4)**
3	Compare the performance of various ideal reactors including multiple reactor systems and recycle reactors and develop skills to choose right kind of reactor. **(BL-5)**
4	Design of suitable ideal reactors for multiple reactions. **(BL-6)**
5	Analyze the effects of temperature and pressure on equilibrium constants and equilibrium conversions and predict the performance of non-isothermal reactors. **(BL-4)**
6	Design of reactors for homogeneous isothermal and non-isothermal reactions **(BL-6)**

SYLLABUS

Unit I **Kinetics of Homogeneous Reactions** **8 hr**

Classification of reactions, Rate equations of elementary and non-elementary reactions, variables affecting the rate of reaction, reaction rate constant, reaction order and molecularity, Elementary and non-elementary reactions; Concentration dependent term of rate equation, Temperature dependent term of rate equation, Comparison of theories with Arrhenius law.

Unit II **Interpretation of Batch reactor kinetic data** **8 hr**

Constant and variable volume reaction systems, integral and differential methods of kinetic analysis, half-lives, fractional life method – general procedure, irreversible unimolecular type first order, bimolecular type second order, and trimolecular type third order reactions, empirical reactions of nth order, zero-order reactions, overall order of irreversible reactions, Irreversible reactions in series and parallel, Analysis of total pressure data obtained in a constant-volume system, First and second order reversible reactions, reactions of shifting order

Unit III **Introduction to Ideal reactors** **8 hr**

Introduction to ideal reactors – Characteristics and performance equations of ideal batch reactor, Steady-state mixed flow reactor, Steady-state plug flow reactors.
Design for single reactions - Size comparison of single reactors, multiple reactor systems, Reactors in series, parallel and series-parallel combinations, Recycle reactor, Autocatalytic reactions.

Unit IV **Design for multiple reactions** **8 hr**

Introduction to multiple reactions - Selectivity and Yield, qualitative discussion and quantitative treatment of product distribution and of reactor size for parallel reactions. Irreversible first order reactions in series, qualitative discussion and quantitative treatment of product distribution, quantitative treatment - plug flow or batch reactor, mixed flow reactor

Unit V	**Temperature and pressure effects**	**8 hr**
Non-isothermal operation of reactors: Optimum temperature progression; Adiabatic and non- adiabatic batch, mixed flow and plug flow reactors; exothermic reactions in mixed flow reactors		
LEARNING RESOURCES		
TEXT BOOKS:		
1	O. Levenspiel, Chemical Reaction Engineering, 3rd ed. John Wiley & Sons, 2007.	
REFERENCE BOOKS:		
1	H. S. Fogler, Elements of Chemical Reaction Engineering, 4th ed., PHI, 2005.	
2	K.G. Denbigh, J.C.R Turner, Chemical Reactor Theory: An introduction, Cambridge University Press, 3rd Ed.,1984.	

Bloom's level and units catchment articulation matrix

CO	**Blooms Level**	**UNIT I**	**UNIT II**	**UNIT III**	**UNIT IV**	**UNIT-V**
CO1	BL5	X				
CO2	BL4		X			
CO3	BL5			X		
CO4	BL6				X	
CO5	BL4					X
CO6	BL6	X	X	X	X	X

R24MCHET009	MASS TRANSFER – 1					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**3**	**0**	**0**	**3**

Course Objectives:

1	To acquire basic understanding of engineering aspects of mass transfer operations to design a suitable equipment and to solve mass transfer operation problems

Course Outcomes

The student will be able to

1	Evaluate the mechanism of mass transfer through various diffusional phenomena (BL-5)
2	Analyse the theories of mass transfer to find the rate of diffusion through mass transfer coefficients (BL-4)
3	Explain the importance of phase equilibrium to describe various separation processes using mass transfer (BL-5)
4	Explain the basic principles of absorption and stripping and deal with the design calculations of equipment for gas absorption (BL-5)
5	Recommend wide applications of distillation in separation of mixtures through its principles and design calculations (BL-5)
6	Propose suitable mass transfer equipment for gas-liquid operations (BL-6)

SYLLABUS

Unit I	**Molecular diffusion**	**8 hr**

Introduction: Classification of Mass Transfer Operations, Methods of conducting the Mass Transfer Operations, Design Principles.

Molecular diffusion: Fick's law, Molecular diffusion in gases, Molecular diffusion in liquids, Diffusion in solids, Fick's law for solids, unsteady state diffusion, Types of solid diffusion.

Unit II	**Mass Transfer Coefficients**	**8 hr**

Mass transfer coefficients, Theories of Mass Transfer: Film Theory, Penetration Theory, Surface Renewal Theory, Combination of film-surface renewal theory, Surface stretch theory.

Flow past solids: Boundary layers, Dimensionless groups in mass transfer, Mass and heat transfer analogies.

Unit III	**Interphase Mass Transfer**	**8 hr**

Equilibrium, Diffusion between phases, Raoult's law, Henry's law, Mass transfer between two phases, Overall mass transfer coefficient, Material balances: Steady state co-current processes, Steady state counter-current processes, Stages, Cascades: Cross flow cascades, Counter-current cascades.

Unit IV	**Gas absorption**	**8 hr**

Equilibrium solubility of gases in liquids, Ideal liquid solutions, Selection of solvent, Co-current flow, Counter-current flow, Determination of the number of stages in a tray tower, Height equivalent to theoretical plate (HETP), Tray efficiency. Gas dispersed: Bubble columns, Mechanically Agitated vessels, Tray towers. Liquid dispersed: Venturi scrubbers, Wetted wall towers, Spray towers, Packed towers.

Unit V	**Distillation**	**8 hr**

Vapor-liquid equilibria, Relative volatility, Flash distillation, Simple distillation, Continuous rectification of binary mixtures, Condenser, Re-boiler, Enriching section, Exhausting section, McCabe-Thiele method, Ponchon Savarit method, Azeotropic distillation, Extractive distillation.

LEARNING RESOURCES

TEXT BOOKS:

1	Principles of Mass Transfer and Separation Processes by Binay K. Dutta
2	Mass Transfer Operations, R.E. Treybal, 3rd Edition., Mc Graw Hill, 1980

REFERENCE BOOKS:	
1	Unit Operations of Chemical Engineering, W.L.Mc Cabe, J.C.Smith & Peter Harriott, McGraw- Hill, 6th Edition, 2001.
2	Coulson and Richardson's Chemical engineering, Vol 1,Backhurst, J.R., Harker, Richardson, J.F., and Coulson, J.M., Butterworth-Heinemann, 1999
3	Coulson and Richardson's Chemical engineering, Vol 2, Richardson, J.F. & Harker, J.H. with Backhurst, J.R., Butterworth-Heinemann, 2002.

Bloom's level and units catchment articulation matrix

CO	Blooms Level	UNIT I	UNIT II	UNIT III	UNIT IV	UNIT-V
CO1	BL5	X				
CO2	BL4		X			
CO3	BL5			X		
CO4	BL5				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCSCT003	PYTHON PROGRAMMING					
	Total Contact Hours	42(L)	**L**	**T**	**P**	**C**
	Pre-requisite	Basic C Programming	**3**	**0**	**0**	**3**

Course Objective

Students will gain knowledge on the basic programming constructs of python language to develop both desktop and Graphical user applications.

Course Outcomes

1	Students will be able to apply the basic building blocks of python language.(BL3)
2	Students will be able to distinguish between various conditional control statements and simplify the problems using functions.(BL4)
3	Students will be able to experiment with various non-scalar data types.(BL3)
4	Students will be able to examine the data using file operations and pandas library.(BL4)
5	Students will be able to decide suitable widgets to implement Graphical User applications.(BL5)
6	Students will be able to design and develop real time applications using Python Programming constructs and GUI tkinter module. (BL6)

SYLLABUS

Unit I	**BASICS – DATA TYPES, OPERATORS, BUILT-IN MODULES**	**8 hr**

Data Types, Escape Sequences, Variables and Basic Input/Output; Assignment Statements, Operators; Arithmetic Expressions, Operator precedence, Type Casting, Program Comments and Docstrings; Program Format and Structure, REPL, IDLE, Running a Script from a Terminal Command Prompt;
Built-In Functions and Modules; User Defined modules creation and importing a user defined module; NumPy – Functions on 1D arrays, Functions on 2D arrays; Pandas Module- Creation of Series, DataFrames, indexing objects;

Unit II	**DECISION-MAKING STATEMENTS, LOOPS AND USER-DEFINED FUNCTIONS**	**8 hr**

Conditional Statements; While loop, for loop; range () function, nested loops; While-else, For- else, break, continue, pass;
Functions: Syntax and basics of function and usage; Passing Parameters, arguments in a function – Default, keyword, positional and Variable - length arguments; local and global scope of variable; return statement, recursive function, recursion vs iteration;

Unit III	**STRINGS, LISTS, TUPLES AND DICTIONARIES**	**8 hr**

Strings- A String is a sequence, Strings are immutable, String slice, String methods; Membership and Identity operators, String search; List- Lists are mutable, List operations; Lambda functions, Map, filter and reduce;
Tuples- Tuples are immutable, Tuple operations; Tuple as return values, List Comprehension, Comparison of Lists and tuples; Dictionaries – Dictionary Creation, operations, Looping through dictionaries; Dictionary Comprehension, Applying dictionary methods to counter objects, Reverse Lookup dictionary;

Unit IV	**FILES AND PANDAS**	**8 hr**

Introduction to Files, modes, types of files, File handling functions: open(), close(), read(), readline(), readlines(); write(), writeline(), append(); seek(), tell(), flush(); file copy using shutil (), delete a file (os.remove ());
Pandas-DataFrame creation with dictionaries, list of dictionaries, dictionary of series, renaming columns and rows labels; Importing data from CSV to DataFrame (Pandas), Inspecting data in DataFrame (head (), tail (), info()), Statistical summary (describe ()); Slicing and Sorting in Pandas; Modifying DataFrames, Data Cleaning in Pandas;

Unit V	TKINTER GUI, EVENT DRIVEN PROGRAMMING, WIDGETS	8 hr
The Behavior of Terminal-Based Programs and GUI-Based Programs, Label, Entry and Button widget; Tkinter Geometry methods (pack(), grid(), place()); Event-Driven Programming, Command Buttons and Responding to Events; CheckButton and Radiobutton widgets; Menu and Menu button widgets; Listbox and Scrollbar widgets; Messagebox and Toplevel widget; File Dialog widget;		
LEARNING RESOURCES		
TEXTBOOKS:		
1	Kenneth A. Lambert. -Fundamentals of Python: First Programs‖, 2nd Edition, Publisher: Cengage Learning	
2	Reema Thareja.-Python Programming using Problem Solving Approach	
3	R. Nageswara Rao, -Core Python Programming	
REFERENCE BOOKS:		
1	Wesley J. Chun. -Core Python Programming - Second Edition‖, Prentice Hall	
2	John V Guttag. -Introduction to Computation and Programming Using Python‖, Prentice Hall of India	
ONLINE COURSES		
1	https://www.w3schools.com/python/	
2	https://www.tutorialspoint.com/python/index.htm	
3	https://docs.python.org/3/tutorial/	
4	https://www.pythontutorial.net/tkinter	
5	https://www.python-course.eu/python3_course.php	
6	https://www.geeksforgeeks.org/python-tkinter-tutorial/	
7	https://www.tutorialspoint.com/python/python_gui_programming.htm	
8	https://www.programiz.com/python-programming	

Bloom's level – Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL3	X				
CO2	BL4		X			
CO3	BL3			X		
CO4	BL4				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCSCT004	DATABASE MANAGEMENT SYSTEMS (Common to all branches)					
	Total Contact Hours	42(L)	**L**	**T**	**P**	**C**
	Pre-requisite	-	**3**	**0**	**0**	**3**

Course Objective

Students will get Exposure on basics of designing relational Database without having any redundancy and also gain the knowledge on handling transaction data in concurrent way and recovering from the failures.

Course Outcomes

1	Students will be able to ***choose*** and appreciate the RDBMS over file system and also be able to ***apply*** the knowledge of ER Modeling design the database from the client requirements (BL-3)
2	Students Will be able to ***analyze*** the SQL query pattern and classify the query patterns based on the client requirements (BL-4)
3	Students will be able to ***Examine*** the database design and classify the different levels of dependencies using Normal Forms and students will be able to identify how triggers are useful in data auditing purpose. (BL-4)
4	Students will be able to ***compare and choose*** different indexing mechanisms to store data in secondary storage devices as per the requirements. (BL-5)
5	Students will be able to ***justify*** the importance of concurrency and recovery Management (BL-5)
6	Students will be able to ***design*** the complete database without redundant storage and able to solve the user queries (BL-6)

SYLLABUS

Unit I	**INTRODUCTION TO DATABASE MANAGEMENT SYSTEM, ER MODELING**	**8 hr**

Need for DBMS, Advantages of DBMS over File Systems, Database applications; Database Users, Different Data Models; 3 Levels of Abstraction in DBMS (External, Conceptual & Physical Schema) and data independence, Database Management System Structure.; Introduction to ER Model, Entity, Entity Set, Attribute – Entity Vs Attribute;

Relationship & Relationship Set – Entity Vs Relationship – Binary Relationship, Ternary Relationship; Introduction to Keys (Candidate Key, Primary Key, Super Key, Unique Key, Not Null Key) – Modeling Key Constraints; Modeling Weak Entities – Mapping concept of Weak Entities to Composite, Primary Key Concept, Referential Integrity Constraint (include cascaded operations of Delete & Update) ; Modeling Participation Constraints – Cardinality, Full participation & Partial, Modeling Class Hierarchies – Mapping concept of class Hierarchies to covering constraints, Modeling Aggregation – Ternary Vs Aggregation;

Unit II	**RELATIONAL ALGEBRA & RELATIONAL CALCULUS**	**8 hr**

Introduction to Relational Model (Translating Entity Set & Relationship set into Tables) ; Introducing Basic operations on Relations: Selection and Projection , Cartesian product, examples; Introducing Basic operations on Relations : Joins, Set Operations and examples ; Introducing Basic operations on relations: Division & Renaming and example;

Syntax & Semantics of Tuple Relational Calculus (notations used to represent a query using DRC); Syntax & Semantics of Domain Relational Calculus (notations used to represent a query using DRC); TRC, DRC Query representations using AND, OR, NOT OPERATORS; IMPLIES operator , Comparison between TRC and DRC;

Unit III	**SQL (STRUCTURED QUERY LANGUAGE)**	**8 hr**

Basic Structure of SQL queries(Basic format of select query, DDL,DML commands) ; Integrity and Referential constraints (Includes syntax for all key constraints, Translating Constraints associated with ER into Tables); Additional Basic Operations(Arithmetic, logical, relational, pattern matching); Functions(String,

Date, Numeric); Aggregate Functions, Clauses and Set Operations**;** Join Expressions; Nested Queries, Correlated Queries; Introduction to Views, Destroying/Altering/Updating of views, Handling Null values;		
Unit IV	**NORMALIZATION**	**8 hr**
FDs and Decomposition: Problems caused by redundancy, FD (definition), Armstrong 's axioms; FD identification from relations, Equivalence of two FD sets; Dependency preserving Decomposition, examples; Lossless join, verification, examples; **Normal Forms:** First normal form, partial dependency, Second normal Form; Transitive dependency, third normal form, Motivation for BCNF; BCNF, Multivalued dependency, Fourth normal form.; Triggers;		
Unit V	**INDEXING, TRANSACTION MANAGEMENT, CONCURRENCY CONTROL & RECOVERY MANAGEMENT**	**8 hr**
Types of indexes (Clustered index, un clustered index primary index, secondary index), Tree based index versus and Hash based index; ISAM, B+ Tree construction (Insertion and Deletion of nodes); Transaction concept, Transaction states, ACID properties of transaction; Transactions and Schedules, Concurrent executions of transactions (anomalies); Serializability, Testing for serializability,2PL; Strict 2PL, Deadlocks, timestamp based protocols; Recoverability, Introduction to Log based recovery, check pointing and shadow paging; ARIES algorithm;		
LEARNING RESOURCES		
TEXTBOOKS:		
1	Data base System Concepts, Silberschatz, Korth, McGraw hill, Sixth Edition.McGrawHill.	
2	Data base Management Systems, Raghurama Krishnan, Johannes Gehrke	
REFERENCE BOOKS:		
1	Fundamentals of Database Systems, Elmasri Navathe Pearson Education.	
2	An Introduction to Database systems, C.J. Date, A.Kannan, S.Swami Nadhan, Pearson, Eight Edition for UNIT III.	
ADDITIONAL REFERENCE MATERIAL		
1	https://docs.oracle.com/cd/B19306_01/server.102/b14200/toc.htm	
2	https://dev.mysql.com/doc/refman/8.0/en/select.html	

Bloom's level – Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL3	X				
CO2	BL4		X	X		
CO3	BL4				X	
CO4	BL5					X
CO5	BL5					X
CO6	BL6	X	X	X	X	

R24MCHEL003	PROCESS HEAT TRANSFER LAB					
	Total Contact Hours	42 (P)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**0**	**0**	**3**	**2**

Course Objectives:

The student will get experimental exposure to calculate the thermal resistance, and calculation of heat transfer coefficients for both natural and forced convection scenarios. The course will impart practical understanding of common heat transfer equipment and apply the concepts of heat transfer, fluid dynamics to the design and operation of heat transfer experiments.

