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 **16** credits fulfilling all the requisites of B.Tech program i.e., **176** 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 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**

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 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.

b) 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.

c) 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. Massive Open Online Courses (MOOCs):

In order to promote the spirit of blended learning, a student is eligible to pursue a maximum of 20% of the credits through MOOCs. A student shall register for the course (minimum of 8 weeks for a 2-credit course, 12 weeks for a 3-credit course and 16 weeks for a 4-credit course as in Honors) offered as self-study through MOOCs with the approval of Chairman, Board of Studies of the concerned Program. The Head of the Department shall appoint one mentor to monitor the students' progression. The student needs to earn a certificate by passing the exam. The student shall be awarded the credits assigned in the curriculum only by submission of the certificate. Examination fee, if any, will be borne by the student.
Students who have qualified in the proctored examinations conducted through MOOCs platform can apply for credit equivalence as specified and are exempted from appearing for the CA and EA examinations (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.

11. 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.

12. Summer Internships

There will be a summer break of 8 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. The Community Project shall be carried out during the summer break after Year 2 and the Mini Project shall be carried out during the summer break after Year 3. The Community Project shall be society oriented and shall be completed in collaboration with government organizations/NGOs & others. The other internship at the end of third year is Industry Internship and shall be completed in collaboration with Industries.

Evaluation of the Community Project and Mini Project shall be through the departmental committee. A student will be required to submit a report to the concerned department and appear for an oral presentation before the departmental committee comprising of Head of the Department, supervisor of the project and a senior faculty member of the department.

A certificate of successful completion of internship from industry/NGO may be included in the report. The report and the oral presentation shall be evaluated for 50 marks as a Summative Assessment. There shall be no Continuous Assessment marks for these projects. A student shall secure minimum 40% of marks for successful completion. In case, if a student fails, he/she shall reappear as and when semester supplementary examinations are conducted by the Institution.

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 organisations (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. 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 16 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 16 weeks for a 4-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.

15. 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 VI 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. Honors is to be completed simultaneously with a Major degree program.

16. 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: The following academic requirements must be satisfied in addition to the attendance requirements.

i. A student shall be promoted from first year to second year if he/she fulfills the minimum attendance requirement as per university norms.
ii. A student will be promoted from II to III year if he/she fulfills the academic requirement of securing 40% of the credits (any decimal fraction should be rounded off to lower digit) in the subjects that have been studied up to either III semester or IV semester from the following examinations irrespective of whether the candidate takes the examination or not.
iii. A student shall be promoted from III year to IV year if he/she fulfills the academic requirements of securing 40% of the credits (any decimal fraction should be rounded off to lower digit) in the subjects that have been studied up to either V semester or VI semester from the following examinations irrespective of whether the candidate takes the examination or not.

iv. And in case, a student is detained for want of credits for a particular academic year by ii) & iii) above, the student may make up the credits through supplementary examinations and only after securing the required credits he/she shall be permitted to join in the III year (V sem) or IV year (VII sem) respectively as the case may be.

v. When a student is detained due to lack of credits/shortage of attendance he/she may be re-admitted when the semester is offered after fulfillment of academic regulations. In such case, he/she shall be in the academic regulations into which he/she is readmitted.

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 ith subject and G_i is the grade point scored by the student in the ith 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 "Si" 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 16 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 III year to IV year if he/she fulfills the academic requirements of securing 40% of the credits (any decimal fraction should be rounded off to lower digit) in the subjects that have been studied up to either V semester or VI semester from the following examinations irrespective of whether the candidate takes the examination or not.

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	EOEC-T1	T1	3	0	0	3
6	EOEC-T2	T2	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	EOEC-L1	L1	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	EOEC-T3	T3	3	0	0	3
6	EOEC-T4	T4	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	EOEC-L2	L2	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	EOEC-E1	E1	3	0	0	3
7	R24MCHEL005	Mass Transfer Lab	0	0	3	2
8	EOEC-L3	L3	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	EOEC-T5	T5	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	EOEC-L4	L4	0	0	3	2
9	R24MTPCT001	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	3	0	0	3
3	R24MCHETXXX	DSC E5	3	0	0	3
4	R24MCHEP002	Mini Project	0	0	2	2
5	R24MCHET018	Industrial Safety Training	0	0	3	2
	R24MCHET019	Training in Pharmaceutical industries	0	0	3	2
	R24MCHET020	ASPEN PLUS	0	0	3	2
6	R24MCHETXXX	HON-1	3	0	2	4
7	R24MCHETXXX	HON-2	3	0	2	4
Total						**13/21**

VIII Semester

S. No	Course Code	Course Title	L	T	P	Credits
1	EOEC-T6	T6 (Self-Study/MOOCS)	3	0	0	3
2	R24MCHEP003	Major-Dissertation/Academic Project-Major	0	0	5	8
3	R24MCHETXXX	HON-3	3	0	2	4
4	R24MCHETXXX	HON-4	3	0	2	4
Total Credits						**11/19**

Professional Electives and Honor Courses offered by the Department of Chemical Engineering

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
HON-1	R24MCHET026	Computer Aided Process Equipment Design	VII
HON-2	R24MCHET027	Computational Methods in Chemical Engineering	VII
HON-3	R24MCHET028	Process Integration	VIII
HON-4	R24MCHET029	Optimization of Chemical Processes	VIII

Specialization-2: Bioprocessing Technologies

Course Code	Type of Course	Course Code	Semester
DSC-E1	R24MCHET030	Fluidization Engineering	V
DSC-E2	R24MCHET022	Biochemical Engineering	VI
DSC-E3	R24MCHET031	Chemical Process Utilities	VI
DSC-E4	R24MCHET032	Advanced Reaction Engineering	VII
DSC-E5	R24MCHET033	Chemical Process Intensification	VII
HON-1	R24MCHET034	Industrial Biotechnology	VII
HON-2	R24MCHET035	Biomass Conversion And Biorefinery	VII
HON-3	R24MCHET036	Biological process design for wastewater treatment	VIII
HON-4	R24MCHET037	Bioreactor Design and Analysis	VIII

