UNIVERSITY OF CALCUTTA

Notification No. CSR/49/19

It is notified for information of all concerned that the Syndicate in its meeting held on 08.8.2019 (vide Item No.55), subsequently confirmed by the Syndicate dated 27.08.019 (Item No.01) approved the revised course syllabus for AICTE model curriculum of 4-year 8-Semester B.Tech course of study in Chemical Technology, under this University, as laid down in the accompanying pamphlet.

The above shall take immediate effect from the session 2019-2020.

SENATE HOUSE
KOLKATA-700 073

The 26th November, 2019.

Prof.(Dr.) Debasis Das
Registrar

[Signature]
### UNIVERSITY OF CALCUTTA
Department of Chemical Technology
Faculty of Engineering & Technology

**Regulation for 4-year 8-semester B. Tech. course in Chemical Technology**
(with effect from the academic year 2019 – 2020)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong></td>
<td>Department of Chemical Technology, Faculty of Engineering and Technology, University of Calcutta shall provide instructions leading towards the 4-year, 8-semester B. Tech. degree in <strong>Chemical Technology</strong>. The course is of four (4) years duration comprised of eight (8) Semesters, each Semester being of six (6) months’ duration.</td>
</tr>
</tbody>
</table>
| **2** | **Eligibility for Admission**  
(a) Category-1: For admission into the FIRST YEAR of 4-Year B. Tech. course in **Chemical Technology**, the candidates must have passed Class XII Examinations in the system of 10+2 under West Bengal Council of Higher Secondary Education or equivalent with Physics, Chemistry, Mathematics securing an average of at least 60% marks (or equivalent grade) in these subjects and cleared West Bengal JEE.  
(b) Category-2: For admission of the B.Sc. (Hons.) qualified students into the SECOND YEAR of B. Tech. course in **Chemical Technology**, the candidates must have passed B.Sc. Honours with Chemistry. The selection will be strictly based on merit as adopted and invoked time to time by University of Calcutta. The ‘Category-2’ students must have to attend and pass ‘Workshop’ and ‘Engineering Drawing’ subjects additionally arranged in the FOURTH Semester curriculum. However, no credit points will be awarded and will not be included for SGPA calculation. In the main mark sheet, mention will be made (at the bottom) that he/she has qualified ‘Workshop/Drawing’ with grade ----. The course of study for students admitted in the 2nd year will be of 6 Semesters (starting from third Semester) in three academic years.  
(c) Any seat(s) remaining vacant at the end of Second Semester will be filled up by Category-2 candidates. |
| **3** | The award of the said B. Tech. Degrees will be conferred to students who are successful in all of the eight (8) / six (6) Semester examinations. |
| **4** | **Attendance:** A student **must attend 75%** of the theoretical and laboratory/ practical classes and **successfully complete sessional assessment** in order to appear at Semester examinations. |
The credit based examination system will be followed for all Semester examinations.

The course shall have a certain number of credits assigned to it depending upon the academic load of the course assessed on the basis of weekly contact hours of lecture, tutorial and laboratory classes, assignments or field study and/or self study.

Generally, the course shall have an integer number of credits reflecting its weight. The number of credits of a course in a semester shall ordinarily be calculated as under:

(i) Lecture (L)/Tutorial (T): One lecture hour per week shall normally be assigned one credit. One hour of tutorial per week shall be assigned one credit. For determining the credits of a theory course, lectures and tutorials shall be added.

(ii) Practical (P): Three laboratory hours per week shall be assigned two (2) credits.

Courses other than Lectures/Tutorials shall be treated as practical courses.

The course credits shall be given as L-T-P. For example, 3-1-0 will mean that it is a lecture based course and has 3 lectures, 1 tutorial, and no practical assigned to it. Similarly, a course with 0-0-3 means that it is a practical course with 3 hours of practical work. Credits will be assigned to seminar, dissertation, project etc. under the practical component.

The 4-year course of study will have subjects covering a total of 180 credits.

In general, examinations on theoretical papers will be on 100 marks of 4 Credits, while papers CT301, CT302, CT303, CT403 and CT801 consisting of 2 modules, examination will be on 50 marks for each module having 2 credits per module.

The laboratory/practical papers will carry 50 marks of 2/1.5 Credits.

Credit points of theoretical and practical papers including project work, design, General Viva Voce, plant training, seminar presentation etc. offered by Department are given in Course Structures separately. There will be two components of examinations of theoretical papers: i) Sessional assessment 30% and ii) End Semester examination 70%.