Course Outcomes

On completion of the lab the student should be able to:

1	Apply Fourier's law of heat conduction in finding out the thermal conductivity of a given material (BL-3)
2	Compare the heat transfer coefficients and rate of heat transfer between natural and forced convection mechanism (BL-5)
3	Apply Stefan–Boltzmann's law to find out Stefan - Boltzmann constant & unknown body emissivity (BL-3)
4	Identify different boiling regimes and evaluate the critical heat flux through pool boiling of water (BL-3)
5	Evaluate effectiveness of co-current and counter current heat exchanger (BL-5)
6	Develop skills in data collection, analysis and interpretation (BL-6)
7	Discuss the results effectively in written and oral reports (BL-6)

List of Experiments

1. Determination of overall heat transfer coefficient of composite wall
2. Determination of thermal conductivity of insulating powder
3. Determination of thermal conductivity of given metal rod
4. Determination of heat transfer coefficient in unsteady state heat transfer
5. Determination of heat transfer coefficient in natural convection
6. Determination of forced convective heat transfer coefficient for air flowing through a pipe
7. Determination of critical heat flux point for pool boiling of water
8. Determination of Stefan–Boltzmann constant for a given test body with black body
9. Determination of emissivity of a given plate at various temperatures
10. Determination of effectiveness and overall heat transfer coefficient in double pipe heat exchanger
11. Determination of efficiency and effectiveness of pin-fin
12. Heat transfer coefficient in drop wise & film type condensation

LEARNING RESOURCES

TEXT BOOKS:

1	W.L. McCabe, J. C. Smith & P. Harriot, Unit Operations of Chemical Engineering, 7th ed., McGraw-Hill, 2005
2	B. K. Dutta, Heat Transfer Principles and Applications, 2nd ed., PHI, 2009
3	J. P. Holman, Heat Transfer, 10th ed., McGraw Hill, 2009

REFERENCE BOOKS:

1	Y.V.C. Rao, Heat Transfer, University Press, 1st ed., 2002
2	D.Q. Kern, Process Heat Transfer, 1st ed., McGraw-Hill Publications, 1950
3	Dr. D.S. Kumar, Heat & Mass transfer, S.K. Kataria& Sons, 2013

R24MCHEL004	CHEMICAL REACTION ENGINEERING LAB					
	Total Contact Hours	42 (P)	L	T	P	C
	Pre-requisite	Nil	0	0	3	2

Course Objectives:

In this lab course, students will perform experiments related to chemical reactions, chemical reaction kinetics and basic operation of chemical reactors like CSTR, Batch, PFR reactors.

Course Outcomes

After successful completion of this lab, the students will be able to,

1	Estimate reaction rate constant by applying Arrhenius theorem **(BL-5)**
2	Analyse the concentration versus time data and determine the specific rate constant and the order of the reaction. **(BL-4)**
3	Design and sizing of industrial scale reactor on the basis of kinetic data obtained at lab scale **(BL-6)**
4	Determine RTD and model parameters in a PFR, Packed bed reactors **(BL-5)**
5	Compare theoretical and experimental conversions in a CSTR and PFR and choose right kind of reactor for a single reaction **(BL-4)**
6	Design lab equipment like CSTR, Batch, PFR reactors. **(BL-6)**

LIST OF EXPERIMENTS

1. Determination of the order of a reaction using a batch reactor and analyzing the data by (a) differential method (b) integral method.
2. To determine the specific reaction rate constant of a reaction of a known order using a CSTR.
3. To determine the order of the reaction and the rate constant using a tubular reactor.
4. To study the effect of temperature on the reaction rate constant and to determine the activation energy of a reaction using
   (a) Batch reactor
   (b) CSTR
   (c) Plug flow reactor
5. To study the effect of residence time on conversion in a CSTR for a given reaction
6. To study the effect of residence time on conversion in a tubular reactor for a given reaction
7. To study the performance characteristics of combined flow reactors connected in series (PFR-MFR) and to determine the best reactor setup for a given reaction.
8. Determination of RTD and dispersion number for a packed-bed using tracer
9. Determination of RTD and dispersion number in a tubular reactor using a tracer.
10. Mass transfer with chemical reaction (solid-liquid system) – determination of mass transfer coefficient.
11. Mass transfer with chemical reaction (liquid-liquid system) – determination of mass transfer coefficient

LEARNING RESOURCES

TEXT/REFERENCE BOOKS:

1	O. Levenspiel, Chemical Reaction Engineering, 3rd ed. John Wiley & Sons, 2007.

REFERENCE BOOKS:

1	H. S. Fogler, Elements of Chemical Reaction Engineering, 4th ed., PHI, 2005.
2	K.G. Denbigh, J.C.R Turner, Chemical Reactor Theory: An introduction, Cambridge University Press, 3rd Ed.,1984

<table>
<tr><td rowspan="3">R24MCSCL002</td><td colspan="6">PYTHON PROGRAMMING LAB
(Common TO ALL Branches)</td></tr>
<tr><td>Total Contact Hours</td><td>42(P)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisite</td><td>C Programming</td><td>0</td><td>0</td><td>3</td><td>2</td></tr>
<tr><td colspan="7">Course Objective</td></tr>
<tr><td colspan="7">Students will implement python programming constructs which are used to develop both desktop and graphical user applications.</td></tr>
<tr><td colspan="7">Course Outcomes</td></tr>
<tr><td>1</td><td colspan="6">Students will be able to apply the basic building blocks of python language like variables, operators and modules.</td></tr>
<tr><td>2</td><td colspan="6">Students will be able to apply conditional control statements and functions.</td></tr>
<tr><td>3</td><td colspan="6">Students will be able to apply various file operations and analyze the data using pandas library.</td></tr>
<tr><td>4</td><td colspan="6">Students will be able to choose and decide the suitable widgets to design and develop Graphical User Interface (GUI) applications.</td></tr>
<tr><td colspan="7">List of Experiments</td></tr>
<tr><td>1</td><td colspan="6">Week – 1: DATA TYPES, OPERATORS, BUILT-IN FUNCTIONS

1. Write a python script to illustrate data types (int, char, float, string).
2. Write a python program to perform the following expressions using operator precedence
(1) 5+3*2
(2) 2*3**2
(3) 2**3**2
(4) (2**3)**2
3. Write a python program to illustrate type conversion functions
4. Write a python program to illustrate pi, sqrt, cos, sin functions of math module</td></tr>
<tr><td>2</td><td colspan="6">Week – 2: PROGRAMS WITHOUT CONTROL STATEMENTS

1. Write a program to calculate simple interest
2. Write a python program to calculate compound interest
3. Write a python program to print ASCII value of a character
4. Write a python program to find the area of a circle
5. Write a python program to find the area of a triangle
6. Write a program to perform string concatenation</td></tr>
<tr><td>3</td><td colspan="6">Week – 3: PROGRAMS ON NUMPY MODULE

1. Write a program to work with 1D array operations including indexing and slicing.
2. Write a program to work with 2D array operations</td></tr>
<tr><td>4</td><td colspan="6">Week – 4: PROGRAMS ON CONTROL STATEMENTS

1. Write a python program find the power of a number without built-in functions.
2. Write a python program to count the number of even and odd numbers upto the given range.
3. Write a python program to print the multiplication table for a given number.
4. Write a python program to display minimum and maximum among three numbers.</td></tr>
<tr><td>5</td><td colspan="6">Week – 5: PROGRAMS ON FUNCTIONS

1. Write a python program to find if a number is prime or not with and without recursion.</td></tr>
</table>

	2. Write a python program to display Fibonacci series using iteration and recursion. 3. Write a python program to find the factorial of a number with and without recursion.
6	**Week – 6: PROGRAMS ON STRINGS** 1. Write a program to work with string built-in functions 2. Write a python program to determine number of times a given letter occurs in a string 3. Write a python program to check if a string is a palindrome or not. 4. Illustrate in operator and write a python program to count number of lowercase characters in a string. 5. Write a program to replace all the occurrences of letter 'a' with letter 'x' in a string.
7	**Week – 7: PROGRAMS ON LISTS** 1. Write a program to implement the following list functions a)len() b)extend() c)sort() d) append() e)insert() f)remove() 2. Write a program to pass list as an argument to a function 3. Write a python program to find the largest and smallest number in a list. 4. Write a python program to merge two lists and sort it. 5. Write a python program to remove the duplicate items from a list. 6. Write a python program to find sum of elements in a list
8	**Week – 8: PROGRAMS ON TUPLES , DICTIONARIES** 1. Write a program to create a list of tuples with the first element as the number and the second element as the square of the first element. 2. Write a python program that takes the list of tuples and sorts the list of tuples in increasing order by the last element in each tuple. 3. Write a program to implement the following dictionary methods a) keys() b) values() c)items() d) pop() e)delete() 4. Write a python program to add a key value pair to a dictionary and update the dictionary based on the key. 5. Write a Program to do a reverse dictionary lookup in python.
9	**Week – 9: PROGRAMS ON FILES** 1. Write a program to implement read(), readline(), readlines(), write(), writelines() methods on files. 2. Write a program to implement seek(), tell() and flush() methods with different arguments in a file. 3. Write a program to generate 20 random numbers in the range of 1 to100 and write to a file.
10	**Week – 10: PROGRAMS ON PANDAS MODULE** 1. Write a program to import data from CSV to DataFrame and inspect data in DataFrame using head(), tail (), info() and describe() functions in pandas. 2. Write a program to perform sorting and slicing operations in pandas. 3. Write a program to perform dataframe modification and data cleaning in pandas.
11	**Week – 11: PROGRAMS ON GUI** 1. Design and develop a GUI application to display -Hello World.

	2. Design and develop a GUI application using Label, Entry and Button widgets. 3. Design and develop a GUI application using Tkinter Geometry methods pack(),grid(), place(). 4. Design and develop a GUI application using CheckButton and Radiobutton widgets.
12	**Week – 12: PROGRAM ON GUI CONTI…** 1. Design and develop a GUI application using Menu and Menubutton widgets. 2. Design and develop a GUI application using Listbox and Scrollbar widgets. 3. Design and develop a GUI application using Messagebox and File Dialog widget
Demonstration experiments	
1	Demonstration of Python IDLE to implement solutions.
2	Demonstration on Colab notebook to read, access and display data from google drive.
3	Demonstration on jupyter notebook to link and access data.
LEARNING RESOURCES	
TEXTBOOKS:	
1	Kenneth A. Lambert. -Fundamentals of Python: First Programs‖, 2nd Edition, Publisher: Cengage Learning
2	Reema Thareja.-Python Programming using Problem Solving Approach
3	R. Nageswara Rao, -Core Python Programming‖
REFERENCE BOOKS:	
1	Wesley J. Chun. -Core Python Programming - Second Edition‖, Prentice Hall
2	John V Guttag. -Introduction to Computation and Programming Using Python‖, Prentice Hall of India.
3	Python Practice Book Release 2014, Anand Chitipothu.
ADDITIONAL REFERENCE MATERIAL	
1	https://www.w3schools.com/python/
2	https://www.tutorialspoint.com/python/index.htm
3	https://docs.python.org/3/tutorial/
4	https://www.pythontutorial.net/tkinter
5	https://www.python-course.eu/python3_course.php
6	https://www.geeksforgeeks.org/python-tkinter-tutorial/
7	https://www.tutorialspoint.com/python/python_gui_programming.htm
8	https://www.programiz.com/python-programming

V Semester

R24MCHET010	TRANSPORT PHENOMENA					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Fluid Mechanics, Heat and Mass transfer	**3**	**0**	**0**	**3**

Course Objectives:

Transport Phenomena covers momentum, mass, and energy transport, highlighting the analogies among them and their applications in chemical process engineering. The course introduces students to the systematic use of shell balances and equations of change, enabling them to analyze and solve a wide range of transport problems. By integrating theory with practical applications, it equips future engineers with the skills needed for effective process design and problem-solving.

Course Outcomes:

After completing this course, student will be able to

1	Analyze the fluid flow behavior predicted by various flow models and compare how transport properties change with temperature and pressure. (BL-4)
2	Analyze velocity profiles obtained from shell momentum balance for different flow geometries, and interpret the influence of geometry on flow behavior. (BL-4)
3	Analyze temperature profiles derived from shell energy balance, and explain how they vary across different heat transport problems. (BL-4)
4	Develop concentration profiles obtained from shell mass balance in mass transport problems, and derive the equations of change for mass, momentum, and heat transport. (BL-3)
5	Develop velocity, temperature, and concentration profiles from the equations of change for transport processes. (BL-3)
6	Formulate mathematical models for momentum, heat, and mass transport problems in process industries using transport phenomena principles. (BL-6)

SYLLABUS

Unit I	**Transport properties – Flow models**	**8 hr**

Analogy between the laws of Transport Phenomena; Flow models for Non-Newtonian fluids; Effect of Temperature and Pressure on Viscosity; Effect of Temperature and Pressure on Thermal conductivity; Effect of Temperature and Pressure on Diffusivity.

Unit II	**Shell Momentum balance**	**8 hr**

Shell momentum balance and boundary conditions; Flow over an inclined plate (Flow of a falling film); Fluid flow between two parallel walls (narrow slit); Fluid flow through a circular tube; Flow of a Bingham plastic fluid through a circular tube.

Unit III	**Shell Energy balance**	**8 hr**

Shell energy balances and boundary conditions; Heat conduction with an electrical heat source: Plane slab, Solid Cylinders, Solid Spheres; Heat conduction through plane walls with constant and variable thermal conductivity; Heat conduction with a viscous heat source; Heat conduction in a cooling fin.

Unit IV	**Shell Mass balance-Equations of change and applications**	**8 hr**

Shell mass balance and boundary conditions; Diffusion through a Stagnant gas film; Diffusion with homogeneous Chemical reaction; Pore diffusion with Chemical reaction.

Equations of change: Equation of continuity; Equation of motion; Equation of energy; Equation of continuity for binary mixtures; Application of equations of change: Heat conduction through plane structures without heat generation.

Unit V	**Applications of Equations of change**	**8 hr**

Heat conduction through plane structures with heat generation; Flow over an

inclined plate (Flow of a falling film); Flow between two parallel stationary plates; Flow through a circular tube; Flow through an annulus; Flow between rotating cylinders; Flow confined between two parallel plates with top plate moving (Simple Couette flow); Flow between two parallel plates with top plate moving (Couette flow).	
LEARNING RESOURCES	
TEXT BOOKS:	
1	Transport Phenomena by Bird R.B., Stewart W.C., Lightfoot F.N., 2nd ed. John Wiley &Sons Inc,U.S.A,1960.
REFERENCE BOOKS:	
1	Transport processes and unit operations by C.J. Geankoplis, PHI, 3rded. 1997.
2	Fundamental of heat, momentum and mass transfer, Welty, Wicks and Wilson, John Wiley.
ONLINE RESOURCES	
1.	https://nptel.ac.in/courses/103105128
2.	https://nptel.ac.in/courses/103108220

Bloom's level and-Units catchment articulation matrix

CO	Blooms Level	UNIT I	UNIT II	UNIT III	UNIT IV	UNIT-V
CO1	BL4	X				
CO2	BL4		X			
CO3	BL4			X		
CO4	BL3				X	
CO5	BL3					X
CO6	BL6	X	X	X	X	X

R24MCHET011	CHEMICAL REACTION ENGINEERING-II					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Chemical Reaction Engineering-I	**3**	**0**	**0**	**3**

Course Objectives:

Understand the basics of non-ideal flow and understand the concepts of Catalysis and Kinetics of heterogeneous catalytic reactions, concepts of pore diffusion resistance combined with surface kinetics and mechanism of Catalyst deactivation and identify the effects of temperature and pressure on equilibrium constants.

Course Outcomes

By the end of this course, student will be able to,

1	Determine RTD and conversion in real reactors using zero parameter models. **(BL-5)**
2	Compare the performance of single parameter models to predict the conversion in real reactor. **(BL-5)**
3	Explain the concepts of Catalysis and synthesizing a rate law- mechanism and design of solid catalysed reactors for heterogeneous reactions. **(BL-5)**
4	Explain the Performance equations for reactors containing porous catalyst particles. **(BL-5)**
5	Determine the effect of catalyst deactivation for design of real solid catalysed reactions. **(BL-5)**
6	Design of reactors for non-ideal reactions and heterogeneous catalytic reactions. **(BL-6)**

SYLLABUS

Unit I	**Introduction to non-ideal flow**	**8 hr**

Basics of non-ideal flow- E, the age distribution of fluid, the RTD, Conversion in Non-ideal flow reactors, Earliness of mixing, segregation and RTD- self-mixing of a single fluid, mixing of two miscible fluids.

Unit II	**Models of non-ideal flow**	**8 hr**

The dispersion model-axial dispersion, correlations for axial dispersion, chemical reaction and dispersion, The tanks in series model- pulse response experiments and the RTD, chemical conversion. The convection model for laminar flow- the convective model and its RTD, chemical conversion in laminar flow reactors.