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	R24MMECT022	Business Analysis	VI				
EOEC-T6	R24MBMCT003	Strategic Management	VIII				

	Course Code	**Course Title**
EOEC-E1	R24MBMCT004	Digital Marketing
	R24MMECT017	Logistics and Supply Chain Management
	R24MBMCT005	Entrepreneurship

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	R24MSCST003	Data Structures	III	EOEC-L1	R24MSCSL003	Data Structures LAB	III
EOEC-T2	R24MSCST011	Operating Systems	III	EOEC-L2	R24MSCSL005	Python Programming Lab	IV
EOEC-T3	R24MSCST007	Python Programming	IV	EOEC-L3	R24MSCSL006	Database Management Systems Lab	V
EOEC-T4	R24MSCST010	Database Management Systems	IV	EOEC-L4	R24MCSCL001	OOP with JAVA Lab	VI
EOEC-T5	R24MCSCT001	OOP with JAVA	VI				
EOEC-T6	R24MSCST018	Software Engineering	VIII				

		Course Title
EOEC-E1	R24MSCST014	Computer Networks
	R24MCSCT002	Artificial Intelligence: Principles and Techniques
	R24MSCST008	Design and Analysis of Algorithms

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CURRICULUM

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

1	Develop comprehensive environmental management and conservation plans (**BL6**)
2	Create programs for energy, water conservation, and waste reduction. (**BL6**)
3	Formulate proposals for combating climate change (**BL6**)
4	Develop models to study climate dynamics and impacts (**BL6**)
5	Develop strategies to mitigate climate change impacts (**BL6**)

SYLLABUS

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

Biodiversity and ecosystem functionality; Natural resources; Environmental pollution; Environmental episodes; Environmental legislation.

Unit II	**LIFE STYLE FOR ENVIRONMENT**	**5 hr**

Sustainability Challenges; Save Energy; Save Water; Reduce waste; Healthy Lifestyles.

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

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

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

Greenhouse gas effect; Paleoclimate; Energy Balance; Water Cycle; Atmospheric motion.

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

Ocean changes; Cryosphere dynamics; Volcanoes; Biosphere and climate regulation; Mitigation strategies.

LEARNING RESOURCES

TEXTBOOKS:

1	E. Bharucha, *Textbook of Environmental Studies for Undergraduate Courses*, 2nd ed. Hyderabad, India: Universities Press, 2012.
2	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.

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.

ADDITIONAL REFERENCE MATERIAL

1	https://missionlife-moefcc.nic.in/Download-Creatives-Save-Energy.php?id=MTE=

ONLINE COURSES

1	https://enterprise.edx.org/APSCHE/program/df4909e1-a837-4c49-b575-a909c3990bf8/progress

Bloom's level - Units catchment articulation matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL6	X				
CO2	BL6		X			
CO3	BL6			X		
CO4	BL6				X	
CO5	BL6					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 the skill to Communicate effectively in a group (**BL 3)**

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 & 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	Identify and understand the current ways of living and develop a plan of action that promotes overall well-being. (**BL 3**)
2	Understand the importance of nutrition, a balanced diet and scheduled sleeping hours for maintaining a healthy lifestyle **(BL2)**
3	Understanding the use of yoga as a holistic tool in improving physical and mental health **(BL3)**
4	Interpret various stress management techniques for better physical and mental health **(BL3)**
5	Understand and identify the importance of Emotional intelligence in the aspects of stress relief, general health and social wellness **(BL2)**

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	…..	**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	Identify 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	Discuss the impact of trust and respect as foundational values in human relationships to achieve comprehensive human goals. (**BL 3)**
3	Understand the relevance of ethical theories and their applications in societal living. (**BL3**)
4	Understand the concept of ethics in engineering practice **(BL 3)**
5	Discuss 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

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, JohnWiley and 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).

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 in variety of processes in chemical, petrochemical, power and pharmaceutical industries. Understanding the fundamentals governing heat transfer is the key to design equipment involving heat exchange. This course introduce to students the fundamental aspects and quantitation of different modes of heat transport. The course aims students to use these fundamentals in typical engineering applications (Heat exchangers, Evaporators, boiling and condensation) evolving into the design of relevant industrial units.

Course Outcomes

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

1	Determine rate of heat transfer by conduction for one dimensional steady and transient heat flow through various geometries (BL-5)
2	Evaluate rate of heat-transfer by convection without phase change for various flows in internal and external configurations (BL-5)
3	Estimate single-component laminar film condensation heat transfer coefficient using Nusselt theory and compare the different regimes of pool boiling, discussing their characteristics and practical implications (BL-5)
4	Determine radiative heat transfer between black as well non-black surfaces (BL-5)
5	Evaluate the relative effectiveness of the LMTD and NTU methods in heat exchanger design (BL-5)
6	Appraise the construction details of various types of heat exchanging equipment and assess the performance of evaporators (BL-5)
7	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; variable thermal conductivity, Electrical analogy, 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); 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; LMTD correction factor in multi pass heat exchangers; choice of tube-side fluid, factors affecting heat exchangers performance.

Evaporators: Types of 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

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	BL5					X
CO7	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 in reversible reactions at given pressure and temperature following rigorous thermodynamic method and Van't Hoff method and interpret the standard Gibb's energy change and the equilibrium constant (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, working equations for different thermodynamic process, Virial Equation of State and its applications, Cubic equation of state:Vander walls EOS, RK EOS. Theorem of corresponding states, Generalized correlation for gases and liquids.

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 balance for open systems**,** Entropy changes for an ideal gas, Third law of thermodynamics.

Property relations for homogeneous phases, Maxwell relations**,** Enthalpy and Entropy as a function of T&P, 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**,** Generalized property correlations for gases**,** Thermodynamic diagrams.