(b) **The Sessional assessment components of theory papers are:**

<table>
<thead>
<tr>
<th>Serial No</th>
<th>Type of evaluation</th>
<th>Marks (100/50)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sessional Assessments through Class Test/ Assignments</td>
<td>25/10</td>
</tr>
<tr>
<td>2</td>
<td>Overall conduct, attendance, manners, skills etc.</td>
<td>05</td>
</tr>
</tbody>
</table>
(c) **Evaluation in Laboratory/ practical papers:**

<table>
<thead>
<tr>
<th>Serial No</th>
<th>Type of evaluation</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Report and results</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Viva</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>Overall conduct, attendance, discipline, manners, skills etc.</td>
<td>10</td>
</tr>
</tbody>
</table>

(d) **Eligibility of success/failure in a Semester Examination:**

(i) A student admitted in 1\textsuperscript{st} semester of B. Tech. course will get total 6 consecutive academic years from his/her year of admission to pass in all the 8 semesters.

A student admitted in 3\textsuperscript{rd} semester of B. Tech. course will get total 5 consecutive academic years from his/her year of admission to pass in all the 6 semesters.

(ii) A student has to secure at least 50% marks i.e. Grade-D in all subjects individually in order to **pass the examination**.

(iii) If a student don’t secure at least 50% marks or absent in the end semester examination of theory subject needs to appear in that paper in the examination of next academic session(s). In the case of theoretical paper, the marks of Sessional assessment would be retained.

(iv) A student will be eligible to take admission to the next immediate higher semester if the number of non-appeared paper in Theoretical examination does not exceed more than two. A student must have to appear in all the papers of the practical examination of the semester concerned.

(v) If a student does not appear in more than two theoretical papers or any of the practical paper of the semester needs to take readmission in that semester of next academic season.

(vi) A student can appear in current semester and along with that could appear supplementary examination of maximum of 2 previous semesters of the corresponding even or odd semester. (e.g. A students has failed in a paper in 1\textsuperscript{st} semester will get 2 additional chances in 3\textsuperscript{rd} and 5\textsuperscript{th} Semester).

(vii) **Special supplementary examinations** will be arranged only for Semester 7 and 8 just after the declaration of results of 7\textsuperscript{th} and 8\textsuperscript{th} Semester. Students who could not secure 50% marks in Special supplementary examination will have to appear in next academic session. (Provided maximum 6 years span for 4 Year B. Tech. and 5 Years span for 3 Years B. Tech. kept intact).
(viii) **Eligibility for a Degree:** A student needs to pass in all the theoretical and practical papers to qualify for B. Tech. Degree.

‘Category 1’ student has to pass all the theoretical and practical papers of 8-Semesters in maximum of 6 year periods from admission to obtain B. Tech. degree in corresponding course.

‘Category 2’ student has to pass all the theoretical and practical papers of 6-Semesters starting from 3rd Semester in maximum of 5 year periods to obtain B. Tech. degree in corresponding course.

(ix) A student failing in any subject should apply to the Secretary, UCSTA through the Head of the Department for appearing at the supplementary examinations within 7 days of the publication of results.

6 (a) On the basis of total marks secured in each paper, **Grade (G) and Grade Point (GP)** shall be awarded to a student.

The equivalence between grades, grade points and the percentage marks is given by:

<table>
<thead>
<tr>
<th>Percentage (%) of marks</th>
<th>Grade (G)</th>
<th>Grade Point (GP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 90</td>
<td>Ex</td>
<td>10</td>
</tr>
<tr>
<td>89 – 80</td>
<td>A</td>
<td>9</td>
</tr>
<tr>
<td>79 - 70</td>
<td>B</td>
<td>8</td>
</tr>
<tr>
<td>69 - 60</td>
<td>C</td>
<td>7</td>
</tr>
<tr>
<td>59 - 50</td>
<td>D</td>
<td>6</td>
</tr>
<tr>
<td>&lt; 50</td>
<td>F</td>
<td>0</td>
</tr>
</tbody>
</table>

(b) Each paper shall carry **Credit (C)** according to the number of hours allotted per week and as indicated in the following table:

<table>
<thead>
<tr>
<th>Paper/subject</th>
<th>No. of hours/week</th>
<th>Credit (C) assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theoretical</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Tutorial</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Practical</td>
<td>3/6</td>
<td>(2/3/4)</td>
</tr>
</tbody>
</table>