Unit III	**Catalysis**	**8 hr**

Catalysis and Catalytic reactors- catalysts, steps in catalytic reactions, synthesizing a rate law, mechanism and rate limiting step. Heterogeneous reactions -Introduction. Solid catalyzed reactions- The rate equation for Surface Kinetics- Pore diffusion resistance combined with surface kinetics.

Unit IV	**Solid Catalyzed Reactions**	**8 hr**

Solid Catalyzed Reactions-Performance equations for reactors containing porous catalyst particles, Experimental methods for finding rates.

Unit V	**Deactivating catalysis**	**8 hr**

Deactivating catalysts, Mechanism of Catalyst De-activation, the rate and performance equations, the rate equation from experiment, determining the rate for independent deactivation, Effect of pore diffusion resistance on the kinetics of reactions with deactivating catalysts.

LEARNING RESOURCES

TEXT BOOKS:

1	Chemical Reaction Engineering by Octave Levenspiel 3rd ed. Wiley Eastern Ltd.
2	Elements of chemical reaction engineering by H.S. Fogler, 3rd ed. PHI, 1999.

Bloom's level and units catchment articulation matrix

CO	Blooms Level	UNIT I	UNIT II	UNIT III	UNIT IV	UNIT-V
CO1	BL4	X				
CO2	BL4		X			
CO3	BL5			X		
CO4	BL5				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCHET012	MASS TRANSFER –II					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Mass Transfer-I	**3**	**0**	**0**	**3**

Course Objectives:

Give an elaborative idea of separation techniques like extraction, leaching, adsorption, drying & crystallization and to understand the thrust of mass transfer operation's solutions & threshold limits of various processes involved.

Course Outcomes

The student will be able to

1	Explain the liquid extraction process to separate the constituents and study the preliminary design of extraction equipment. (BL-5)
2	Explain the separation of soluble constituents of a solid material using a suitable solvent by leaching operation. (BL-5)
3	Evaluate the process design aspects of adsorption principles through adsorption isotherms and study fundamental design of equipment used. (BL-5)
4	Estimate total time of drying and discuss the role of drying in product manufacturing in process industries. (BL-5)
5	Conclude the importance of crystallization and select a suitable membrane separation process for different applications. (BL-5)
6	Recommend the most important separation equipment in the process industries.(BL-6)

SYLLABUS

Unit I	**LIQUID LIQUID EXTRACTION**	**8 hr**

Liquid-liquid operations, fields of usefulness, liquid –liquid equilibrium, Equilateral triangular co-ordinates, choice of solvent, stage wise contact, multi stage cross current extraction, Multistage counter current without reflux. differential extractors (continuous contact), spray towers, packed towers, Mechanically agitated counter current extractors, centrifugal extractors, dilute solutions,

Unit II	**LEACHING**	**8 hr**

Leaching: Fields of applications, Preparation of solid for leaching, Types of leaching, leaching equilibrium, single stage and multi stage leaching calculations, constant under flow conditions, Equipment for leaching operations.

Unit III	**ADSORPTION**	**8 hr**

Types of adsorption, nature of adsorbents, adsorption equilibrium, single gases and vapors, adsorption hysteresis, effect of temperature, heat of adsorption, vapor and gases mixtures: one component adsorbed, effect of change of temperature or pressure. Freundlich equation, application of the Freundlich equation to single and multistage adsorption(cross current and counter. Fluidized and teeter beds, continuous contact steady state moving bed adsorbers, unsteady state –fixed bed adsorbers, chromatography, pressure swing adsorption, Ion – exchange techniques and applications, ion movement theory, ion exclusion.

Unit IV	**DRYING**	**8 hr**

Drying: Equilibrium, definitions, drying conditions-rate of batch drying under constant drying conditions, Mechanisms of batch drying, drying time through

circulation drying, Classification of drying operations: Batch and continuous drying equipment, Material and energy balances of continuous driers, rate of drying for continuous direct heat driers.		
Unit V	**CRYSTALLIZATION & MEMBRANE SEPARTION PROCESSES**	**8 hr**
Crystallization: Nucleation and crystal growth, controlled rate of crystals, crystallization equipment. Membrane separation processes: Basic principles of membrane separation, Brief introduction on reverse osmosis, nanofiltration, ultrafiltration, microfiltration, Pervaporation, dialysis, membrane extraction, electro dialysis; Types of synthetic membranes-micro porous, asymmetric, thin film composite, electrically charged and inorganic membranes, Membrane modules-industrial applications		
LEARNING RESOURCES		
TEXT/REFERENCE BOOKS:		
1	Mass transfer operations by R.E. Treybal, 3rd ed. McGraw Hill, 1980.	
2	Principles of Mass Transfer and Separation Processes by Binay K. Dutta	
REFERENCE BOOKS:		
1	Unit Operations of Chemical Engineering, W.L.Mc Cabe, J.C.Smith & Peter Harriott, McGraw- Hill, 6th Edition, 2001.	
2	Coulson and Richardson's Chemical engineering, Vol 1,Backhurst, J.R., Harker, Richardson, J.F., and Coulson, J.M., Butterworth-Heinemann, 1999	
3	Cussler E. L., Diffusion: Mass Transfer in fluid system, Cambridge University Press, 2009.	

Bloom's level and units catchment articulation matrix

CO	Blooms Level	UNIT I	UNIT II	UNIT III	UNIT IV	UNIT-V
CO1	BL5	X				
CO2	BL5		X			
CO3	BL5			X		
CO4	BL5				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCHET013	PROCESS INSTRUMENTATION					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Physics, Chemistry, thermodynamics	**3**	**0**	**0**	**3**

Course Objectives:

This course aims to help students to learn the basic elements of an instrument and its static and dynamic characteristics, the various types of industrial instruments to measure pressure, temperature, composition, head, level, flow rate etc in various industries.

Course Outcomes: The student will be able to

1	Analyze instrumentation elements and characteristics for their industrial applications. (BL-4)
2	Apply temperature measurement techniques for various industrial applications (BL-3)
3	Recommend the various pressure and flow measurement systems for accurate monitoring. (BL-5)
4	Evaluate methods for composition and level measurement to recommend optimal solutions. (BL-5)
5	List advanced techniques for instrumentation and process analysis to enhance system performance. (BL-4)
6	Elaborate and design comprehensive industrial instrumentation systems to enhance process efficiency and reliability. (BL-6)

SYLLABUS

Unit I	**Introduction to Instrumentation**	**8 hr**

Introduction about instruments: Elements of Instruments, Static and Dynamic Characteristics, Response of First Order Instruments.

Expansion thermometers: Mercury-in-Glass Thermometer, Bimetallic Thermometer, Pressure Spring Thermometer, static accuracy and response of thermometers.

Unit II	**Temperature Measurement and Indicating Instruments**	**8 hr**

Thermoelectric and resistance temperature measurement: Thermo electricity, Industrial thermocouples, thermocouple wires and wells, Thermal coefficient of resistance, industrial resistance thermometer bulbs and circuits.

Radiation thermometers: Laws of radiation, Radiation receiving elements, radiation Thermometers, Photoelectric Pyrometers, Optical Pyrometers.

Unit III	**Pressure and Flow Measurement**	**8 hr**

Pressure measurement: Liquid Column Manometers, Gauge Pressure Measuring Elements, Vacuum Measurement, Indicating Elements for Pressure Gauges, measurement of absolute pressure.

Flow metering: Open channel meters, Area flow meters, viscosity measurements and quantity meters.

Unit IV	**Composition and Level Measurement**	**8 hr**

Composition Analysis: Spectroscopic Analysis by absorption, emission and mass spectroscopy, Gas Chromatography, Refractometer.

Measurement of head and level: Direct measurement of liquid level, Level Measurement in Open Vessels, Level Measurement in Pressure Vessels, Density Measurement.

Unit V	**Advanced Instrumentation Techniques**	**8 hr**

Thermal Conductivity Measurement, small angle X-ray scattering (SAXS), X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM) and Field Ion Microscopy (FIM).

LEARNING RESOURCES	
TEXT BOOKS:	
1	Industrial instrumentation by Donald P.Eckman, Wiley eastern, 1950.
REFERENCE BOOKS:	
1	Principles of industrial instrumentation by Patra Nabis, TMH
2	Nanoscience and nanotechnology by BS Murthy, P Shankar, B Raj, BB Rath and James Murday, Universities Press,2013.
3	Instruments for measurements and control by Holbrock W.C. Van Nostrand East West.
4	Hand book Instrumentation, Considine, McGraw Hill.
5	Instrumentation for Process measurement and Control, Norman A. Anderson,3rd Edition, CRC press.

Bloom's level and units catchment articulation matrix

CO	**Blooms Level**	**UNIT I**	**UNIT II**	**UNIT III**	**UNIT IV**	**UNIT-V**
CO1	BL4	X				
CO2	BL3		X			
CO3	BL5			X		
CO4	BL5				X	
CO5	BL4					X
CO6	BL6	X	X	X	X	X

R24MCHET021 (DSC-E1)	PETROLEUM REFINING					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**3**	**0**	**0**	**3**

Course Objectives:

This course aims will help in understanding the science and engineering that sustenance the transformation of crude oil into fuels, petrochemicals, and countless other indispensable commodities.

Course Outcomes:

After completing this course, the students will be able to,

1	Identify various ways of petroleum formation, refine crude oil, and understand their properties. (**BL-3)**
2	Evaluate and test the properties of petroleum products. (**BL-5)**
3	Distinguish between important petroleum operations involved in thermal and catalytic cracking processes. (**BL-4)**
4	Differentiate and compare various aspects of petroleum fractionation. (**BL-4)**
5	Evaluate the processing methods for gasoline, kerosene, and lubricants. (**BL-5)**
6	Design an optimal process technology for transforming crude petroleum into refined products. (**BL-6)**

SYLLABUS

Unit I	**Origin, Formation and Composition of Petroleum**	**8 hr**

Origin, formation and composition of petroleum: Origin and formation of petroleum, Reserves and deposits in world, Indian Petroleum Industry, Evaluation of petroleum.

Unit II	**Properties of petroleum**	**8 hr**

Past, present and future of petroleum refining, Characterization of petroleum & Petroleum products, Chemical Composition of Crude Petroleum. Thermal properties of petroleum fractions, important products of Petroleum, properties and test methods.

Unit III	**Thermal and Catalytic Processes**	**8 hr**

Thermal and catalytic processes: Cracking, catalytic cracking, catalytic reforming, Naphtha cracking, coking, Hydrogenation processes, Alkylation processes, Isomerization process.

Unit IV	**Fractionation of Petroleum**	**8 hr**

Fractionation of petroleum: Dehydration and desalting of crudes, heating of crude, pipe still heaters, distillation of petroleum, blending of gasoline.

Unit V	**Treatment Techniques**	**8 hr**

Treatment techniques: Fraction-impurities, treatment of gasoline, treatment of kerosene, treatment of lubes.

LEARNING RESOURCES

TEXT BOOKS:

1	B.K.B Rao. "Modern Petroleum Refining Processes", 5th Edition, Oxford and IBH Publishing, 2002.
2	Nelson. W.L. "Petroleum refining Engineering", 4th Edition, Mc Graw Hill, New York, 1969.
3	Mohamed A.Fahim, Taher A. Alsahhaf and Amal Elkilani, "Fundamentals of Petroleum Refining", Elsevier science, 2010.

REFERENCE BOOKS:

1	Hengstebeck R.J., "Petroleum Refining", McGraw Hill, New York 1959.
2	Goldstine. R.F. "The Petroleum Chemicals Industry", Taylor and Francis, London, 1967.

Bloom's level and-Units catchment articulation matrix

CO	Blooms L	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
CO 1	BL 3	X				
CO 2	BL 5		X			
CO 3	BL 4			X		
CO 4	BL 4				X	
CO 5	BL 5					X
CO 6	BL 6	X	X	X	X	X

R24MCHET026 (DSC-E1)	FLUIDIZATION ENGINEERING					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Basics of Fluid Mechanics, Heat Transfer, Mass Transfer and Reaction Engineering	**3**	**0**	**0**	**3**

Course Objectives:

This course mainly covers the basic principles of fluidization phenomenon and introduces the fundamental and practical aspects of basic fluidization operations for industrial applications.

Course Outcomes

The student will be able to

1	Explain the fluidization phenomena and analyze flow characteristics of various types of fluidization (BL-5)
2	Determine pressure drop across the fluidized beds by analysing flow patterns and solid movement (BL-5)
3	Classify various types of gas distributors for fluidized beds and determine effectiveness of gas mixing at the bottom region. (BL-4)
4	Explain entrainment and attrition mechanisms and to estimate rate of mass transfer for the fluidized beds. (BL-5)
5	Evaluate rate of heat transfer for the fluidized beds and design a suitable fluidized bed reactors. (BL-5)
6	Recommend the most suitable fluidization techniques for the process industries.(BL-6)

SYLLABUS

Unit I	**Introduction to Fluidization**	**8 hr**

The phenomenon of fluidization; Advantages and disadvantages of fluidized beds; Industrial applications of fluidized beds; Classification of solids, Flow characteristics and its outline in the different types of fluidization.

Unit II	**Flow pattern of fluidization system**	**8 hr**

Flow pattern and its transition, flow pattern map, Frictional pressure drop and its model to analyse. Solid movement, mixing, segregation and staging

Unit III	**Gas distribution in Fluidized beds**	**8 hr**

Type of gas distributors in small and large scale industries, Design of distributor, Bubbling fluidized beds: Gas dispersion and gas interchange in bubbling beds, mixing characteristics

Unit IV	**Particle distribution and Mass Transfer phenomenon**	**8 hr**

Entrainment and elutriation from fluidized beds, Attrition: Attrition mechanism and its analysis by model

Mass transfer phenomena: Particle to gas mass transfer phenomena and its analysis by model in two e phase system.

Unit V	**Heat Transfer phenomena**	**8 hr**

Heat transfer between fluidized beds and surfaces and modeling. Design of fluidized bed reactors: Design for physical operation, catalytic and non-catalytic system.

LEARNING RESOURCES	
TEXT BOOKS:	
1	D. Kunii and O. Levenspiel, Fluidization Engineering, Butterworth, 1991.
2	D. Gidaspow, Multiphase flow and fluidization: continuum and kinetic theory description, Elsevier Science & Technology Books, 1993
REFERENCE BOOKS:	
1	L.G. Gibilaro, Fluidization-dynamics, Butterworth-Heinemann, 2001
2	S. K. Majumder, Hydrodynamics and Transport Processes of Inverse Bubbly Flow, 1st ed. Elsevier, Amsterdam (2016)

Bloom's level and units catchment articulation matrix

CO	**Blooms Level**	**UNIT I**	**UNIT II**	**UNIT III**	**UNIT IV**	**UNIT-V**
CO1	BL5	X				
CO2	BL5		X			
CO3	BL4			X		
CO4	BL5				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCSCT005	SOFTWARE ENGINEERING (Common to all Branches)					
	Total Contact Hours	42(L)	**L**	**T**	**P**	**C**
	Prerequisite	None	**3**	**0**	**0**	**3**

Course Objective

This course introduces students to fundamental Software Engineering principles, including software processes, requirements engineering, design, testing, quality assurance, and risk management.