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, The liquid phase properties from VLE data, Activity Coefficient, Excess Gibbs energy, Models for the excess Gibbs energy (Margules, Vanlaar, 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 concurrent processes, Steady state countercurrent processes, Stages, Cascades: Cross flow cascades, Countercurrent 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

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 total thermal resistance and thermal conductivity 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

EXTENDED OPEN ELECTIVE CLUSTER IN COMPUTER SCIENCE & ENGINEERING

R24MSCST003	DATA STRUCTURES					
	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	**TREES- 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

R24MSCST011	OPERATING SYSTEMS					
	Total Contact Hours	42 (L)	**L**	**T**	**P**	**C**
	Pre-requisite	-	**3**	**0**	**0**	**3**

Course Objective

Students will gain a comprehensive understanding of operating systems, covering topics such as system architecture, functionalities, structures, processes, file systems, storage management, and advanced concepts like inter-process communication, multithreading, disk scheduling, and RAID, enabling them to grasp the fundamental principles and practical aspects of managing computer systems effectively.

Course Outcomes

1	Students will be able to analyze the diverse structures and functionalities of operating systems.
2	Students will be able to design and make use of efficient process management strategies, employing system calls and various threading models to improve overall system responsiveness.
3	Students will be able to analyze the system's performance and effectiveness by comparing different strategies for deadlock resolution and memory management.
4	Students will be able to analyze the performance of virtual memory management techniques, including TLB, different page table structures, and page replacement algorithms. Examine system behavior to identify and understand the causes of thrashing and evaluate the effectiveness of various file management methods and directory structures.
5	Students will be able to analyze the effectiveness of various file system structures and management techniques. Evaluate the efficiency of free space management techniques and disk scheduling algorithms. Examine RAID levels to assess their impact on disk and swap space management.
6	Students will be able to adapt to build basic internals of operating system framework that integrates diverse OS concepts (process management strategies, efficient file system structures, and virtual memory management techniques), choose different approaches for inter-process communication to enhance system responsiveness and collaboration, and discuss various solutions for ensuring improved performance and reliability in storage systems.

SYLLABUS

Unit I	**INTRODUCTION TO OS AND CONCEPTS OF PROCESS AND THREADING**	**8 hr**

What Operating Systems do? Computer System architecture; OS Functionalities: Process Management, Memory Management, Storage Management, Protection and Security; Computing Environment: Traditional Computing, Client Server computing, Peer to Peer computing, web based computing, OS Services; System calls, Types of System calls; Operating System Structure: Simple, Layered, Microkernels, Modules; Introduction to Processes: Process, Process States, Process Control Block. Threads.; Operations On Processes: Process Creation, Process Termination (fork(),exec(),exit() system calls); Inter-Process communication: Shared memory, Message Passing;

Unit II	**PROCESS SCHEDULING AND SYNCHRONIZATION**	**8 hr**

Multithreading Models: Overview, Benefits, Many to One, One to One, Many to Many. Process Scheduling: Scheduling queues, Schedulers, Context switch;

Process Scheduling: Basic Concepts, CPU Scheduler, Preemptive Scheduling, Dispatcher, Scheduling Criteria; Scheduling Algorithms (Non-pre-emptive): FCFS, SJF; Scheduling Algorithms II(pre-emptive): Priority Scheduling, Round Robin; Multilevel Queue, Multilevel Queue feedback, Process Synchronization: Introduction to process synchronization. Producer Consumer Problem; Critical Section Problem, Peterson's Solution, Synchronization Hardware; Semaphore, Classical problems of synchronization: Bounded-buffer Problem, Readers Writers Problem; Dining Philosophers Problem, Monitors: Introduction, Usage;		
Unit III	**DEADLOCKS AND MEMORY MANAGEMENT**	**8 hr**
Deadlocks: Introduction, System Model, Deadlock Characterization; Methods for Handling Deadlocks Deadlock Prevention; Deadlock Avoidance (Part -1) Safe state, resource allocation graph algorithm; Deadlock Avoidance (Part -2) Banker's algorithm, Deadlock Detection single instance of each resource type; Deadlock Detection several instances of resource type and Recovery from Deadlocks; Memory Management, Address Binding, Logical vs Physical Address space; Swapping, Contiguous Memory; Paging (Basic Method);		
Unit IV	**PAGING TECHNIQUES, PAGE REPLACEMENT AND ACCESSING FILES TECHNIQUES**	**8 hr**
Hardware, TLB, Protection, Shared Pages,; Structure of the Page table, hierarchy, hashed,; Inverted page table, Segmentation; Virtual memory management, Demand paging; Page Replacement Algorithms: FIFO, Optimal page replacement; LRU Page replacement, Thrashing: causes of thrashing,; File concept, File Attributes, File operations, File types, File Structure; Access methods: Sequential Access, Direct Access, Directory Structure: Single level directory, Two level directory;		
Unit V	**FILE ORGANIZATION AND DISK SCHEDULING TECHNIQUES**	**8 hr**
Tree structured directories, Acyclic graph directories, File System Mounting File Sharing; File Protection: types of access, Access control, File allocation methods: Contiguous allocation,; File allocation methods: Linked allocation, Indexed allocation, Free space management: Bit vector, Linked list, Grouping,; Overview of Mass Storage Structure: Magnetic disks, Magnetic Tapes, Disk Structure; Disk Scheduling: FCFS,SSTF,SCAN,; CSCAN,LOOK,CLOOK; Disk Management, Swap Space Management; Raid Structure: Levels: 0-6, RAID levels 0+1;		
LEARNING RESOURCES		
TEXT BOOKS:		
1	"Operating System Concepts" by Abraham Silberschatz, Peter B. Galvin, and Greg Gagne.	
2	"Modern Operating Systems" by Andrew S. Tanenbaum.	
REFERENCE BOOKS:		
1	"Operating Systems: Internals and Design Principles" by William Stallings.	
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	**Coursera: "Operating Systems and System Programming"** ● Offered by Stanford University, this course covers fundamental	

	concepts and principles of operating systems. ● https://www.coursera.org/specializations/codio-introduction-operating-systems
2	**edX: "Introduction toss Operating Systems"** ● Provided by Georgia Institute of Technology, this course exploresthe design and implementation of modern operating systems. ● Link: https://www.udacity.com/course/introduction-to-operating-systems--ud923
3	**MIT OpenCourseWare: "Operating System Engineering"** ● A free online course from MIT, offering in-depth coverage ofoperating system design and implementation. **Link:** ● https://ocw.mit.edu/courses/6-828-operating-system-engineering- fall-2012/