Course Outcomes

After completing this course, the students will be able to

1	Students will have the ability to apply the core concepts of software engineering, including the nature of software, layered technology, and common software myths, to analyze real-world software development scenarios. (BL-3)
2	Students will have the ability to analyze various software process models to determine their suitability for different types of projects. (BL-4)
3	Students will have the ability to apply requirements engineering techniques to elicit, document, and validate software requirements and utilize software design models (BL-3)
4	Students will evaluate various software testing strategies, assess the effectiveness of black box and white box testing methods, and recommend improvements in testing strategies based on product metrics and testing outcomes to optimize software quality. (BL-5)
5	Students will have the ability to analyze software project risks and develop strategies for risk mitigation and management (BL-6)
6	Students will write the entire software engineering process, assess the effectiveness of each phase from requirements gathering to deployment, and recommend improvements for optimizing the overall workflow and activities involved in software engineering. (BL-6)

SYLLABUS

Unit I	**INTRODUCTION TO SOFTWARE ENGINEERING**	**8 hr**

The Nature Of Software; Software Engineering - A Layered Technology; Software Engineering Practice; Software Myths; A Generic Process Model, Software Process Framework; Process flow, Identifying Task set, Process pattern; Process Assessment and Improvement (SCAMPI, CMM-IPI,SPICE, ISO 9001:2000); The Capability Maturity Model Integration (CMMI);

Unit II	**PROCESS MODELS & SOFTWARE REQUIREMENTS**	**8 hr**

The Waterfall Model, Incremental Process Models; Evolutionary Process Models: The Prototype Model, Spiral Model; Unified Process, Personal And Team Process Models; Agile Process Model; Feasibility Studies, User Requirements and System Requirements; Functional and Non - Functional Requirements; The software requirements document; Requirements engineering processes;

Unit III	**REQUIREMENTS ENGINEERING & DESIGN ENGINEERING**	**8 hr**

Establishing The Groundwork, Requirements Elicitation; Requirement Analysis - DFD, Data Dictionaries; Developing Use Cases, Use Case Diagrams; Requirements Negotiation and Validation; Requirements Management; Preparation of SRS; Design Concepts - Abstraction, Architecture, Patterns, Separation of concerns and Modularity ;The Design Model - Data Design Elements, Architectural Elements- Interface, Component and Deployment design elements;

Unit IV	**TESTING STRATEGIES & METRICS**	**8 hr**

A Strategic Approach to Software Testing, Test Strategies for Conventional Software - Unit and Integration Testing; Testing Strategies - Validation Testing, System Testing;

Black Box Testing - Graph-Based Testing Methods;White box testing - Basis path

testing; A Framework for Product Metrics - Measures, Metrics, and Indicators;Metrics for the Requirements Model - Function-Based Metrics;Metrics for the Design Model-Architectural Design Metrics and Metrics for Source Code ;Metrics for Testing		
Unit V	**QUALITY MANAGEMENT & RISK MANAGEMENT**	**8 hrs**
Quality Management - Software Quality (McCall's software quality factors) ; Review Techniques - Informal and Formal Review Techniques; Software Quality Assurance - Elements of SQA, SQA Tasks, Goals and Metrics; Statistical SQA, ISO 9000 Quality Standards; Reactive vs. Proactive Risk Strategies; Software Risks; Risk Identification; Risk Projection, Risk Refinement; RMMM Plan;		
LEARNING RESOURCES		
TEXTBOOKS:		
1	Software Engineering, A practitioner's Approach- Roger S. Pressman, 6th Edition, McGrawHill International Edition.	
2	Software Engineering- Sommerville, 7th edition, Pearson education.	
REFERENCE BOOKS:		
1	Software Engineering- K.K. Agarwal & Yogesh Singh, New Age International Publishers	
2		
ADDITIONAL REFERENCE MATERIAL		
1	https://ocw.mit.edu/courses/16-355j-software-engineering-concepts-fall-2005/pages/lecture-notes/	
2		
ONLINE COURSES		
1	https://nptel.ac.in/courses/106101061	
2		

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL3	X	X			
CO2	BL4		X			
CO3	BL3			X		
CO4	BL5				X	
CO5	BL6					X
CO6	BL6	X	X	X	X	X

R24MCHEL005	MASS TRANSFER LAB					
	Total Contact Hours	42 (P)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**0**	**0**	**3**	**2**

Course Objectives:	
1	Understand various mass transfer operations (Distillation, leaching, liquid-liquid extraction, humidification, drying, and adsorption) and their principles.
2	Understand the concept of equilibrium in various mass transfer operations.
3	Understand the influence of various parameters like temperature, concentration, flow rate, time, etc. on different mass transfer operations.
4	Evaluate Mass transfer coefficient for gas-liquid systems.
5	Understand the Hydrodynamics in a Packed Bed Column.
6	Understand the Solubility characteristics of a Ternary liquid system.
7	Become familiar with separation equipment in lab scale that is useful in design of industrial mass transfer equipment.
Course Outcomes: Students will be able to	
1	Design and conduct experiments related to mass transfer in distillation, leaching, liquid -liquid extraction, humidification, drying and adsorption.(BL-6)
2	Interpret and analyse the data related to various mass transfer operations. (BL-5)
3	Evaluate Mass transfer coefficient for gas-liquid systems. (BL-5)
4	Inspect the Hydrodynamics in a Packed Bed Column. (BL-4)
5	Evaluate the Solubility characteristics of a Ternary liquid system. (BL-5)
6	Propose an appropriate mass transfer operation for a given application. (BL-6)

LIST OF EXPERIMENTS

1. **Diffusivity coefficient of vapors of organic liquid in air**: To find the diffusivity of vapors of organic liquid in air and compare with the values obtained from empirical equations.
2. **Open pan evaporation:** To study the vaporization efficiency of an open pan evaporator and to determine heat transfer coefficient.
3. **Studies on Batch adsorption:** To study the adsorption of acetic acid on activated carbon & to calculate the constants of Freundlich equation.
4. **Simple/ Differential Distillation**: To verify the Rayleigh's equation for a simple/ differential distillation in a binary system.
5. **Hydrodynamic studies in a packed column**: To study the relationship between pressure drop with different gas and liquid flow rates and to observe loading and flooding conditions.
6. **Studies of Drying characteristics of wet solids:** To determine the drying characteristics of a solid sample in a tray dryer.
7. **Solid Dissolution of benzoic acid**: To determine the solid-liquid mass transfer coefficient for benzoic acid and water system.
8. **Studies on Batch extraction**: To obtain the equilibrium relationship between raffinate and extract phase and to find out the percentage recovery with a given solvent system
9. **Studies on solubility characteristics of a ternary liquid system**: To determine the binodal solubility curve, tie line data and plait point of a given ternary liquid system
10. **Studies on Leaching**: To determine percentage recovery of solute for a given leaching system.

LEARNING RESOURCES	
TEXT BOOKS:	
1	Principles of Mass Transfer and Separation Processes by Binay K. Dutta
2	Mass Transfer Operations, R.E. Treybal, 3rd Edition., Mc Graw Hill, 1980
REFERENCE BOOKS:	
1	Unit Operations of Chemical Engineering, W.L.Mc Cabe, J.C.Smith & Peter Harriott, McGraw- Hill, 6th Edition, 2001.
2	Coulson and Richardson's Chemical engineering, Vol 2, Richardson, J.F. & Harker, J.H. with Backhurst, J.R., Butterworth-Heinemann, 2002.

R24MCSCL003	DATABASE MANAGEMENT SYSTEMS LAB (Common to all Branches)					
	Total Contact Hours	42(P)	**L**	**T**	**P**	**C**
	Pre-requisite	-	**0**	**0**	**3**	**2**

Course Objective

Students will gain exposure on ER model, R- Model to design the database, Data Retrieval using SQL and Procedural SQL. Students will be able to explore view level of data abstraction levels.

Course Outcomes

After completing this course, the students will be able to

1	Students will be able to design the database for the given client requirements using ER- Model and also be able to convert the ER design to R model by covering all sorts of constraints
2	Students will be able to retrieve the data for any given user constraints using SQL features group by, nested Queries and joins
3	Students will be able to design the different views and also able to identify the execution differences between a query and query as a view.
4	Students will be able to identify the importance of data and auditing.
List of Experiments	
1,2	Designing of ER model for the given constraints
3	Conversion of entities to relational tables with constraints using DDL statements (CREATE, ALTER, DROP)
4	Conversion of relations to relational tables with referential integrity constraint (using ON DELETE CASCADE and ON UPDATE CASCADE) and DML operations (INSERT, DELETE, UPDATE)
5	Querying the data using SELECT, WHERE, AND, BETWEEN, LIKE
6	Applying string, number and date functions while querying the data
7	Querying the data using set operations(UNION, UNION ALL, INRESECT, MINUS/EXCEPT) and GROUPBY, HAVING clauses
8	Querying the data using Nested Queries (Correlated Queries- EXISTS, NOT EXISTS, independent queries- IN, NOT IN, ANY, ALL, =, > and <).
9	Querying the data using JOINS and Handling NULL values using JOINS
10	Designing views for different user perspectives (updatable views and non-updatable views),
11	Designing of procedures and functions in PL/SQL
12	Design of Triggers
Additional experiments	
1	Sequence generation and its usage as primary key
2	Verifying DCL-grant, revoke
3	Verifying TCL commands- commit, roll back and save point.
Demonstration experiments	
1	Case study - Library Management system
2	Case study- E-commerce store management
3	Case Study**-** Hospital management

LEARNING RESOURCES	
TEXTBOOKS:	
1	Data base System Concepts, Silberschatz, Korth, McGraw hill, Sixth Edition. McGrawHill.
2	Data base Management Systems, Raghurama Krishnan, Johannes Gehrke
3	Learning SQL, Alan Beaulieu, O'Reilly Media, Inc., 3rd Edition,
ADDITIONAL REFERENCE MATERIAL	
1	https://docs.oracle.com/cd/B19306_01/server.102/b14200/toc.htm
2	https://dev.mysql.com/doc/refman/8.0/en/select.html

VI Semester

R24MCHET014	PROCESS MODELING AND SIMULATION					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Mathematics, Mass transfer, heat transfer and chemical reaction.	**3**	**0**	**0**	**3**

Course Objectives:

This course aims to help students in applying fundamental laws in developing model equations, modeling and simulations of various chemical equipment's such as isothermal and non-isothermal CSTR, distillation column, batch reactor and also the application of numerical methods to solve various chemical engineering problems.

Course Outcomes: The student will be able to

1	Apply the component and energy balances to the chemical engineering problems (BL3)
2	Analyze non isothermal CSTR (BL4)
3	Model the distillation column and batch reactor (BL3)
4	Solve chemical engineering problems using numerical methods (BL3)
5	Evaluate chemical engineering problems using any modern tool (BL5)
6	Develop models for various chemical operations and simulate (BL6)

SYLLABUS

Unit I	**Mathematical models of Chemical Engineering systems**	**8 hr**

Mathematical models for chemical engineering systems, Uses of mathematical models, principles of formulation, introduction to fundamental laws, transport equations, equation of state, Equilibrium, chemical kinetics.

Unit II	**Examples of mathematical models of Chemical Engineering systems**	**8 hr**

Examples of mathematical models of chemical engineering systems, constant volume CSTRS, variable volume CSTR's, bubble point and dew point calculations, Gravity flow tanks, two heated tanks, gas phase pressurized CSTR, non-isothermal CSTR.

Unit III	**Examples of mathematical models of Chemical Engineering systems**	**8 hr**

Examples of single component vaporizer, batch reactor, reactor with mass transfer, ideal binary distillation column, batch distillation with holdup, Interacting and non-interacting systems.

Unit IV	**Numerical methods for simulation**	**8 hr**

Numerical methods for simulation 1: .Bisection, false position, Newton –Raphson method, Gauss elimination method, Gauss-Jordan and Gauss-Seidel's method.
Numerical methods for simulation2: Euler method, Runge Kutta fourth order method, Computation of Eigenvalues and Eigen vectors, least square approximation of functions, linear regression, polynomial regression.

Unit V	**Simulation Examples**	**8 hr**

Computer simulation examples-Gravity flow tank, three CSTRs in series, binary distillation column, batch reactor, Simulation of Non-isothermal CSTR, VLE dew point, bubble point calculations, heated tanks, counter current heat exchanger, Interacting and non-interacting systems.

LEARNING RESOURCES	
TEXT BOOKS:	
1	W. L. Luyben, *Process modeling simulation and control for chemical engineers*, 2nd Edition, McGraw Hill, 1990.
2	S. K. Gupta, *Numerical methods in engineering*, New Age international, 1995.
REFERENCE BOOKS:	
1	WF Ramirez, *Computational methods for process simulation*, Butterworth- Heinmann, 1998
2	Roger G.E. Franks, *Modeling and Simulation in Chemical Engineering*, Wiley-Interscience, 1972.

Bloom's level and-Units catchment articulation matrix

CO	**Blooms Level**	**UNIT I**	**UNIT II**	**UNIT III**	**UNIT IV**	**UNIT-V**
CO1	BL3	X				
CO2	BL4		X			
CO3	BL3			X		
CO4	BL3				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCHET015	PROCESS DYNAMICS AND CONTROL					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Laplace Transforms, Chemical Process Calculations	**3**	**0**	**0**	**3**

Course Objectives:

The course aims to analyse the dynamic behavior of first and second order processes and various controllers and control systems used in chemical process industries to various forcing functions. The course introduces the stability of control system and tuning of controllers.

Course Outcomes

Student will be able,

1	Model first order order systems and analyze the response to different forcing functions**(BL-3)**
2	Model first second order systems and analyze the response to different forcing functions **(BL-3)**
3	Analyze closed loop performance of a control system with different controllers **(BL-4)**
4	Determine the stability analysis of a control system using Routh Test and Bode plots**(BL-5)**
5	Estimate initial tuning parameters for P, PI, PID controllers using Z-N Method and Cohen & Coon (CC) methods**(BL-5)**
6	Design and selection of controller for a process, Analyze the performance of multi loop control systems, and understand valve characteristics**(BL-6)**

SYLLABUS

Unit I	**Response of first order systems**	**8 hr**

Introduction to process dynamics and control. Response of First Order Systems. Physical examples of first order systems

Unit II	**Response of second order systems and Transportation lag**	**8 hr**

Response of first order systems in series, Higher order systems: Second order and transportation lag

Unit III	**Controllers and Control systems**	**8 hr**

Control systems, Controllers and final control elements

Closed loop transfer functions, Transient response of simple control systems

Unit IV	**Stability and Control systems design by frequency response**	**8 hr**

Stability, Introduction to frequency response, Control systems design by frequency response.

Unit V	**Advanced control strategies**	**8 hr**

Controller tuning and process identification, Advanced control strategies: Cascade control, Feed forward control, ratio control, Control valves.

LEARNING RESOURCES

TEXT BOOK:

1	Process systems analysis and control by D.R. Coughanowr, 3 rd. Mc Graw Hill 2009

REFERENCE BOOKS:

1	Chemical process control by G. Stephanopoulos, PHI, 1998
2	Process Dynamics and Control, Dale Seaborg, Thomas F, Edgar, Duncan Mellichamp, 4 th edition, Wiley India pvt Ltd, 2016.
3	Principles of process control, Patranabis, 3rd edition, McGraw –Hill Education Pvt LTD, 2012.
4	Industrial Process Control systems, 2nd edition, Dale R, Patrick, Stephon, W.Fardo, CRC Press, 2009.

5	Process control: Concepts, Dynamics and Control, S.K.Single, PHI Learning, 2009.
6	Process modeling simulation and control for chemical engineers by W. L. Luyben, McGraw Hill, 2nd Ed.,

Bloom's level and-Units catchment articulation matrix

CO	**Blooms Level**	**UNIT I**	**UNIT II**	**UNIT III**	**UNIT IV**	**UNIT-V**
CO1	BL3	X				
CO2	BL3		X			
CO3	BL4			X		
CO4	BL5				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCHET016	PLANT DESIGN AND ECONOMICS FOR CHEMICAL ENGINEERS					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**3**	**0**	**0**	**3**

Course Objectives:

The course aims at cost components involved in estimation of Investment cost and product cost, concepts like interests, investments, taxes and insurance, depreciation, profitability, optimum design of operations in chemical plants.

Course Outcomes

Students will be able to:

1	Understand the procedure involved in Process design development **(BL-3)**
2	Estimate capital requirements for a process plant **(BL-4)**
3	Evaluate interest cost and depreciation and understand how they affects the product cost. **(BL-4)**
4	Analyze and Select the best investment among various alternatives available. **(BL-5)**
5	Formulate optimization problem and solve it using graphical method / Analytical methods. **(BL-5)**
6	Perform preliminary economic evaluation for a process. **(BL-6)**

SYLLABUS

Unit I	**Process Design Development**	**8 hr**

Introduction, Process Design development, Plant location, plant layout.

Unit II	**Cost estimation**	**8 hr**

Cost estimation: Cash flow for industrial operations, factors effecting investment and production cost, capital investments, estimation of capital investments, cost indices, cost factors in capital investment, estimation of total product cost, production costs, fixed charges, plant overhead costs, financing.

Unit III	**Interest and Depreciation**	**8 hr**

Interest and investment cost: types of interest, nominal and effective interest rates, continuous interest, present worth , annuities , capitalized costs
Depreciation: Types of depreciation, services life, salvage value, present value, methods for determining depreciation, single unit and group depreciation.

Unit IV	**Profitability Analysis**	**8 hr**

Profitability, alternative investments and replacements: profitability standards, discounted cash flow, capitalized cost, payout period or payout time, alternative investments and replacements

Unit V	**Optimum Design and Design Strategy**	**8 hr**

Optimum Design and Design Strategy: Intangible and practical considerations, General procedure for determining optimum conditions, optimum production rates in plant operation, optimum conditions in cyclic operations, optimum economic pipe diameter, optimum flow rate of cooling water in condenser, optimum reflux ratio in distillation.

LEARNING RESOURCES

TEXT BOOKS:

1	Plant Design and Economics for Chemical Engineering, 4th ed., M.S. Peters and K.D. Timmerhaus, McGraw-Hill, 1991

REFERENCE BOOKS:

1	Process Engineering Economics, Schweyer
2	S. M. Walas, Revised 2nd Edition, Butterworth-Heinemann, 2010.

Bloom's level and-Units catchment articulation matrix

CO	Blooms Level	UNIT I	UNIT II	UNIT III	UNIT IV	UNIT-V
CO1	BL3	X				
CO2	BL4		X			
CO3	BL4			X		
CO4	BL5				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCSCT006	OOP WITH JAVA (for MEC, ECE, EEE, CIV and CHE)					
	Total Contact Hours	42(L)	**L**	**T**	**P**	**C**
	Pre-requisite	Data Structures	**3**	**0**	**0**	**3**

Course Objective

Students will have the ability to understand, design, integrate, and evaluate complex Java systems by combining object-oriented principles, multithreading, GUIs, exception handling, and collections to create efficient, scalable, and robust applications.

Course Outcomes

1	Students will be able to **apply** object-oriented concepts, Java programming constructs, and control structures.**(BL3)**
2	Students will be able to **analyze** and implement constructors, access control, static and final keywords, nested classes, and string handling. **(BL4)**
3	Students will be able to **apply** inheritance concepts, interfaces, access control, and Java standard libraries to develop modular and reusable Java programs. **(BL3)**
4	Students will be able to **Evaluate** and design robust Java applications by implementing effective exception handling, thread lifecycle management, multithreading, synchronization, and custom exception handling to ensure performance, stability, and efficient concurrency. **(BL5)**
5	Students will be able to **apply** the Delegation Event Model, AWT and Swing components, layout managers, and collections to create interactive Java applications with event handling and efficient data management. **(BL3)**
6	Students will be able to **design** and implement advanced Java applications by integrating OOPS principles, inheritance, polymorphism, exception handling, multithreading, GUIs, and collections for efficient problem-solving. **(BL6)**

SYLLABUS

Unit I	**BASICS OF JAVA**	**8 hr**

Deficiencies with Structured Programming in C, History and Evolution of Java; OOP Principles - abstraction, encapsulation, inheritance and polymorphism; Java virtual machine, features of java, A First Simple Java Program(Command lines,scanner class) Compilation, execution, CLASS PATH; Data Types, Literals, Variables; Type Conversion, Operators, Precedence, Associativity; Control Statements – Selection; Control Statements - Iteration statements; Arrays (One Dimensional, Multi-Dimensional);

Unit II	**CLASS FUNDAMENTALS**	**8 hr**

Class fundamentals, Declaring objects, Introducing Methods; Constructors, parameterized constructors; this keyword, garbage collection, returning objects, Access control; understanding static (static variable, static method, static block); final keyword, nested and inner classes; String Class, String Methods; String Buffer Class, Passing Arrays as parameters to methods; Method overloading, overloading constructors;

Unit III	**INHERITANCE, INTERFACES AND ABSTRACT CLASS**	**8 hr**

Inheritance Basics – Base class, sub class, types of inheritance; Member Access, Method overriding; super keyword, Using final with inheritance; Abstract classes, Multiple inheritance issues; Interfaces – Defining an interface, implementing interfaces; Packages - Defining a Package, Finding Package with CLASSPATH, importing packages, Access Protection; Exploring java.util Package (Random, String Tokenizer, Scanner); Exploring java.io package (Byte and Character streams, File class);

Unit IV	EXCEPTION HANDLING AND MULTITHREADING	8 hr
Exception Handling Fundamentals, Exception Types, Uncaught Exceptions; Using Try and Catch, Multiple Catch Clauses, Nested Try Statements; Throw, Throws and Finally; Handling of User Defined Exceptions; The Java Thread Model, Thread Life Cycle, Comparison of Thread and Process. The Main Thread; Creating a Thread: Implementing Runnable Interface, Extending Thread class; Creating Multiple Threads, isAlive () and join(); Synchronization (Keyword and Block), Thread Priorities;		
Unit V	**EVENT HANDLING, AWT, SWING**	**8 hr**
Delegation Event Model: Events, Event sources, Event Listeners; Event Classes, Event Listeners (Action Listener, Window Listener); Key Listener, keyboard events; Mouse Listeners, mouse events; AWT classes, AWT Controls (Button, Text Field, Label, Checkbox); Layout manager: BorderLayout, GridLayout, FlowLayout; Swings: JLabel, JButton, JTextField, JCheckbox; Collections: Array List, iterator;		

LEARNING RESOURCES

TEXTBOOKS:	
1	Herbert Schildt, "Java The Complete Reference" 9th Edition, Oracle Press
2	Paul Deitel and Harvey Deitel, "Java How to Program", 11th Edition, Pearson.
REFERENCE BOOKS:	
1	Herbert Schildt, "Java: A Beginner's Guide", 9th Edition, McGraw Hill, 2022
2	Bruce Eckel, "Thinking in Java", 9th Edition, Mind View, 2022.
ADDITIONAL REFERENCE MATERIAL	
1	https://www.w3schools.com/java
2	https://docs.oracle.com/javase/tutorial/
3	https://www.geeksforgeeks.org/java/
ONLINE COURSES	
1	https://www.udemy.com/courses/search/?q=java
2	https://www.coursera.org/specializations/java-programming

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL3	X				
CO2	BL4		X			
CO3	BL3			X		
CO4	BL5				X	
CO5	BL3					X
CO6	BL6	X	X	X	X	X

R24MCHET022 (DSC-E2)	BIOCHEMICAL ENGINEERING					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Mass Transfer, Chemical Reaction Engineering	**3**	**0**	**0**	**3**

Course Objectives:	
1	Differentiate the different types of microorganisms/biomolecules.
2	Derive the kinetics of enzyme catalyzed reactions and the effect of various parameters on enzyme activity**.**
3	Develop the kinetics of cell growth including substrate utilization and product formation.
4	Develop the basic concepts of design and analysis of various types of bioreactors**.**
5	Train on various downstream processing strategies for product recovery and purification

Course Outcomes: After completing this course, the student will be able to	
1	Differentiate the different classes of biomolecules/microbes and their role in the bioprocess (**BL-4)**
2	Develop the kinetics of enzyme catalyzed reactions and the effect of various parameters on enzyme activity (**BL-6)**
3	Develop the kinetics of cell growth including substrate utilization and product formation. (**BL-6)**
4	Design a bio-reactor for a given microbial/enzymatic process (**BL-6)**
5	Develop strategies for the separation of bio products from the fermentation broths (**BL-6)**
6	Develop a bioprocess for the production of important bio products (**BL-6)**

SYLLABUS

Unit I	**Overview of microbiology and biochemistry of cells**	**8 hr**

Fundamentals of Microbiology - Bacteria-Structure and functions, Fungi- Structure and functions, Algae- Structure and functions, Protozoa- Structure and functions
Chemicals of life: Carbohydrates- types and functions, Proteins- types and functions; basic idea about primary, secondary and tertiary structure of proteins, protein denaturation. Lipids- classifications and functions. Nucleic acids- types and functions, Structure, chemistry, DNA, RNA.

Unit II	**The Kinetics of Enzyme-Catalyzed Reactions**	**8 hr**

Enzymes – Classification and Properties of enzymes, The Enzyme-Substrate Complex and Enzyme Action, Michaelis-Meneten Kinetics, Determination of Michaelis-Meneten parameters, Substrate Activation and Inhibition, Other Influences of Enzyme Activity, Enzyme inhibition-Types of inhibition, Enzyme immobilization-different methods of immobilization.

Unit III	**Kinetics of Substrate Utilization, Product formation, and Biomass Production in Cell Cultures**	**8 hr**

Production Media-Media preparation; different types of media, Sterilization-Sterilization of Air, media and equipment; batch and continuous sterilization, Biomass production in cell cultures, phases of microbial growth, Kinetics of balanced growth, Monod growth kinetics, Determination of kinetic parameters, Other Influences of Microbial growth rate.

Unit IV	**Design and analysis Bioreactors**	**8 hr**

Batch reactor, Fed batch reactor, stirred tank reactor and stirred tank reactor with recycle of biomass, Plug flow reactor, Alternate Bioreactor Configurations, Aeration and Agitation, Oxygen requirement in fermentations, Determination of K_La values.

Unit V	**Downstream processing (product recovery and purification)**	**8 hr**

Recovery and purification of products, Cell disruption-mechanical methods, non-mechanical methods, Separation of insoluble Products-Filtration and

centrifugation, Separation of soluble products (Liquid-liquid extractions, Distillation, Adsorption), Chromatographic Separation- Gas chromatography, Liquid chromatography, Final steps in purification – Crystallization and Drying.	
LEARNING RESOURCES	
TEXT BOOKS:	
1	Biochemical Engineering Fundamentals, J.E.Bailey and D.F.Ollis, 2nd Edition, McGraw Hill, 1986.
2	Bioprocess Engineering, Michael L. Shuler and Fikret Kargi, 2nd Edition, Prentice Hall, 2002.
REFERENCE BOOKS:	
1	Introduction to Biochemical Engineering, D.G.Rao, Tata McGraw-Hill, 2008.
2	Bioprocess Engineering principles, Pauline M. Doran, Academic Press, 2012.

Bloom's level and Units catchment articulation matrix

CO	Blooms Level	UNIT I	UNIT II	UNIT III	UNIT IV	UNIT-V
CO1	BL4	X				
CO2	BL3		X			
CO3	BL6			X		
CO4	BL6				X	
CO5	BL6					X
CO6	BL6	X	X	X	X	X

R24MCHET023 (DSC-E3)	INDUSTRIAL SAFETY AND HAZARDS MANAGEMENT					
	Total Contact Hours	40 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**3**	**0**	**0**	**3**

Course Objectives:

This course aims to provide a strong foundation in process safety, focusing on accident prevention, risk management, and safety regulations. It covers toxicology, fire and explosion prevention, safety system design, including ventilation and sprinklers, and relief mechanisms. Students will also learn methods for identifying, evaluating, and managing hazards in chemical industries.

Course Outcomes

After completing this course, student will be able to

1	Evaluate safety programs, engineering ethics, and accident statistics to evaluate risks and public perceptions. Examine toxicants and how they enter biological systems. (**BL-3)**
2	Analyze toxin effects, elimination mechanisms, regulatory frameworks, and differentiate fires from explosions while assessing the fire triangle and flammability characteristics. **(BL-4)**
3	Analyze MOC principles, ignition energy, and auto-ignition processes to assess explosion risks, evaluate inerting methods, and inspect explosion-proof equipment and instruments. **(BL-4)**
4	Design ventilation systems, sprinkler systems, and relief mechanisms. Evaluate the location, types, and characteristics of relief systems in chemical industries to effectively manage safety scenarios. **(BL-5)**
5	Apply data for sizing relief systems, conduct hazard checklists, surveys, and studies, and perform operability studies. Design and execute both informal and formal safety reviews to improve safety in industrial processes. **(BL-5)**
6	Integrate process safety, toxicology, and hazard management to design effective safety programs, evaluate risks, and develop mitigation strategies. Apply engineering ethics, regulations, and hazard analysis to optimize safety systems and conduct comprehensive safety reviews in industrial scenarios. **(BL-6)**

SYLLABUS

Unit I	**Safety Engineering: Ethics, Risk, and Human Impact**	**8 hr**

Introduction to Safety program, Engineering ethics, Accident and Loss statistics, Acceptable risk, Public perception, Process Safety, What are Toxicants, How toxicants enter biological organisms

Unit II	**Industrial Toxicology and Fire Risk Management**	**8 hr**

Effect of toxins on biological organisms, How toxicants are eliminated from biological organisms, Government regulations, Identification and Evaluation methodology for Toxins, Control mechanism of Toxins, The fire triangle, Distinction between fire and explosions, Flammability characteristics of liquids and vapors

Unit III	**Fire and Explosion Hazards: Mechanisms and Mitigation**	**8 hr**

MOC (Minimum Oxygen Concentration)**,** Ignition energy**,** Auto ignition and Auto oxidation**,** Adiabatic compression**,** Explosions**,** Inerting definition**,** Different ways of Inerting**,** Explosion proof equipment and Instruments

Unit IV	**Passive and Active Safety Measures in Industrial Processes**	**8 hr**

Ventilations and Types of ventilations**,** Sprinkler systems**,** Design of Sprinkler systems**,** Relief Concepts**,** Definitions used within the chemical industry to describe various reliefs**,** Location of Reliefs in an industry**,** Relief Types and Characteristics**,** Relief Scenarios

Unit V	**Process Hazard Evaluation and Safety Review Methodologies**	**8 hr**

Data for Sizing Reliefs**,** Relief Systems**,** Process Hazards Checklists, Hazards Surveys**,** Hazards Studies**,** Operability Studies**,** Safety Reviews: Informal and

Formal Reviews	
LEARNING RESOURCES:	
TEXT BOOKS:	
1	D.A.Crowl & J.F.Louvar – Chemical Process Safety (Fundamentals with applications), Prentice Hall 1990.
2	Industrial Hygiene and Chemical Safety " to "R.E. Sanders - Chemical Process Safety, 3rd Edition, Elsevier Butterworth–Heinemann, 2005"
REFERENCE BOOKS:	
1	H.H.Fawcett and W.S.Wood –Safety and Accident Prevention in Chemical Operations, 2nd edition, John Wiley and sons, New York 1982
2	Coulson and Richardson's – Chemical engineering – R.K.Sinnot, Vol.6, Butterworth-Heinmann Limited 1996

Bloom's level – Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL3	X				
CO2	BL4		X			
CO3	BL4			X		
CO4	BL5			X	X	
CO5	BL5		X			X
CO6	BL6	X	X	X	X	X

R24MCHET027 (DSC-E3)	CHEMICAL PROCESS UTILITIES					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Chemical Engineering Thermodynamics, Chemical Technology, Heat Transfer	**3**	**0**	**0**	**3**

Course Objectives:	
1	Understand the fundamental principles of chemical process utilities, including energy perspectives, power cycles, and heat transfer utilities.
2	Learn about water chemistry, inhibition, and water treatment in the context of boiler water treatment and steam generation.
3	Familiarize yourself with the principles of air filtration, pneumatic conveying, and natural gas transmission.
4	Comprehend the concept of heat transfer in cooling towers and their components, types, and applications.
5	Understand the principles of refrigeration, refrigeration system components, and refrigeration cycles.
6	Learn about refractories, thermodynamic principles, and corrosion in refractories.
7	Apply mathematical principles to solve problems related to power cycles, heat transfer, and other chemical process utilities.

Course Outcomes After completing this course, student will be able to	
1	Analyze the energy perspective of chemical process utilities and evaluate the efficiency of power cycles. (**BL4**)
2	Analyze steam generation systems, including boiler water treatment and safety devices, to optimize efficiency and sustainability in industrial settings (**BL4**)
3	Select and design appropriate air filtration and pneumatic conveying systems for various industrial applications. (**BL3**)
4	Calculate heat transfer coefficients and design cooling towers for efficient heat transfer. (**BL3**)
5	Evaluate the performance of refrigeration systems and recommend improvements. (**BL5**)
6	Apply problem-solving skills to real-world scenarios in chemical process utilities, using mathematical principles and technical knowledge. (**BL6**)

SYLLABUS

Unit I	**Energy and Heat Transfer Utilities**	**8 hr**

Introduction to Chemical Process Utilities, Energy Perspective to the Utilities,
Power Cycle, Fuel Analysis, Practice Problems related to Power Cycle and Fuel Analysis
Heat transfer utilities, Plate and Frame Heat exchangers types, Heat transfer media and solar energy

Unit II	**Steam Generation and Water Treatment**	**8 hr**

Water chemistry, Inhibition and water treatment, Boiler water treatment, Steam, Boilers, Industrial boiler types, Steam generation unit, Heaters, Attemperator and steam drum, Steam traps, Centralization and fuel selection, Economizer, super heaters, and safety devices, Insulation of steam generators

Unit III	**Air and Pneumatic Conveying Systems**	**8 hr**
Air, Air filtration, and Pneumatic conveying, Introduction to Pneumatic conveying system, Conveying system types, Material properties and pipeline feeding devices, Gas solid flows, Design of pipelines, elements of pipeline design, Natural gas transmission		
Unit IV	**Cooling Towers and Heat Transfer**	**8 hr**
Cooling tower, Theory and some basic calculations, Concept of heat transfer in cooling tower and it's components, Types of cooling tower, Material of construction and applications of cooling tower, Control and maintenance in cooling towers, Pressure levels and terminology, Gauges for pressure measurement		
Unit V	**Refrigeration and Insulation Materials**	**8 hr**
Refrigerants and refrigeration, Introduction to refrigeration, Refrigeration system components and refrigeration cycle, Refractories, Thermodynamic principles and corrosion in refractories, Slag attack and kinds of refractories in uses, Heat transfer in insulation materials		
LEARNING RESOURCES		
TEXT BOOKS:		
1	Plant Utilities by Dr. Mujawar, Nirali Prakashan Publication.	
REFERENCE BOOKS:		
1	Plant Utilities by D.B. Dhone, Nirali Prakashan Publication.	
2	P.L.Balleney, Thermal Enginnering, Khanna Publisher, New Delhi.	
3	Nordell,Eskel."Water Treatment for industrial and other uses" Reinhold Publishing Corporation, New York (1961).	

Bloom's level and Units catchment articulation matrix

CO	**Blooms Level**	**UNIT I**	**UNIT II**	**UNIT III**	**UNIT IV**	**UNIT-V**
CO1	BL4	X				
CO2	BL4		X			
CO3	BL3			X		
CO4	BL3				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCHEL006	PROCESS CONTROL AND SIMULATION LABORATORY					
	Total Contact Hours	42 (P)	**L**	**T**	**P**	**C**
	Pre-requisite	Process modeling and simulation and Process Dynamics and control	**0**	**0**	**3**	**2**

Course Objectives

This lab enables the student to understand,

1	This course aims to train the students on evaluation of thermodynamic properties, dynamics of conventional processes using MATLAB or any modern tool and also on process instrumentation and controlling techniques.