Bloom's level - Units catchment articulation matrix

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

R24MSCST007	PYTHON PROGRAMMING					
	Total Contact Hours	42(L)	L	T	P	C
	Pre-requisite	Basic C Programming	3	0	0	3

Course Objective

To teach students the basic programming constructs of python language to develop desktop and Graphical user applications

Course Outcomes

1	Students will be able to apply the basic building blocks of python language to develop solutions.
2	Students will be able to distinguish between various conditional control statements and using functions simplify the problem using functions.
3	Students will be able to illustrate the non-scalar data types with suitable examples.
4	Students will be able to examine file operations and interpret data using pandas library.
5	Students will be able to construct the various widgets to implement Graphical User applications.
6	Students will be able to design and develop End-to-End applications using Python Programming constructs and GUI module (tkinter module).

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; NumPy – Functions on 1D arrays; Functions on 2D arrays; Math Module and Pandas Module (DataFrame Creation); User Defined modules creation and importing a user defined module;

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, examples;

Functions: Syntax and basics of function and usage; Passing Parameters, arguments in a function – Default, keyword, fixed and Variable - length arguments; local and global scope of variable; return statement, recursive function;

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; Map filter and reduce, deleting elements, Lists and Strings;

Tuples- Tuples are immutable, Variable - length argument tuples; Tuple as return values, Comparison of Lists and tuples; Dictionaries – Dictionary Creation, Looping and dictionaries; Dictionary as a collection of counters, Reverse Lookup;

Unit IV	FILES	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 ());

Importing data from CSV to DataFrame (Pandas); Inspecting data in DataFrame (head (), tail ()), Statistical summary (describe ()); Sorting and slicing records and filtering data; Create a DataFrame by passing Dict of Series (ColumnSelection, Addition, Deletion),Triggers;

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	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
ADDITIONAL REFERENCE MATERIAL	
ONLINE COURSES	
1	https://www.tutorialspoint.com/python/
2	https://docs.python.org/3/tutorial/
3	https://www.python-course.eu/python3_course.php

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	BL3				X	
CO5	BL5					X
CO6	BL6	X	X	X	X	X

R24MSCST010	DATABASE MANAGEMENT SYSTEMS					
	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

After completing this course, the students will be able to

1	Students will be able to apply the knowledge of ER Modeling design the database from the client requirements
2	Students Will be able to analyze the SQL query pattern and classify the query patterns based on the client requirements
3	Students will be able to Examine the database design and classify the different levels of dependencies using Normal Forms
4	Students will be able to compare and choose different indexing mechanisms to store data in secondary storage devices as per the requirements.
5	Students will be able to justify the importance of concurrency and recovery Management
6	Students will be able to design the complete database without redundant storage and able to solve the user queries

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**

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; 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	BL6					X
CO5	BL6					X
CO6	BL6	X	X	X	X	

R24MSCSL003	DATA STRUCTURES LAB					
	Total Contact Hours	45 (P)	**L**	**T**	**P**	**C**
	Pre-requisite	Basic Programming	**0**	**0**	**3**	**2**

Course Objective

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.

Course Outcomes

1	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.
2	Student will be able to implement, and apply linked lists for dynamic data storage, demonstrating understanding of memory allocation.
3	Student will be able to develop programs using stacks to handle recursive algorithms, manage program states, and solve related problems.
4	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.
5	Student will be able to devise novel solutions to small scale programming challenges involving data structures such as stacks, queues, trees, graphs.
6	Student will be able to recognize scenarios where hashing is advantageous, and design hash-based solutions for specific problems.

LIST OF EXPERIMENTS

1	**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)
2	**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.
3	**WEEK 3(LINKED LIST)** • Write a C Program to create a Single linked list and perform basic operations on Single Linked List.
4	**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.
5	**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.
6	**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.
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

<table>
<tr><td rowspan="3">R24MSCSL005</td><td colspan="6">PYTHON PROGRAMMING LAB</td></tr>
<tr><td>Total Contact Hours</td><td>42(L)</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 learn about basic programming constructs which are used to develop bothdesktop and web applications using python programming.</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 the various 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:
1. Write a python script to illustrate data types (int, char, float, string).
2. Write a python program to perform the following expressions usingoperator 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 mathmodule</td></tr>
<tr><td>2</td><td colspan="6">Week – 2:
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 program whether the given number is prime or not.
6. Write a python program to find the area of a triangle
7. Write a program to perform string concatenation</td></tr>
<tr><td>3</td><td colspan="6">Week – 3:
Illustrate Numpy operations.
1 Program to read, process and display data
2 Program to access data using various numpy functions on 1D arrays.
3 Illustrate other built-In functions of Numpy on 2D arrays.</td></tr>
<tr><td>4</td><td colspan="6">Week – 4:
1. Write a python program to display minimum and maximum among three numbers.
2. Write a python program to count the number of even and odd numbers from a series of numbers.
3. Write a python program to display Fibonacci series using iteration and recursion.
4. Write a python program to find the factorial of a number with and without recursion.</td></tr>
<tr><td>5</td><td colspan="6">Week – 5:
1. Write a python program to find sum of elements in a list recursively
2. Write a python program to determine number of times a given letter occurs in a string using recursion
3. Write a python program to find if a number is prime or not a prime using recursion
4. Write a python program to find the product of two numbers usingrecursion.</td></tr>
</table>