Course Outcomes: Students will be able to,

1	Apply the computer applications in chemical engineering design (BL3)
2	Evaluate the thermodynamic and transport properties (BL5)
3	Model the steady state design of conventional process and equipment's (BL3)
4	Utilize the instruments and learn its characteristics and control techniques (BL3)
5	Analyse the characteristics of control valves (BL4)
6	Develop and simulate the various unit operations/unit process using MATLAB (BL6)

LIST OF EXPERIMENTS:

1	Gravity flow tank
2	Three CSTR's in series - open loop
3	Three CSTR's in series - closed loop
4	Non- interacting system - two tank liquid level
5	Interacting system - two tank liquid level
6	Bubble point calculations
7	Dew point calculations
8	To calibrate and study the response of mercury in glass thermometer for a step input and to estimate the time constant of the system.
9	To study the dynamic response of a U-tube manometer.
10	Experiments on Pneumatic control valve: a. To determine the flow coefficient of a given control valve. b. To study inherent characteristics of Control valve
11	Experiments on Temperature control system a. Open loop response (manual control) b. On/off controller c. Proportional Controller D. Proportional-Integral-Derivative Controller

LEARNING RESOURCES

TEXT BOOKS:

1	W. L. Luyben, *Process modeling simulation and control for chemical engineers*, 2nd Edition, McGraw Hill, 1990.
2	S.K. Gupta, *Numerical methods in engineering*, New Age international, 1995.
3	Process Systems Analysis and Control by D.R. Coughanowr, 2nd ed. McGraw Hill, 1991
4	Industrial Instrumentation, Donald P.Eckman, CBS, 2004.

REFERENCE BOOKS:	
1	WF Ramirez, Computational methods for process simulation, 2nd edition, Butterworth- Heinmann 1998.
2	Roger G.E. Franks, *Modeling and Simulation in Chemical Engineering*, Wiley-Interscience, 1972.
3	Instrumentation and Control Systems, K.Padmaraju, Y.J. Reddy, McGraw Hill Education, 2016.
4	Automatic Process Control, Donald P. Eckman, John wiley, Reprint 2011.

<table>
<tr><td rowspan="3">R24MCSCL004</td><td colspan="6">OOP WITH JAVA LAB
(for MEC, ECE, EEE, CIV and CHE)</td></tr>
<tr><td>Total Contact Hours</td><td>42(P)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisite</td><td>-</td><td>0</td><td>0</td><td>3</td><td>2</td></tr>
<tr><td colspan="7">Course Objective</td></tr>
<tr><td colspan="7">Students will have the ability to apply object-oriented programming concepts in Java to develop and implement modular and reusable software solutions.</td></tr>
<tr><td colspan="7">Course Outcomes</td></tr>
<tr><td>1</td><td colspan="6">Students will be able to implement object-oriented programming concepts such as classes, inheritance, polymorphism, and exception handling to build modular Java applications.</td></tr>
<tr><td>2</td><td colspan="6">Students will be able to examine and debug Java programs to identify and resolve logical errors, ensuring correctness and efficiency.</td></tr>
<tr><td>3</td><td colspan="6">Students will be able to assess the design and performance of Java applications, optimizing for scalability, maintainability, and resource management.</td></tr>
<tr><td>4</td><td colspan="6">Students will be able to design and develop advanced Java applications by integrating OOP principles, multithreading, GUIs, and data structures to solve real-world problems.</td></tr>
<tr><td colspan="7">List of Experiments</td></tr>
<tr><td>1</td><td colspan="6">Week 1: Introduction to Java and Structured Programming
1. Write a simple Java program that prints "Hello, World!" to the console.
2. Write a Java program that takes user input using the Scanner class.
3. Write a Java program to demonstrate all primitive data types.
4. Implement a Java program that converts a floating-point number to an integer.
5. Create a Java program that uses the final keyword to define constants.</td></tr>
<tr><td>2</td><td colspan="6">Week 2: Operators, Control Statements - Selection
1. Implement a Java program that uses arithmetic, relational, and logical operators.
2. Write a Java program to find the largest of three numbers using if-else statements.
3. Use the ternary operator to implement a simple conditional check.</td></tr>
<tr><td>3</td><td colspan="6">Week 3: Control Statements - Iteration
1. Write a Java program that prints all even numbers between 1 and 100 using a for loop.
2. Create a Java program that calculates the factorial of a given number using a while loop.
3. Write a JAVA program to display the Fibonacci sequence.
4. Implement a menu-driven program using a do-while loop.</td></tr>
<tr><td>4</td><td colspan="6">Week 4: Arrays
1. Write a Java program to reverse a one-dimensional array of integers.
2. Write a Java program to search for an element in an array.
3. Implement a Java program to find matrix multiplication using two-dimensional arrays.</td></tr>
<tr><td>5</td><td colspan="6">Week 5: Classes and Methods
1. Create a class with fields and methods, then instantiate and use it.
2. Implement a method to calculate the area of a rectangle (accepting length and width as parameters).
3. Create a program that returns the area of different shapes (circle, square, rectangle) using method overloading.</td></tr>
</table>

6	**Week 6: Constructors, this Keyword, and Garbage Collection** 1. Implement a class with parameterized constructors and demonstrate object initialization. 2. Use 'this' keyword to resolve variable shadowing within methods and constructors. 3. Write a program that simulates garbage collection using System.gc() and observe the results.
7	**Week 7: Inheritance and Polymorphism** 1. Create a superclass and subclass to demonstrate basic inheritance. 2. Override a method in the subclass and call it from the main method. 3. Use the super keyword to call the parent class constructor and method.
8	**Week 8: Abstract Classes and Interfaces** 1. Write an abstract class with an abstract method and a concrete method. 2. Implement an interface and demonstrate how to implement it in a class. 3. Create a scenario where interfaces solve the multiple inheritance problem.
9	**Week 9: Exception Handling** 1. Write a program that demonstrates basic exception handling using try-catch blocks. 2. Implement a program that handles multiple exceptions using multiple catch clauses. 3. Create a custom exception class and use it to handle a specific error in a program.
10	**Week 10: Multithreading** 1. Implement a thread by extending the Thread class and demonstrate thread execution. 2. Create a program that demonstrates thread life cycle and state transitions. 3. Implement thread synchronization to avoid race conditions in a multi-threaded environment.
11	**Week 11: Event Handling, AWT** 1. Create a simple AWT program that displays a window with a button, text field, and label. 2. Implement mouse and keyboard event listeners in an AWT program.
12	**Week 12: Swings** 1. Create a Swing-based GUI with a JFrame, JButton, and JLabel, demonstrating layout managers like FlowLayout or BorderLayout. 2. Write a Java program that works as a simple calculator. Use a grid layout to arrange buttons for the digits and for the +, -,*, % operations. Add a text field to display the result.
LEARNING RESOURCES	
TEXTBOOKS:	
1	Herbert Schildt, "Java The Complete Reference" 9th Edition, Oracle Press
2	Paul Deitel and Harvey Deitel, "Java How to Program", 11th Edition, Pearson.
REFERENCE BOOKS:	
1	Herbert Schildt, "Java: A Beginner's Guide", 9th Edition, McGraw Hill, 2022
2	Bruce Eckel, "Thinking in Java", 9th Edition, Mind View, 2022.

ADDITIONAL REFERENCE MATERIAL	
1	https://www.w3schools.com/java
2	https://docs.oracle.com/javase/tutorial/
3	https://www.geeksforgeeks.org/java/
4	https://www.javatpoint.com/java-tutorial
5	https://www.udemy.com/courses/search/?q=java
6	https://www.coursera.org/specializations/java-programming
7	https://www.freecodecamp.org/news/tag/java/
8	https://www.tutorialspoint.com/java/index.htm

R24MTPCT001	QUANTITATIVE PROBLEM-SOLVING TECHNIQUES					
	Total Contact Hours	28 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	NIL	**2**	**0**	**0**	**2**

Course Objective

The course aims to equip the students with standard concepts and techniques of arithmetic and logical thinking to handle various real-world problems and their applications.

Course Outcomes: After completing this course, the students will be able to

1	Enhance the aptitude and reasoning round clearing ability.
2	Solve real-time problems for performing job functions easily.
3	Improve individual decision–making abilities, how to think critically, and logically and analyze information as corporate company-based decisions.
4	Acquire satisfactory competency in the use of VERBAL REASONING as well as LOGICAL REASONING.
5	Develop knowledge, skills, and judgment around human communication that facilitate their ability to work collaboratively with others.

SYLLABUS

Unit I	**ARITHMETIC ABILITY**	**5 hr**

Number System and LCM & HCF; Ratio & Proportion; Percentages; Profit & Loss; Mixture and Allegation.

Unit II	**ALGEBRAIC ANALYSIS**	**5 hr**

Quadratic & Linear eq's; Inequalities; Speed, Time and Distance; Time and Work; Simple Interest & Compound Interest.

Unit III	**ADVANCED MATHS**	**5 hr**

Circles, lines, angles & Co-ordinate geometry; Triangles, quadrilaterals & polygons; Areas & perimeter-2D; Surface area & volumes-3D; Trigonometry.

Unit IV	**MODERN MATHS**	**5 hr**

Probability; Permutation and Combination; Surds, indices & set theory; Functions; Logarithms.

Unit V	**DATA INTERPRETATION & ELEMENTARY STATISTICS**	**5 hr**

Tables, charts & pie-diagrams; Venn diagrams; Data sufficiency; Mean, median & mode; Standard deviation ,variance & Case studies.

LEARNING RESOURCES

TEXTBOOKS:

1	ARIHANT Publications - RAJESH VERMA Fast Track Objective Arithmetic (Revised Edition)
2	MCGRAWHILL Education- ABHIJIT GUHA Quantitative aptitude (6th edition)
3	ARIHANT Publications - B.S. SIJWALI & INDU SIJWALI Verbal, Non-verbal & Analytical reasoning
4	ARIHANT SERIES - JAI KISHAN & PREM KISHAN Verbal, Non-verbal & Analytical reasoning
5	R. S. Aggarwal - S. Chand Publications Quantitative Aptitude for Competitive Examinations

REFERENCE BOOKS	
1	A SURE SHOT GUIDE TO CRACK SSB: YES, YOU HAVE IT IN YOU(MAJ GEN VPS BHAKUNI (Author), VSM (Author), KAVITA MODI (Author)) https://amzn.in/d/9QFY0oF
2	Excel in Quantitative Aptitude: Chapter-wise Maths 10 Years Previous Solved Papers (PYQ) of SSC CGL, IBPS PO & Clerk, SBI PO, & RRB NTPC Tier I & II | Mathematics for SSC, Banking, Railways Exams 2024 (Arun Sharma (Author)) https://amzn.in/d/3OTZ5uI
3	Ace Reasoning Ability for Banking and Insurance Book 2024 (Third English Edition)(Adda247 Publications (Author)) https://amzn.in/d/4aMMHvq
4	Ultimate Guide to SSC CGL - Combined Graduate Level - Tier I & Tier II Exam with Previous Year Questions & 5 Online Practice Sets 9th Edition | Combined Graduate Level Prelims & Mains| PYQs https://amzn.in/d/9IEwmYc (Disha Experts (Author))
5	Excel in Quantitative Aptitude: Chapter-wise Maths 10 Years Previous Solved Papers (PYQ) of SSC CGL, IBPS PO & Clerk, SBI PO, & RRB NTPC Tier I & II | Mathematics for SSC, Banking, Railways Exams 2024 (Arun Sharma (Author)) https://amzn.in/d/3OTZ5uI
6	Quantitative Aptitude for CAT 2025 | 11th Edition (Latest) | Quant | CAT Preparation Exam Book with Solved Previous Years Papers (PYQ) | McGraw Hill edge Access: Mock Tests, Expert Sessions & Strategies (Arun Sharma (Author)) https://amzn.in/d/9OQMQBX
7	Ace Reasoning Ability for Banking and Insurance Book 2024 (Third English Edition) (Adda247 Publications (Author)) https://amzn.in/d/4aMMHvq

VII Semester

R24MCHET017	BASIC ENVIRONMENTAL ENGINEERING AND POLLUTION ABATEMENT (SELF STUDY / MOOCS COURSE)					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**3**	**0**	**0**	**3**

Course Objectives:

The course deals with the fundamentals of environmental engineering and its application in pollution control. It is intended to impart the fundamental knowledge of environmental engineering along with the design aspect of some pollution control equipment.

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

1	Identify strategies to mitigate the risks associated with pollutants in the environment (BL3)
2	Analyze and evaluate the effectiveness of environmental standards, regulations, and sampling methods for assessing air, water, and industrial pollution. (BL4)
3	Classify latest treatment techniques of air pollution control (BL4)
4	Analyse various waste water treatment methods (BL4)
5	Apply appropriate technologies and schemes for managing solid, hazardous, and special category wastes. (BL3)
6	Develop integrated knowledge on various pollution control and its treatment methods (BL6)

SYLLABUS

Unit I	**Ecological Principles and Environmental Concerns**	**8 hr**

Introduction; Ecology, Environment, and Biodiversity; Ecosystem Services and its Risks; Pollution types and sources; Impact/consequences of pollutants; Transmission of pollutants in environment.

Unit II	**Environmental Quality and Regulations**	**8 hr**

Ambient Air Quality and Standards; Water Quality and Standards; Industrial Pollution and Standards; Sampling and Characterization of Gas/Air/Emission; Sampling and Characterization of water/waste water; Characterization of solid wastes and soil; Environmental law and regulatory framework.

Unit III	**Pollution Prevention and Control**	**8 hr**

Pollution Prevention Strategies and Processes; Pollution Prevention by using optimum water; Air pollution control methods and equipment.

Unit IV	**Water and Wastewater Treatment Technologies**	**8 hr**

Treatment of surface and ground water for drinking water generation; Treatment of domestic and industrial waste water; Methods of primary treatments: screening, sedimentation, flotation, neutralization; Secondary treatment process; Secondary treatment equipment.

Unit V	**Solid Waste Management and Treatment**	**8 hr**

Solid waste management schemes; Incineration, Gasification, Pyrolysis, Anaerobic digestion, Hazardous waste management, Management of special category wastes

LEARNING RESOURCES

TEXT BOOKS:

1	"Pollution Control Acts, Rules, Notification issued there under" CPCB, Ministry of Env. And Forest, G.O.I., 3rd Ed.(2006)
2	Vallero D., "Fundamentals of Air Pollution", 4th Ed. Academic Press.(2007

REFERENCE BOOKS:

1	Eckenfelder W. W., "Industrial water pollution Control", 2nd Ed., McGraw Hill.(1999)
2	Kreith F. and Tchobanoglous G., "handbook of Solid waste Management", 2nd Ed., McGraw Hill.(2002)
3	Pichtel J., "Waste Management Practices: Municipal, Hazardous and

	Industrial", CRC.(2005)
4	Tchobanoglous G., Burton F. L. and Stensel H.D., "Waste Water Engineering: Treatment and Reuse", 4th Ed., Tata McGraw Hill.(2003)
ONLINE RESOURCES	
1.	https://archive.nptel.ac.in/courses/103/107/103107215/

Bloom's level and-Units catchment articulation matrix

CO	Blooms Level	UNIT I	UNIT II	UNIT III	UNIT IV	UNIT-V
CO1	BL3	X				
CO2	BL4		X			
CO3	BL4			X		
CO4	BL4				X	
CO5	BL3					X
CO6	BL6	X	X	X	X	X

R24MCHET024 (DSC-E4)	PHYSICO-CHEMICAL PROCESSES FOR WASTEWATER TREATMENT (SELF STUDY / MOOCS COURSE)					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	MUO, Mass Transfer	**3**	**0**	**0**	**3**

Course Objectives:	
1	Develop a comprehensive understanding of the fundamental principles of physico-chemical processes used in wastewater treatment.
2	Analyse and evaluate the role of various physico-chemical processes in achieving wastewater quality standards.
3	Explore advanced and emerging physico-chemical techniques for the removal of contaminants from wastewater.
4	Examine real-world industrial wastewater treatment scenarios and apply physico-chemical concepts to solve practical challenges.
Course Outcomes: Upon successful completion of this course, students will be able to	
1	Evaluate the effectiveness of various physico-chemical treatment methods (e.g., coagulation, flocculation) for different types of wastewater. (**BL-4)**
2	Analyse and explore the effectiveness of various physico-chemical treatment methods (e.g., Sedimentation, filtration, adsorption etc.) for different types of wastewater. (**BL-5)**
3	Critically assess the performance and limitations of advanced treatment processes such as advanced oxidation processes (AOPs), electrochemical methods, and hybrid systems. (**BL-5)**
4	Design a bio-reactor for a given microbial/enzymatic process (**BL-6)**
5	Solve complex problems in industrial wastewater treatment by integrating physico-chemical and biological processes. **(BL-6)**
6	Develop optimized treatment strategies incorporating physico-chemical processes to meet specific industrial or municipal wastewater treatment requirements.(**BL-6)**

SYLLABUS

Unit I	**Pre-treatment & Physical treatment**	**8 hr**

Introduction to Water Pollution and Control, Pre-treatment & Physical treatment: Flow equalization & Aeration, Principle of Coagulation and Flocculation – types of coagulants, coagulant aids, coagulation theory, and optimum dose of coagulant, design criteria.

Unit II	**Primary treatment**	**8 hr**

Principles of sedimentation: Types of settling and settling equations, design criteria and design of settling tanks. Filtration: Theory, types, filter bed, design criteria and design of filters, filter backwash, operational problems and trouble shooting.

Adsorption Process: Types, factors affecting adsorption, kinetics and equilibrium – different isotherm equations and their applications.