	5. Write a python program find the power of a number using recursion.
6	**Week – 6:** 1. Write a python program to find the largest and smallest number in a list. 2. Write a python program to merge two lists and sort it. 3. Write a python program to remove the duplicate items from a list. 4. Write a python program to check if a string is a palindrome or not. 5. Write a program to replace all the occurrences of a with x in a string.
7	**Week – 7:** 1. Write a program to create a list of tuples with the first element as thenumber and the second element as the square of the number. 2. Write a python program that takes the list of tuples and sorts the list oftuples in increasing order by the last element in each tuple. 3. Write a python program to add a key value pair to a dictionary andupdate the dictionary based on the key.
8	**Week – 8:** 1. Illustrate in operator and write a python program to count number of lowercase characters in a string. 2. Illustrate the following functions of list 1)len 2)extend 3)sort 4) append 5)insert 6)remove 3. Program to pass list as an argument to function illustrate with example 4. Illustrate the following methods of dictionary with examples 5. 1) keys() 2) values() 3)items() 4) pop() 5)delete() 6. Write a Program to do a reverse dictionary lookup in python.
9	**Week – 9:** 1. Write a program to generate 20 random numbers in the range of 1 to100 and write to a file 2. Program to Illustrate seek(), tell() and flush() methods with different arguments. 3. Program to Illustrate read, readline and readlines methods.
10	**Week – 10:** 1. Program to illustrate how to import data from CSV to DataFrame usingPandas. 2. Program to illustrate how to Inspect data in DataFrame using head(),tail () and describe() functions. 3. Program to perform sorting and slicing operations.
11	**Week – 11:** 1. Program to design an application to display –Hello World. 2. Program to design an application using Label, Entry and Button widgets. 3. Program to design an application using Tkinter Geometry methods pack(),grid(), place() methods. 4. Program to design an application using CheckButton and Radiobuttonwidgets.
12	**Week – 12:** 1. Program to design an application using Menu and Menubutton widgets. 2. Program to design an application using Listbox and Scrollbar widgets. 3. Program to design an application using Messagebox and File Dialogwidget
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	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.tutorialspoint.com/python/
2	https://docs.python.org/3/tutorial/
3	https://www.python-course.eu/python3_course.php
4	https://www.w3schools.com/python/pandas/default.asp
5	https://www.geeksforgeeks.org/python-programming-language/
6	https://www.programiz.com/python-programming

EXTENDED OPEN ELECTIVE CLUSTER IN BUSINESS MANAGEMENT

R24MBMCT001	FINANCIAL MANAGEMENT					
	Total Contact Hours	40(L)+Introduction(2)	**L**	**T**	**P**	**C**
	Pre-requisite	-	**3**	**0**	**0**	**3**

Course Objective

This course will help students understand the foundations of managerial economics and demand, investigate market structures, pricing policies, and business forms, basic financial accounting concepts, financial statements and ratio analysis, to understand the time value of Money.

Course Outcomes

After completing this course, the students will be able to

1	Infer demand analysis to optimize strategic decision- making and resource allocation (**BL4**)
2	Formulate competitive pricing strategies and analyze business environment (**BL6**)
3	Adapt fundamental accounting principles to maintain records and thereby financial transparency (**BL6**)
4	Prepare and analyze financial statements to effectively evaluate financial data of a firm. (**BL5**)
5	Evaluate different savings, investments, and loan options by estimating the interest rates and time value of money. (**BL5**)

SYLLABUS

Unit I	**MANAGERIAL ECONOMICS & DEMAND ANALYSIS**	**8 hr**

Definition and Nature of Managerial Economics; Scope of Managerial Economics; Demand Determinants; Law of Demand and its exceptions; Elasticity of Demand: Types; Demand Forecasting types; Factors governing demand forecasting; Methods of demand forecasting.

Unit II	**MARKET STRUCTURES & PRICING POLICIES**	**8 hr**

Market structures; Types of competition; Features of Perfect and Imperfect Competitions; Pricing Methods; Pricing Strategies; Forms of Business Organizations; Sources of capital; Cost concepts.

Unit III	**FUNDAMENTALS OF FINANCIAL ACCOUNTING**	**8 hr**

Introduction to accounting; Types of accounting; Classification of Accounts, Accounting Cycle; Double-Entry Book Keeping and GAAP; Role of technology in accounting; Evolution and Importance of Green accounting; Journal; Ledger.

Unit IV	**FINANCIAL STATEMENTS PREPARATION AND ANALYSIS**	**8 hr**

Preparation of Trial Balance; Trading Account ; Profit and Loss Account; Balance Sheet (Simple problems) ; Introduction to Ratio Analysis, Liquidity Ratios; Solvency Ratios ; Turnover Ratios; Profitability Ratios.

Unit V	**INTRODUCTION TO PERSONAL FINANCE AND TIME VALUE OF MONEY**	**8 hr**

Six step Financial Planning; Concept of Present Value and Future Value; Real and Nominal Interest rates ;Simple Interest Calculation; Compound Interest Calculation; Applications of TVM in Real Life; Inflation and its Impact on TVM; Introduction to Fintech-Digital Payment Gateways.

LEARNING RESOURCES

TEXTBOOKS:

1	Varshney, R. L., & Maheswari, K. L. (2003). *Managerial economics*. Sultan Chand.
2	Narayanaswamy, R. (2022). *Financial Accounting—A Managerial Perspective* (7th ed.). PHI Learning
3	Dean, J. (2010). *Managerial Economics* (7th ed.). PHI Learning

REFERENCE BOOKS:

1	Maheswari, S. N., & Maheswari, S. K. (2018). *Financial accounting*. Vikas Publications

2	Seth, M. L. (2020). *Microeconomics*. Lakshmi Narain Agarwal publications
ADDITIONAL REFERENCE MATERIAL	
1	https://web.mei.edu/IDtrack?pdfid=S38x726&FilesData=Managerial+Economics+Lecture+Notes+Mba.pdf
2	https://r13csevignanlara.files.wordpress.com/2015/09/managerial-economics-and-financial-analysis-aryasri.pdf
3	https://www.bput.ac.in/lecture-notes-download.php?file=lecture_note_302311150242400.pdf
ONLINE COURSES	
1	https://www.edx.org/learn/economics/stanford-university-principles-of-economics
2	https://www.coursera.org/learn/principles-of-economics-intro
3	https://www.udemy.com/course/basics-of-accounting-indian/

Bloom's level - Units catchment articulation matrix

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

R24MMECT013	LEADERSHIP AND TEAM MANAGEMENT					
	Total Contact Hours	40 (L) + 2 (Introduction) + 6 (Case Discussion)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**3**	**0**	**0**	**3**

Course Objective:

This course is aimed at helping students:

- To understand ***what leadership is*** and the ***various perspectives*** put forward by the scientific community
- To understand the ***intrinsic challenges*** faced by the individual in his/her development of leadership abilities
- To understand the ***extrinsic challenges*** faced by the individual in discharging his/her role as a leader

Course Outcomes:

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

1	Assess the current world leadership scenario and critique different approaches taken **(BL5)**
2	Evaluate leadership styles and determine applicability to various societal contexts **(BL5)**
3	Evaluate ability for self-awareness and perception, mental and emotional ability, courage and morality and followership **(BL5)**
4	Evaluate ability to motivate and empower others, communicate better, lead teams, handle diversity, influence others and provide direction **(BL5)**
5	Evaluate organisational ecosystem and develop a leadership style to meet current challenges **(BL6)**

SYLLABUS

Unit I	**INTRODUCTION**	**8 hr**

Need for leadership, Goal of an Organisation- Forces of Change- New Realities and Learning Organisations- Prime Task of Leadership- Management and Leadership- Great Man Theory and Leadership Evolution- Leader Fatal Flaws- Systemic Leadership

Unit II	**PERSPECTIVES ON LEADERSHIP**	**8 hr**

Trait Theory-Behaviour Approaches: Autocratic v/s Democratic, Ohio State Studies - University of Michigan Studies, Leadership Grid- Individualised Leadership-Contingency Approach: Hersey Blanchard Theory-Fiedler's Contingency Model-Path-Goal Theory- Vroom-Jago Model

Unit III	**PERSONAL SIDE OF LEADERSHIP**	**8 hr**

Personality and Leadership (Values/Attitudes, Social Perception, Cognitive Difference)-Mental Models, Developing Leader's Mind- Emotional Intelligence- Leading with Love Versus Leading With Fear- Moral Leadership- Leading with Courage-Art of Followership- Strategies for Managing Up

Unit IV	**LEADERSHIP AND RELATIONSHIP**	**8 hr**

Leadership and Motivation, Theories of Motivation- Empowering People to Meet Higher Needs-Leadership and Communication, Channels of Communication- Leading Teams-Handling Diversity- Inclusive Leadership-Influential Leadership-Hard and Soft Power, Increasing Power

Unit V	**LEADER AS A SOCIAL ARCHITECT**	**8 hr**

Vision and Strategic Leadership-Themes of Vision, Mission-Strategic Direction- Organisational Culture- Competing Values Approach-Value-Based Leadership-Leading Change: Appreciative Inquiry- Implementing Change

LEARNING RESOURCES

TEXT BOOKS:

1	Richard L. Daft, "*The Leadership Experience*", 6TH Edition, Cengage Learning, 2015.

2	Annabel Beerel, "*Leadership and Change Management*", Sage Publication, 2009.
REFERENCE BOOKS:	
1	Gary Yukl, "*Leadership in Organizations*", Eighth edition, Pearson, 2017.
ONLINE COURSES	
1	https://hbsp.harvard.edu
2	https://www.coursera.org/learn/leading-diverse-teams-and-organizations
3	https://www.coursera.org/learn/leadershipskills
4	https://www.coursera.org/specializations/inspired-leadership

Bloom's level - Units Catchment Articulation Matrix

CO	Blooms Level	Unit I	Unit II	Unit III	Unit IV	Unit V
CO1	BL5	**x**				
CO2	BL5	**x**	**x**			
CO3	BL5			**x**		
CO4	BL5				**x**	
CO5	BL6			**x**	**x**	**x**

R24MMECT020	PRODUCT LIFECYCLE MANAGEMENT					
	Total Contact Hours	40 (L) + 2 (Introduction) + 6 (Case Discussion)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**3**	**0**	**0**	**3**

Course Objective:

This course is aimed at helping students:

- To understand the philosophy and methodology of product design
- To understand the concept of lifecycle and its management
- To build an insight into the real world and the challenges related to product data management

Course Outcomes:

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

1	Verify the efficacy of a good engineering design **(BL 5)**
2	Create a suitable development process for an engineering product **(BL 6)**
3	Develop a PLM implementation strategy for a product company **(BL 6)**
4	Assess a physical product in terms of product data management requirements **(BL 5)**
5	Recommend suitable PLM process requirements for a product **(BL 5)**

SYLLABUS

Unit I	**ENGINEERING DESIGN**	**8 hr**

4 C's of Engineering Design; Importance of the Engineering Design Process and Types of Design; Modelling Design Thought; Design as a Problem-solving Methodology; Considerations of a Good Design; The Design Process; Codes/Standards and Review; Societal Considerations in Engineering Design.

Unit II	**PRODUCT DEVELOPMENT**	**8 hr**

The Product Development Process; Factors for Success, Static/Dynamic Products, Variations on the Generic Process; Product and Process Cycles; Organisation for Product Development; Markets and Marketing; Identifying Customer's Needs; Kano Model, Quality Function Deployment; Design Specification and Product Architecture.

Unit III	**PRODUCT LIFECYCLE MANAGEMENT**	**8 hr**

Challenges and Emergence of PLM, Definition of PLM; PLM Model, Characteristics of PLM; Environment Driving PLM; PLM Elements; Developing PLM Strategy; Implementing PLM Strategy; PLM Readiness Assessment; Capability Maturity Model.