Unit III	**Advanced treatment**	**8 hr**

Advanced water treatment: Ion exchange, electro-dialysis, Reverse Osmosis, Ultra filtration

Advanced Oxidation Processes: Introduction, Photo-induced processes, Sono

treatment, Electro-chemical Treatment.		
Unit IV	**Chemical treatment**	**8 hr**
Disinfection: different types, disinfectants, factors affecting disinfection, methods of disinfection, and chemistry of chlorination. Fluoridation and de-fluoridation - Principles and design.		
Unit V	**Biological treatment and Industrial case studies**	**8 hr**
Biological treatment processes, case studies on wastewater treatment in various chemical and allied industries like Pulp and paper mill wastes, Breweries and Distilleries waste, Sugar mill waste, Pharmaceutical waste, Refineries waste, Fertilizers waste etc.		
LEARNING RESOURCES		
TEXT BOOKS:		
1	Eckenfelder W.W., "Industrial Water Pollution Control", 2nd Ed., McGraw Hill, 1999.	
2	Metcalf & Eddy, George Tchobanoglous, H. David Stensel, and Franklin L. Burton, "Wastewater Engineering: Treatment and Resource Recovery" Tata McGraw-Hill, 2017.	
REFERENCE BOOKS:		
1	Arceivala S.J. and Asolekar S.R., "Wastewater Treatment for Pollution Control and Reuse", 3rd Ed., Tata McGraw Hill, 2007.	
2	S. Vigneswaran and C. Visvanathan, "Water Treatment Processes: Simple Options", CRC Press, 1995.	

Bloom's level and Units catchment articulation matrix

CO	Blooms Level	UNIT I	UNIT II	UNIT III	UNIT IV	UNIT-V
CO1	BL4	X				
CO2	BL3		X			
CO3	BL6			X		
CO4	BL6				X	
CO5	BL6					X
CO6	BL6	X	X	X	X	X

R24MCHET028 (DSC-E4)	ADVANCED REACTION ENGINEERING (SELF STUDY / MOOCS COURSE)					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Chemical Reaction Engineering	**3**	**0**	**0**	**3**

Course Objectives:

Advanced reaction engineering applies the basic concepts of reaction rate, stoichiometry and equilibrium to the design and analysis of chemical and biological reacting systems. The course is designed for graduate students with interests in the design and optimization of process reaction vessels in the chemicals/petrochemicals, biological/food as well as materials/minerals processing industries.

Course Outcomes

By the end of this course, student will be able to

1	Analyze and predict the performance of various types of reactors. **(BL-4)**
2	Analyze and predict the performance of various multi-phase reactors. **(BL-4)**
3	Analyze the different models for non-ideal flow. **(BL-4)**
4	Explain the concepts of Catalysis and synthesizing a rate law- mechanism and design of solid catalyzed reactors for heterogeneous reactions. **(BL-5)**
5	Determine the effect of catalyst deactivation for design of real solid catalysed reactions. **(BL-5)**
6	Design of reactors for heterogeneous catalytic reactions and non-ideal flow. **(BL-6)**

SYLLABUS

Unit I	**Introduction to types of reactors**	**8 hr**

Introduction of various reactors (BR, CSTR, PFR)
Pressure drop in reactor design (PBR)
Catalyst deactivation: types of deactivations, deactivation rate laws Temperature–time trajectories, Moving bed reactor (MBR), and straight-through transport reactor (STTR)

Unit II	**Multi-phase reactors**	**8 hr**

Multi-phase reactors (Slurry reactor, Trickle bed reactor, Bioreactors)
Bioreactors, Steady state non-isothermal reactor design: Energy Balance
Multiple steady states.

Unit III	**Models of non-ideal flow**	**8 hr**

Non-ideal flow: RTD: Step/pulse input, Segregation model, Tank in series (TIS) model, Dispersion model, the effect of dispersion on effluent concentration, Two-parameter model.

Unit IV	**Surface reaction mechanism and model studies**	**8 hr**

Surface reaction mechanism and model studies: Langmuir-Hinshelwood reaction kinetics, Eley-Rideal reaction kinetics, LHHW model and parameter estimation, Mars-Van Krevlen model, and parameter estimation, Diffusion, and reaction: Internal effectiveness factor, Falsified-kinetics, Weisz-Prater criteria, Mear's criteria, temperature effect.

Unit V	**Collection and analysis of rate law data**	**8 hr**

Collection and analysis of rate law data (ODE/Non-linear regression).
Heterogeneous catalysis data analysis for reactor design (Numerical method, polynomial fit, integrating method, Non-linear regression).

LEARNING RESOURCES

TEXT BOOKS:

1	Chemical Reaction Engineering by Octave Levenspiel 3rd ed. Wiley Eastern Ltd.
2	Elements of chemical reaction engineering by H.S. Fogler, 3rd ed. PHI, 1999.
3.	Kulkarni Sulabha K., "Nanotechnology Principles and Practices", 3rd Ed.,

	Capital Publishing Company, New Delhi, 2016.
4.	Banwell Colin N., and McCash Elaine M., "Fundamentals of Molecular Spectroscopy", 5th Ed., McGraw Hill Education (India) Pvt. Ltd, New Delhi, 2013
5.	Published articles from Journals on Catalysis, Reaction Engineering, Kinetics, and Material characterizations

Bloom's level and-Units catchment articulation matrix

CO	Blooms L	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
CO 1	BL 4	X				
CO 2	BL 4		X			
CO 3	BL 4			X		
CO 4	BL 5				X	
CO 5	BL 5					X
CO 6	BL 6	X	X	X	X	X

R24MCHET025 (DSC-E5)	RENEWABLE ENERGY ENGINEERING: SOLAR, WIND AND BIOMASS ENERGY SYSTEMS (SELF STUDY / MOOCS COURSE)					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	None	**3**	**0**	**0**	**3**

Course Objectives:

1	Understand the fundamental principles of solar energy, including thermal applications, solar radiation, and energy storage systems.
2	Learn about biomass energy conversion routes, including biochemical and thermochemical methods.
3	Analyze the characteristics and properties of biomass and its structural components.
4	Comprehend the principles of biogas production, gasification, and thermochemical conversion of biomass.
5	Understand the basics of wind energy, including turbine types, characteristics, and power generation.
6	Apply mathematical principles to solve problems related to solar, biomass, and wind energy systems.
7	Evaluate the technical and economic feasibility of renewable energy systems for various applications.

Course Outcomes

After completing this course, student will be able to

1	Design and optimize solar thermal systems, including non-concentrating and parabolic solar collectors. (**BL6**)
2	Calculate biomass energy potential and evaluate different conversion routes for various biomass feedstocks. (**BL3**)
3	Analyze the technical and economic feasibility of biogas production and gasification systems. (**BL4**)
4	Apply knowledge of thermochemical conversion processes to design and optimize biomass-to-energy systems. (**BL3**)
5	Evaluate the performance of wind turbines and calculate power generation from wind energy systems. (**BL5**)
6	Integrate knowledge of solar, biomass, and wind energy systems to design and evaluate hybrid renewable energy systems for various applications. (**BL6**)

SYLLABUS

Unit I	**Solar Energy Systems**	**8 hr**

Solar Energy and Overview of Thermal Applications, Solar Radiation, Practice Problems, Non-Concentrating Solar Collectors Practice Problems, Parabolic Solar Collectors Practice Problems, Thermal Energy Storage Systems, Solar Energy Utilisation Methods

Unit II	**Biomass Energy Systems**	**8 hr**

Classification of Energy Resources, Broad Classification and Compositional Analysis, Characteristics and Properties of Biomass, Properties and Structural Components of Biomass, Biomass Residues and Energy Conversion Routes

Unit III	**Biomass Conversion Technologies**	**8 hr**

Utilisation of Biomass through Biochemical and Thermochemical Routes, Conversion Mechanism of Biomass to Biogas and Biogas and its Properties, Gasification of Biogas Plants, Practice Problems, Bioconversion of Substrates into Alcohol

Unit IV	**Thermochemical Conversion of Biomass**	**8 hr**

Thermochemical Conversion, Combustion Processes, Thermochemical Conversion of Biomass to Solid, Liquid, and Gaseous Fuels, Gasification Processes, Practice Problems

Unit V	**Wind Energy Systems**	**8 hr**
Turbine Terms, Types, and Theories, Characteristics and Power Generation from Wind Energy, Practice Problems		
LEARNING RESOURCES		
TEXT BOOKS:		
1	Khan B. H., Non-Conventional Energy Resources, 2 nd Edition, Tata McGraw-Hill Education Pvt. Ltd. 2009.	
REFERENCE BOOKS:		
1	Sukhatme S. P., Nayak J. K., Solar Energy: Principles of thermal Collection and Storage, 3 rd Ed., Tata McGraw-Hill Education Pvt. Ltd 2008.	
2	Twidell, J. and Tony W., Renewable Energy Resources, 2 nd Edition, Taylor & Francis 2006.	
3	Prabir Basu, Biomass Gasification, Pyrolysis and Torrefaction, Academic Press, Elsevier, 2013.	

Bloom's level and Units catchment articulation matrix

CO	**Blooms Level**	**UNIT I**	**UNIT II**	**UNIT III**	**UNIT IV**	**UNIT-V**
CO1	BL6	X				
CO2	BL3		X			
CO3	BL4			X		
CO4	BL3				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCHET029 (DSC-E5)	CHEMICAL PROCESS INTENSIFICATION (SELF STUDY / MOOCS COURSE)					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Mathematics, Mass transfer, heat transfer and chemical reaction	**3**	**0**	**0**	**3**

Course Objectives:

This course aims to help students in applying the various techniques for process intensification and developing various models for RDC, counter-current multiphase flow in rotating systems , compact heat exchangers etc.

Course Outcomes

By the end of this course, student will be able to

1	Apply the various techniques for process intensification (BL3)
2	Develop model for thin film on rotating disc reactor (BL3)
3	Model the counter-current multiphase flow in rotating systems (BL3)
4	Construct compact heat exchangers (BL4)
5	Recommend various micro reactors for heat, mass and mixing applications (BL5)
6	Elaborate the importance of Process Intensification (BL6)

SYLLABUS

Unit I	**Introduction to Process Intensification**	**8 hr**

Definition of Process Intensification (PI). Benefits of PI. Techniques for PI application: active and passive techniques.

Unit II	**Spinning disc reactor (SDR)**	**8 hr**

Spinning disc reactor (SDR): Operating principle and development of models for thin film flow on rotating disc. Examples of application of SDR to a range of processes.

Unit III	**Rotary packed bed (RPBs)**	**8 hr**

Rotary packed bed (RPBs): Operating principle of rotating contactors. Development of models for counter-current multiphase flow in rotating systems. Examples of the application of multiphase contactors. Oscillatory baffled reactor (OBR): Description & operating principles. History. Explanation of niche applications. Design. Case studies.

Unit IV	**Compact heat exchangers (CHE)**	**8 hr**

Compact heat exchangers (CHE): Definition of CHEs. Construction and main properties. Applications. Basic design procedures. Examples.

Unit V	**Micro-reactors**	**8 hr**

Micro-reactors: Description and operating principles. Heat transfer, mass transfer and mixing applications.

LEARNING RESOURCES

TEXT BOOKS:

1	David Reay, Colin Ramshaw and Adam Harvey, Process Intensification (Second Edition)
2	Engineering for Efficiency, Sustainability and Flexibility, Elsevier publishers

REFERENCE BOOKS:

1.	Jirí Jaromír Klemeš, Petar Sabev Varbanov, Process Integration and Intensification, De Gruyter publishers 1st edition , 2014.

Bloom's level and-Units catchment articulation matrix

CO	Blooms Level	UNIT I	UNIT II	UNIT III	UNIT IV	UNIT-V
CO1	BL3	X				
CO2	BL3		X			
CO3	BL3			X		
CO4	BL4				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCHEL007	INDUSTRIAL SAFETY TRAINING (SKILL COURSE)					
	Total Contact Hours	42 (P)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**0**	**0**	**3**	**2**

Course Objective: To equip students with the knowledge, skills, and mind-set necessary to create and maintain a safe and healthy work environment, thereby preventing workplace injuries, illnesses, and accidents, and fostering a culture of safety and well-being among employees.

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

1	Apply risk assessment techniques to identify workplace hazards and implement appropriate control measures. (BL-3)
2	Select and use personal protective equipment (PPE) effectively in various work environments. (BL-3)
3	Analyze emergency situations and develop comprehensive response plans, including conducting drills. (BL-4)
4	Assess ergonomic and physical risks in the workplace and implement injury prevention strategies. (BL-4)
5	Design and communicate safety programs that foster a strong safety culture through training and awareness.(BL-5)
6	Implement workplace wellness initiatives and high-risk protocols, including violence prevention and confined space safety. (BL-6)

SYLLABUS

1. Module 1: Introduction to Workplace Safety (2 hours)
    - Overview of workplace safety regulations and standards
    - Importance of safety culture
    - Key roles and responsibilities in safety management
2. Module 2: Hazard Identification Techniques (2 hours)
    - Methods for identifying workplace hazards
    - Hazard recognition training exercises
    - Practical examples and case studies
3. Module 3: Risk Assessment and Management (2 hours)
    - Understanding risk assessment methodologies
    - Prioritizing hazards based on severity and likelihood
    - Developing risk mitigation strategies
4. Module 4: Personal Protective Equipment (PPE) (2 hours)
    - Selection, proper use, and maintenance of PPE
    - Hands-on demonstration of different types of PPE
    - PPE fit testing and evaluation
5. Module 5: Hazard Control Measures (2 hours)
    - Implementing engineering controls, administrative controls, and PPE
    - Case studies on effective hazard control strategies
    - Continuous monitoring and improvement of controls
6. Module 6: Emergency Preparedness Planning (2 hours)
    - Developing comprehensive emergency response plans
    - Conducting hazard-specific emergency drills
    - Evaluating and improving emergency preparedness measures
7. Module 7: Chemical Safety and Hazardous Materials Management (2 hours)
    - Safe handling, storage, and disposal of hazardous chemicals
    - Understanding Safety Data Sheets (SDS)
    - Spill response and containment procedures
8. Module 8: Fire Safety and Prevention (2 hours)
    - Identifying fire hazards in the workplace
    - Fire prevention strategies and practices
    - Fire extinguisher training and hands-on exercises
9. Module 9: Electrical Safety (2 hours)
    - Recognizing electrical hazards and risks

- Safe work practices around electrical equipment
- Lockout/tagout procedures and electrical safety controls

10. Module 10: Ergonomics and Injury Prevention (2 hours)
    - Identifying ergonomic risk factors in the workplace
    - Implementing ergonomic solutions and best practices
    - Strategies for preventing musculoskeletal injuries
11. Module 11: Safety Communication and Training (2 hours)
    - Effective safety communication strategies
    - Conducting safety meetings and toolbox talks
    - Developing engaging safety training programs and materials
12. Module 12: Building a Strong Safety Culture (2 hours)
    - Fostering employee involvement in safety initiatives
    - Recognizing and rewarding safety performance
    - Continuous improvement in safety practices and culture
13. Module 13: Workplace Violence Prevention (2 hours)
    - Understanding the risk factors for workplace violence
    - Implementing prevention strategies and security measures
    - Responding to incidents of workplace violence
14. Module 14: Confined Space Entry and Rescue (2 hours)
    - Identifying confined spaces and associated hazards
    - Developing confined space entry procedures and permits
    - Conducting confined space rescue drills and training
15. Module 15: Health and Wellness Promotion (2 hours)
    - Promoting employee health and wellness in the workplace
    - Strategies for managing stress and fatigue
    - Integrating health promotion into safety programs

LEARNING RESOURCES

TEXT BOOKS:

1	"Safety and Health for Engineers" by Roger L. Brauer**.**
2	"Introduction to Health and Safety at Work: The Handbook for the NEBOSH National General Certificate" by Phil Hughes and Ed Ferrett
3	"Industrial Hygiene Simplified: A Guide to Anticipation, Recognition, Evaluation, and Control of Workplace Hazards" by Frank R. Spellman and Nancy E. Whiting
4	"Safety Culture: An Innovative Leadership Approach" by James Roughton and James Mercurio.