Unit IV	**PRODUCT IN PLM**	**8 hr**

Collaborative Product Development: Part 1; Collaborative Product Development: Part 2; Product Structure and Specifications; Bill of Material; Product Range, Instance, Identifier; Product Data and Metadata, Product Data Models; Types of Product Data in PLM; Product Data Issues

Unit V	**PROCESS IN PLM**	**8 hr**

Overall Business Process Architecture, Managing BoM; Engineering Change Process; Workflow; Process Mapping and Modelling; Change Management; Variant and Version Management; Configuration Management; PLM Integration with Other Applications.

*****

LEARNING RESOURCES

TEXT BOOKS:

1	Dieter, George. E. and Schmidt, Linda. C., "Engineering Design", 4th Edition, McGraw-Hill, 2009
2	Grieves, Michael, "Product Lifecycle Management", McGraw-Hill, 2006
3	Antti Saaksvuori, Anselmi Immonen, "Product Lifecycle Management", 1st Edition,

	Springer-Verlag
4	Sark, John, "Product Lifecycle Management: 21st Century Paradigm for Product Realisation", 2nd Edition, Springer-Verlag, 2011
REFERENCE BOOKS:	
1	https://books.google.co.in/books?id=q9AdtdDeuPsC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
2	https://books.google.co.in/books?id=CiHbLm6twJMC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
ONLINE RESOURCES	
1	https://www.slideshare.net/anandsubramaniam/product-life-cycle-management
2	http://productlifecyclestages.com/
3	https://nxrev.com/2018/02/windchill-vs-enovia/
4	https://www.cimdata.com/en/education/plm-basics-e-learning-course
5	https://www.cimdata.com/en/education/plm-certificate-program

Bloom's level - Units Catchment Articulation Matrix

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

R24MBMCT002	QUALITY MANAGEMENT					
	Total Contact Hours	40 (L) + 2 (Introduction) + 6 (Case Discussion)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**3**	**0**	**0**	**3**

Course Objective:

This course is aimed at helping students:

- To understand the philosophy of quality management
- To understand Lean philosophy and its implementation tools/techniques
- To understand the Six Sigma methodology

Course Outcomes:

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

1	Assess an organisation from a quality management perspective **(BL 5)**
2	Assess how lean philosophy can be implemented in a traditional organisation **(BL 5)**
3	Evaluate a factory for JIT and TPM practices **(BL 5)**
4	Decide upon a Six Sigma project and carry out suitable measurements **(BL 5)**
5	Evaluate hypothesis and present control charts to ensure quality **(BL 5)**
6	Develop an action plan for quality management **(BL 6)**

SYLLABUS

Unit I	**INTRODUCTION TO QUALITY MANAGEMENT**	**8 hr**

Organising for Quality; Planning for Quality; Staffing and Motivating; Pioneers of Quality; Total Quality Management; Customer and Quality; The Juran Trilogy; Benchmarking.

Unit II	**THE LEAN PHILOSOPHY**	**8 hr**

1. The Emergence of Lean; House of Lean, Muda, Mura, Muri; 5S, Value Stream Mapping; Standardised Work; SMED, Jidoka, Poka-yoke; Kaizen; Hoshin Kanri; Lean Culture

Unit III	**JIT AND TPM**	**8 hr**

1. JIT Production System; Flow Production; Kanban; Visual Control, Heijunka; Total Productive Maintenance: Introduction; Overall Equipment Efficiency; Autonomous Maintenance; Fault Analysis

Unit IV	**SIX SIGMA METHODOLOGY: PART 1**	**8 hr**

Six Sigma Methodology; Define Phase: Project Identification, Voice of Customer; Define Phase: Project Management; Define Phase: Management and Planning Tools; Measure Phase: Data Collection; Measure Phase: Graphical Methods; Measure Phase: Measurement System Analysis; Measure Phase: Process and Performance Capability

Unit V	**SIX SIGMA METHODOLOGY: PART 2**	**8 hr**

Analyse Phase: Exploratory Data Analysis, Analyse Phase: Hypothesis Testing Basics, Analyse Phase: Tests for Means, Variances and Proportions, Analyse Phase: Paired Comparison Test, ANOVA, Chi-Square Test; Improve Phase: Design of Experiments; Improve Phase: Root Cause Analysis; Control Phase: Statistical Process Control; Control Phase: Control Charts.

*****

LEARNING RESOURCES

TEXT BOOKS:

1	Mouch, Peter. D., "Quality Management: Theory and Application", CRC Press, Taylor and Francis Group, 2010
2	Besterfield, Dale. H., Besterfield-Michna, Carol, Besterfield, Glen. H., Besterfield-Sacre, Mary., Urdhwareshe, Hemant., Urdhwareshe, Rashmi., "Total Quality Management", Revised Third Edition, Pearson, 2012

3	Dennis, Pascal., “Lean Production Simplified”, Third Edition, CRC Press, Taylor and Francis Group, 2015
4	Hirano, Hiroyuki., “JIT Implementation Manual: A Complete Guide to Just-in-Time Manufacturing”, Second Edition, CRC Press, Taylor and Francis Group, 2009
5	Borris, Steven., “Total Productive Maintenance”, McGraw-Hill, 2006
6	Munro, Roderick. A., Govindarajan Ramu and Zrymiak, Daniel. J., “The Certified Six Sigma Green Belt Handbook”, Second Edition, ASQ Quality Press, 2015

Bloom’s level - 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**

R24MMECL001	COMPUTER AIDED GEOMETRIC DESIGN AND ASSEMBLY LAB					
	Total Contact Hours	42 (P)	**L**	**T**	**P**	**C**
	Pre-requisite	Computer Aided Engineering Graphics	**0**	**0**	**3**	**2**

Course Objective

To equip students with the knowledge and skills to proficiently utilize computer-aided design (CAD) software, specifically focusing on geometric design and assembly, enabling them to create, modify, and analyze complex geometric models and assemblies for applications in various industries.