R24MCHEL007	TRAINING IN PHARMACEUTICAL INDUSTRIES (SKILL COURSE)					
	Total Contact Hours	42 (P)	**L**	**T**	**P**	**C**
	Pre-requisite	Fluid mechanics, Unit Operations, Mass transfer, heat transfer and chemical reaction.	**0**	**0**	**3**	**2**

Course Objectives This lab enables the student to understand,	
1	This course aims to help students to train on quality management systems, regulatory guidance, industry common known activities, various unit operations and processes involved in Pharmaceutical industries.
Course Outcomes: Students will be able to,	
1	Build the quality management systems and quality documentation (BL6)
2	Equip with the industrial common known words and activities (BL3)
3	Select the pumps for various applications (BL3)
4	Design the reactors, heat exchangers and distillation columns. (BL6)
5	Plan usage of various types of filters for different applications (BL6)
6	Adapt the various unit operations and unit operations (BL6)
LIST OF EXPERIMENTS:	
1	Introduction to Quality Management System (QMS) (Objectives, QMS Elements)
2	Quality Organization structure and Importance (Quality Policy, Quality culture, Organization structure and Responsibilities, Quality Competency – Review, training and auditing skills)
3	Quality Documentation and its importance (Documentation structure and Good Documentation Practices, Data Integrity Compliance)
4	Regulatory guidance & Compliance, Pharmacopoeia monographs and compliance
5	Industrial common known words & activities (solvents ,workup, distillation, reactors, membrane separations)
6	Industrial common known word & activities (Catalyst & Catalytic reactions, Hydrogenator, drying, milling and adsorption)
7	Selection of pipe, designing & sizing, Selection of the pump , motor, PUMP NPSH calculation
8	Selection of vacuum pump and capacity design, Selection of impellers, Agitator design calculation like- Torque per unit volume, Power per unit volume, bending moment etc.
9	Reactor design standards, Reactor heat transfer area, condenser area calculation.
10	Selection of equipment, impeller, Volume mapping& capacity calculation, Selection of flow meters
11	Cooling tower calculation, Portable water & purified water capacity mapping.
12	Distillation & Boil up rate calculation
13	Filtration equipment sizing and filtration characteristics and flux calculation
14	P&ID and GA Drawings and MOCs.
15	Return on Investments and Costing
LEARNING RESOURCES	
TEXT BOOKS:	
1	Warren, L., McCabe, Julian C. Smith , Peter Harriot, *Unit operations of Chemical Engineering*,7th Edition, McGraw Hill, 2008.
REFERENCE BOOKS:	
1	J.H.Coulson and Richardson, *Chemical Engineering, vol.-II*, 5th edition,

	Elsevier India, 2006.
2	C. M. Narayana and B.C.Bhattacharyya, *Mechanical Operations for Chemical Engineers*, Khanna Publishers, 1992.
3	Perry Rober H, *Chemical Engineers Hand Book*, 8th edition, McGraw Hill, 2007.

R24MCHEL007	ASPEN PLUS (SKILL COURSE)					
	Total Contact Hours	42 (P)	**L**	**T**	**P**	**C**
	Pre-requisite		0	0	3	2

Course Objectives:
To introduce students to use of ASPEN Plus software package for simulation, design and optimization and also analysing flow sheets.

Course Outcomes: After successful completion of this lab, the students able to:

1	Carry out thermodynamic property estimations using Aspen (BL-3)
2	Simulate Mixer, splitter, pumps (BL-6)
3	Simulate heat exchangers, reactors and distillation columns (BL-6)
4	Apply sensitivity, design specification and case study tools in Aspen (BL-6)
5	Carryout material and energy balance calculations using Aspen Plus tool (BL-6)
6	Simulate chemical process plant and effect of process variables on the plant operation using Aspen Plus (BL-6)

SYLLABUS

Solve the following steady state simulation exercises using Aspen:
1. Physical property estimations.
2. Simulation of individual units like, mixers, splitters, heat exchangers, flash columns
and reactors
3. Simulation of heat exchangers
4. Simulation of distillation columns.
5. Mass and Energy balances using ASPEN PLUS
6. Handling user specifications on output streams – Sensitivity and design Spec tools.
7. Simulation of a Chemical process flow sheet.

LEARNING RESOURCES

TEXT BOOKS:

1	Lab manuals / Exercise sheets
2	A.K.Jana, Chemical Process Modelling and Computer Simulation, Prentice Hall India, 3rd Edition, 2018.
3	Kamal I.M. Al-Malah, Aspen Plus: Chemical Engineering Applications, 2016, John Wiley & Sons Inc., USA.

VIII Semester

R24MCSCT007	COMPUTER NETWORKS					
	Total Contact Hours	42(L)	**L**	**T**	**P**	**C**
	Pre-requisites	DLD,CAO	**3**	**0**	**0**	**3**

Course Objective

Students will gain an ability to identify and design network architecture and apply the essence of various protocols.

Course Outcomes

1	Students will be able to analyse and **apply** key concepts of data communication, including network topologies, layering, and protocols; the OSI and TCP/IP reference models in order to design and evaluate efficient communication systems.
2	Students will be able to **describe**, **demonstrate**, and **analyse** various data link layer techniques and apply this knowledge to design and evaluate reliable data communication systems
3	Students will be able to **identify**, **explain**, and **apply** random access methods and assess their impact on the performance and evolution of network communication systems.
4	Students will be able to **describe**, **compare**, and **apply** the roles of connecting devices (switches, hubs, routers, bridges, gateways), **analyze** and **evaluate** various routing algorithms and **assess** the effectiveness of flooding in network communication.
5	Students will be able to **compare**, and **apply** the TCP and UDP datagram formats, congestion control techniques and flow control methods and their roles in Internet communication.
6	Students will be able to design and evaluate efficient, reliable and effective network communication systems.

SYLLABUS

Unit I	**OVERVIEW OF DATACOMMUNICATION AND NETWORKING**	**8 hr**

Introduction to Data Communication**,** Network Topologies; Layering and Protocols, Reference-Model: OSI Reference Model; TCP/IP Reference Model, Addressing; Physical Layer-Different types of Transmission Media-Guided; Different types of Transmission Media-Unguided; Multiplexing-TDM, FDM, WDM; Line Encoding (NRZ, NRZI, Manchester, AMI, 4B/5B); Switching and Taxonomy: Circuit Switched, Packet Switched.

Unit II	**DATALINK LAYER : ERROR CONTROL & FLOW CONTROL**	**8 hr**

Error Detection: CRC, Checksum; Error Correction: Hamming Distance, Linear Block Codes; Framing: Bit and Byte Stuffing ; Flow Control: Noiseless-Simplest, Stop and Wait; Noisy: Stop and wait ARQ; Go Back N, Selective repeat; PPP, HDLC; Random Access: Aloha: Pure and Slotted;

Unit III	**DATALINK LAYER**	**8 hr**

Random Access: CSMA, CSMA/CD; Random Access: CSMA/CA; Controlled Access-Reservation, Polling and Token passing; Channelization-FDMA,TDMA and CDMA; Standard Ethernet-MAC; Standard Ethernet-Physical Layer; Changes in the Standard- Fast Ethernet; Gigabit Ethernet,10 Gigabit Ethernet.

Unit IV	**NETWORK LAYER**	**8 hr**

ConnectingDevices-Switches,Hubs,Routers,Bridges,Gateways;IPv4addressing-Classful,Classless; IPv4 Datagram Format; IPv6 Datagram Format; Address Mapping: ARP; RARP,BOOTP, DHCP; Routing: Routing table, Optimization, Distance Vector Routing ; Link State Routing, Path Vector Routing;

Unit V	TRANSPORT LAYER AND APPLICATION LAYER	8 hr
TRANSPORT LAYER: TCP Datagram Format; UDP Datagram Format; Congestion Control: Data Traffic, Open Loop, Closed Loop; Quality of Service: Flow characteristics, Scheduling ; Flow Control: Leaky Bucket and Token Bucket; **REMOTE LOGIN & APPLICATION LAYER:** Telnet, Electronic Mail; DNS, Distribution of Name Space, DNS in the Internet; WWW and HTTP.		

LEARNING RESOURCES	
TEXTBOOKS:	
1	Data Communications and Networking, Behrouz Forouzan ,4th Edition,McGrawHill.
REFERENCE BOOKS:	
1	Computer Networks –Andrew S Tanenbaum,4th Edition, Pearson Education/PHI.
2	Computer Networking: *A Top Down Approach-James F Kurose and Keith W Ross,* 6th Edition, Pearson Education.
ADDITIONAL REFERENCE MATERIAL	
1	https://www.geeksforgeeks.org/computer-network-tutorials
2	https://www.javatpoint.com/computer-network-tutorial
3	https://www.tutorialspoint.com/data_communication_computer_network
ONLINE COURSES	
1	https://onlinecourses.nptel.ac.in/noc22_cs19
2	https://www.coursera.org/learn/illinois-tech-computer-networking

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL3	X				
CO2	BL4		X			
CO3	BL3			X		
CO4	BL5				X	
CO5	BL4					X
CO6	BL6	X	X	X	X	X

R24MCSCT008	ARTIFICIAL INTELLIGENCE: PRINCIPLES AND TECHNIQUES					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	Data Structures	**3**	**0**	**0**	**3**

Course Objective

This course aims to help students conversant with the theoretical concepts and algorithm approaches that can be applied to the design of AI applications and students will gain insights into foundational principles, algorithms, and theoretical frameworks underlying Machine Learning.

Course Outcomes

After completing this course, the students will be able to

1	Apply AI Search Algorithms and Backtracking Techniques to Solve Constraint Satisfaction Problems. (**BL3**)
2	Analyze and Compare the Applications and Limitations of Propositional Logic and First-Order Logic in Knowledge Representation and Reasoning. (**BL4**)
3	Apply Machine Learning Techniques and Neural Network Models to Solve Real-World Problems Across Various Domains. (**BL3**)
4	Analyze and Compare the Effectiveness of the Find-S and Candidate Elimination Algorithms in Designing a Learning System, Focusing on Version Spaces and Their Applications. (**BL4**)
5	Evaluate the Effectiveness and Applicability of Decision Tree Learning and Single and Multi-Layer Perceptrons in Solving Classification Problems Across Various Domains. (**BL5**)
6	Design and Develop an Integrated Intelligent System that Utilizes AI Search Algorithms, Knowledge Representation, and Machine Learning Techniques, Including Decision Trees and Neural Networks, to Solve Complex Real-World Problems. (**BL6**)

SYLLABUS

Unit I	**INTRODUCTION TO ARTIFICIAL INTELLIGENCE**	**8 hrs**

Introduction to Artificial Intelligence (AI), machine learning, deep learning, Types of AI, Advantages and Applications of AI; Agents in Artificial Intelligence, Types of agents; State Space Search: Uninformed search: (Iterative Deepening, Bidirectional search); Informed search: Best First Search; A* Algorithm; Hill Climbing Algorithms in Artificial Intelligence (Simple and Steepest Ascent); Constraint satisfaction problems (Constraint propagation: Arc Consistency), Backtracking Algorithm for CSP's; Knowledge-Based Agent (KBA): Architecture and Various level of KBA.

Unit II	**KNOWLEDGE REPRESENTATION AND REASONING**	**8 hrs**

Knowledge representation (KR), Approaches to KR, Techniques of KR; Propositional Logic, Logical Connective and Equivalence; Rules of Inference; PEAS description of Wumpus world; First Order Logic in AI, Inference in First-Order Logic; Knowledge Engineering in First-order logic; Forward Chaining and backward chaining in AI; Reasoning in Artificial intelligence;

Unit III	**BASICS AND TYPES OF MACHINE LEARNING**	**8 hrs**

Conceptual introduction to Machine Learning and Neural Networks: Biological Neural Networks and Artificial Neural Networks; Supervised Learning: (Linear and Non-Linear regression); Logistic Regression; Classification: Decision Tree and Support Vector Machines; Unsupervised Learning (clustering approach); Association; Semi-Supervised Learning; Reinforcement Learning

Unit IV	MACHINE LEARNING TRAINING EXAMPLES	8 hrs
Well Posed Learning Problems, Designing A Learning System, Perspectives and Issues in Machine Learning; Introduction to Concept Learning: A Concept Learning as a Task; Concept Learning as Search; Find-S: Finding a Maximally Specific Hypothesis; Version Spaces Representation: The List-Then-Eliminate Algorithm, Compact Representation for Version Spaces; Candidate Elimination Algorithm and Example; Remarks on Version Spaces and Candidate-Elimination: Converge, Order of Training Examples, Usage of Partially Learned Concepts; Inductive Bias		
Unit V	**DECISION TREE LEARNING AND SINGLE AND MULTI-LAYER PERCEPTRON**	**8 hrs**
Introduction, Decision Tree Representation and Appropriate Problems for Decision Tree Learning;ID3 Algorithm: An Illustrative Example; Hypothesis Space Search and Inductive Bias in Decision Tree Learning; Neural Network Representation, Appropriate Problems for Neural Network Learning; Perceptrons - Representational Power of Perceptrons, The Perceptron Training Rule; Gradient Descent and The Delta Rule, Stochastic Approximation to Gradient Descent; Multilayer Networks and The Back Propagation Algorithm - A Differentiable Threshold Unit; The Back Propagation Algorithm		
LEARNING RESOURCES		
TEXTBOOKS:		
1	Tom M. Mitchell "Machine Learning", Indian Edition.	
2	Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach", Third Edition.	
3	Kevin Knight, Elaine Rich, B. Nair, "Artificial Intelligence", Tata McGraw-Hill Education, 3rd Edition, 2010.	
REFERENCE BOOKS:		
1	Christopher M. Bishop, "Pattern recognition and machine learning", Springer,2007.	
2	Ethem Alpaydin, "Introduction to Machine Learning", PHI, Third edition, 2015.	
ADDITIONAL REFERENCE MATERIAL		
1	https://www.javatpoint.com/artificial-intelligence-ai/	
2	https://www.geeksforgeeks.org/machine-learning/	

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL3	X				
CO2	BL4		X			
CO3	BL3			X		
CO4	BL4				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MCSCT009	OOAD AND DESIGN PATTERNS (SELF STUDY / MOOCS COURSE) (Common to all Branches)					
	Total Contact Hours	42(L)	**L**	**T**	**P**	**C**
	Prerequisite	Object Oriented Programming	**3**	**0**	**0**	**3**

Course Objectives

1. Understand the importance and basic concepts of object oriented modeling,
2. Specify, analyze and design the requirements for a system and model the state of the set of objects and their implementation specifications.
3. Identify, Analyze the subsystems, various components and collaborate them interchangeably.
4. Describe the design patterns that are common in software applications
5. Design a module structure to solve a problem, and evaluate alternatives

Course Outcomes

On the successful completion of this course, Students will be able to

1	Examine the Object Oriented Models required for Software development through use case driven approach (**BL4**)
2	Categorize and model the structural and behavioural concepts of the software system. (**BL4**)
3	Develop and explore the transformation of conceptual models into various scenarios and real time applications. (**BL4**)
4	Construct a design consisting of a collection of modules using creational and structural design patterns.(**BL5**)
5	Identify appropriate behavioral patterns to demonstrate the dynamic aspects of a given software model during execution.(**BL5**)
6	Design a Small-Scale Application with Unified Models and Integrated Design Patterns.(**BL6**)

SYLLABUS

Unit I	**INTRODUCTION TO UNIFIED MODELING LANGUAGE**	**8 hr**

Introduction to UML, Importance of Modeling; Principles of Modeling; Object oriented modeling; Conceptual model of UML: Basic building blocks; Conceptual model of UML: Rules; Conceptual model of UML: Common Mechanisms; Architecture; Software Development life cycle

Unit II	**STRUCTURAL MODELING**	**8 hr**

Basic Structural Modeling: Classes ; Relationships;Common Mechanisms; Diagrams; Advanced Structural Modeling: Advanced classes; Advanced Relationships; Interfaces, Types and Roles**;** Packages & Instances**;**

Unit III	**ARCHITECTURAL MODELING & UML 2.0**	**8 hr**

Usecase Diagrams**;** Interactions : Sequence & Collaboration Diagrams**;** Activity Diagrams**;** State Diagrams; Component Diagrams; Deployment Diagrams; Updations in UML 2.0: Interaction overview diagram and Timing diagrams; Unified Process Models in Software Engineering;

Unit IV	**DESIGN PATTERNS-1**	**8 hr**

Introduction to Design patterns; Creational Design Patterns : Factory Method & Abstract Factory; Builder; Prototype; Singleton; Case study on Creational Design Patterns ; Structural Patterns: Adapter ; Bridge;

Unit V	**DESIGN PATTERNS-2**	**8 hrs**

Composite; FlyWeight; Case study on Structural Patterns; Behavioral Patterns: Chain of Responsibility; Iterator; Memento ; Observer ; Case study on Behavioral Patterns

LEARNING RESOURCES	
TEXTBOOKS:	
1	Grady Booch, James Rumbaugh, Ivar Jacobson: The Unified Modeling Language User Guide, Pearson Education.
2	Design Patterns By Erich Gamma, Pearson Education.
3	Hans-Erik Eriksson, Magnus Penker, Brian Lyons, David Fado: UML 2 Toolkit, WILEY-Dreamtech India Pvt. Ltd.
REFERENCE BOOKS:	
1	https://www.ibm.com/developerworks/rational/library/769.html
2	https://www.visual-paradigm.com/tutorials/uml-class-diagram-in-diff-programming-languages.jsp
3	https://www.uml-diagrams.org/index-examples.html
4	https://www.tutorialspoint.com/design_pattern/
5	http://www.oodesign.com/
6	https://praveenthomasln.wordpress.com/2012/03/03/interfaces-types-and-roles-s8-cs/
7	https://www.uml-diagrams.org/uml-25-diagrams.html
8	https://www.tutorialspoint.com/uml/uml_2_overview.htm#:~:text=UML%202.0%20offers%20four%20interaction,of%20interactions%20as%20interaction%20occurrences.
ONLINE COURSES	
1	NPTEL :: Computer Science and Engineering - NOC:Object-Oriented Analysis and Design
2	https://onlinecourses.nptel.ac.in/noc22_cs99/preview

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL4	X				
CO2	BL4		X			
CO3	BL4			X		
CO4	BL5				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X