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

1	Prepare 2-D drawings of different components
2	Model 3-D geometries of components used for different engineering applications
3	Explain the importance of assembly drawings and prepare the assembly drawings.
4	Convert the assembly drawings into 2-D drawings by using different draughting tools

List of Exercises

1	Basic Sketching: Creating 2D sketches, applying constraints and dimensions.
2	Advanced Sketching: Complex sketch constraints, relations
3	Basic Modeling Techniques: Extrusions, revolve, Hole and basic solid modeling operations.
4	Boolean operations (Union, Subtract, Intersect), Creation of Datum coordinate system, axis and planes
5	Solid Modified Features: Editing and modifying features such as Move, Delete, Replace, Offset etc
6	Solid Modified Features: Edge Blend, Chamfer, shell, patterns, mirror.
7	Basic Assembly Constraints: Applying constraints (Touch, Align, Parallel and Perpendicular) for defining relationships.
8	Basic Assembly Constraints: Applying constraints (Bond, Distance, Concentric) for defining relationships.
9	Creating and managing sub-assemblies.
10	Creating detailed engineering drawings, annotations, and part lists.

Additional Exercises

1	Surface Modeling: Creating and editing surfaces
2	Sheet Metal Design: Creating sheet metal parts, Bending, flanging, and forming tools, Flattening and exporting sheet metal parts

LEARNING RESOURCES

TEXT BOOKS:

1	Sham Tickoo, *CATIA V5R14 for Designers*, Cadcim Technologies, 2005
2	Louis Gary Lamit, *Creo Parametric 2.0*, CL Engineering, 2013
3	NX Basic Design with Teamcenter Integration Student Guide October 2011 MT10053_TC_S — NX 8
4	Solid Works Users Manual

R24MBMCL001	FINANCIAL ACCOUNTING LAB					
	Total Contact Hours	42(P)	**L**	**T**	**P**	**C**
	Pre-requisite	Nil	**0**	**0**	**3**	**2**

Course Objective

The course on Personal Finance Fundamentals aims to equip students with the skills to analyze, interpret, and manage financial data using Excel, encompassing budgeting, financial statements, investment strategies, capital budgeting, and tax planning.

Course Outcomes

1	**Create** and **apply** financial goals and budgets using Excel, and **analyze** financial statements.
2	**Calculate** financial ratios and **evaluate** performance metrics, and **construct** and **interpret** financial charts.
3	**Describe** stocks and bonds, **compare** investment types, and **develop** and **assess** basic investment strategies.
4	**Calculate** NPV, IRR, and Payback Period using Excel, and **evaluate** and **select** projects based on financial analysis.
5	**Compute** income taxes using Excel, and **design** and **implement** financial planning and retirement strategies.

List of Experiments

1	**Week 1: Personal Finance Fundamentals** **Financial goal-setting and budgeting using Excel** Experiment 1: Creating a Personal Budget in Excel Experiment 2: Building and Analyzing a Balance Sheet
2	**Week 2: Personal Finance Fundamentals** **Understanding financial statements (balance sheet, income statement)** Experiment 1: Constructing and Analyzing an Income Statement Experiment 2: Creating a Cash Flow Statement
3	**Week 3: Financial Analysis using Excel** **Ratio analysis and financial performance metrics** Experiment 1: Calculating Liquidity Ratios Experiment 2: Analyzing Profitability Ratios
4	**Week 4: Financial Analysis using Excel** **Ratio analysis and financial performance metrics** Experiment 1: Assessing Solvency Ratios Experiment 2: Visualizing Financial Ratios
5	**Week 5: Financial Analysis using Excel** **Charting and graphing financial data using Excel** Experiment 1: Creating Bar Charts for Financial Ratios Experiment 2: Constructing Line Graphs for Trend Analysis
6	**Week 6: Financial Analysis using Excel** **Charting and graphing financial data using Excel** Experiment 1: Using Pie Charts to Illustrate Financial Composition Experiment 2: Building a Financial Dashboard

7	**Week 7: Investment Basics** **Understanding stocks and bonds** Experiment 1: Analyzing Stock Performance Experiment 2: Evaluating Bond Prices and Yields Experiment 3: Comparing Stocks and Bonds
8	**Week 8: Investment Basics** **Basic investment strategies and risk management** Experiment 1: Understanding Risk and Return Experiment 2: Diversification Strategies
9	**Week 9: Capital Budgeting Basics** **Understanding capital budgeting decisions using Excel (NPV, IRR, Payback Period)** Experiment 1: Calculating Net Present Value (NPV) Experiment 2: Determining Internal Rate of Return (IRR) Experiment 3: Analyzing Payback Period
10	**Week 10: Capital Budgeting Basics** **Project evaluation and selection using Excel formulas** Experiment 1: Evaluating Investment Projects Experiment 2: Decision Criteria and Project Selection
11	**Week 11: Taxation and Financial Planning** **Income tax calculations using Excel (personal and business)** **Basic financial planning and retirement savings strategies** Experiment 1: Personal Income Tax Calculations Experiment 2: Business Income Tax Calculations
12	**Week 12: Taxation and Financial Planning** **Basic financial planning and retirement savings strategies** Experiment 1: Personal Financial Planning Experiment 2: Retirement Savings Strategies
LEARNINGRESOURCES	
TEXTBOOKS:	
1	Gitman, L. J., Juchau, R., & Flanagan, J. (2015). *Principles of managerial finance* (7th ed.). Pearson Education Australia.
2	Brigham, E. F., & Houston, J. F. (2016). *Fundamentals of financial management* (14th ed.). Cengage Learning.
REFERENCEBOOKS:	
1	Ross, S. A., Westerfield, R. W., & Jordan, B. D. (2019). *Fundamentals of corporate finance* (12th ed.). McGraw-Hill Education.
2	Brealey, R. A., Myers, S. C., Allen, F., & Mohanty, P. (2017). *Principles of corporate finance* (13th ed.). McGraw-Hill Education.
3	Brigham, E. F., & Ehrhardt, M. C. (2016). *Financial management: Theory & practice* (15th ed.). Cengage Learning.
ADDITIONAL REFERENCE MATERIAL	
1	https://www.investopedia.com/financial-planning-beginners
2	https://www.financialplanning.org/retirement-tips
3	https://openstax.org/books/intro-financial-markets