(c) The performance of a candidate in n\textsuperscript{th} Semester examination, who earns all the credits of that semester, will be assessed by the ‘**Semester Grade Point Average**’ (SGPA), ‘S\textsubscript{n}’ to be computed as:

\[
SGPA [S_n] = \frac{\sum_{k} [C_k \cdot GP_k]}{\sum_{k} C_k}
\]

where ‘k’ denotes the number of papers in a particular semester and \(\sum_{k} C_k\) denotes the total credits of a particular semester and \(GP_k\) is the grade point of \(k\)\textsuperscript{th} paper.
(d) On completion of the B. Tech. course in Chemical Technology, the overall performance of a candidate will be assessed by the ‘**Cumulative Grade Point Average**’ (CGPA) to be computed as:

\[
CGPA = \frac{\sum_n [C_n S_n]}{\sum_n C_n}
\]

where, \( C_n = \sum_k C_k \) and \( \sum_n C_n \) denotes total credits of all the semesters, i.e. 180 credits for Category-1 and 137 credits for Category-2.

(e) Each theory and each practical paper will be assessed by internal examiner(s). Design, Project, seminar and General Viva Voce examinations will be assessed by a board consisting of at least two (2) internal examiners and at least one (1) external examiner.

(f) If a candidate is unable to appear at any of the theory or practical examination(s), he/she will earn zero (0) credit in that paper(s).

7 Candidates appearing in a semester examination shall join classes in the next semester immediately, wherever applicable, after completion of the examination.

8 The Calcutta University Syndicate shall publish a list of successful candidates of the B. Tech. examination for each of the Semester examinations.

9 At the end of each Semester examination, a Grade-Sheet showing the Semester performance (Semester Grade Sheet) indicated by **SGPA** will be issued to the students. However, SGPA will not be calculated for those candidates who fail to earn all the credits in that Semester.

The Semester Grade Sheet should have the following basic information: The merit list will be prepared on the basis of the total marks obtained.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Module Details of courses</th>
<th>Credits</th>
<th>Course Total</th>
<th>Grade</th>
<th>Letter Grade</th>
<th>SGPA</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Full Marks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Marks obtained</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10 (a) A consolidated Grade-Sheet, showing the overall performance in the B. Tech course indicated by **CGPA**, will be issued only to those successful students who have earned 180 credits for Category-1 and 137 credits for Category-2 in the B. Tech. course.

The consolidated grade sheet shall consist of two components. The first component will have the information of the final Semester as follows:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Module Details of courses</th>
<th>Credits</th>
<th>Course Total</th>
<th>Grade</th>
<th>Letter Grade</th>
<th>SGPA</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Full Marks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Marks obtained</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The second component will have a **summary** of all the semesters having the following basic information:

<table>
<thead>
<tr>
<th>Semester</th>
<th>Total credit</th>
<th>Credit obtained</th>
<th>Full marks</th>
<th>Marks obtained</th>
<th>SGPA</th>
<th>Cumulative statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>8&lt;sup&gt;th&lt;/sup&gt;</td>
<td></td>
<td>Total Credit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7&lt;sup&gt;th&lt;/sup&gt;</td>
<td></td>
<td>Credit Obtained</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6&lt;sup&gt;th&lt;/sup&gt;</td>
<td></td>
<td>Full Marks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5&lt;sup&gt;th&lt;/sup&gt;</td>
<td></td>
<td>Grand Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
<td></td>
<td>CGPA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td></td>
<td>Result</td>
<td></td>
<td></td>
<td>#</td>
<td></td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td></td>
<td>$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The hash (#) in the last row of last column will contain the information regarding the final achievement of the candidate in all the examinations. This box will contain only one (1) of the following three (3) information: ‘1<sup>st</sup> Class’ / ‘2<sup>nd</sup> Class’ / ‘Failed’.

(b) Candidates securing CGPA at least 7.5 in B. Tech. Examination shall be placed in the First Class and those securing 6.0 or more but less than 7.5 shall be placed in the ‘Second Class’. Candidates securing CGPA less than 6.0 shall be declared ‘Failed’.

The Degree of **“Bachelor of Technology”** under the seal of the University shall be awarded to a successful candidate mentioning the grade and class he/she has obtained. The format will be as follows:

![UNIVERSITY OF CALCUTTA](attachment:logo.png)

**It is hereby certified that after satisfying all the conditions prescribed by the University**

----------*(Name)* was on the ---th day of -----(month), ------(year)

Duly admitted to the Degree of

**Bachelor of Technology in CHEMICAL TECHNOLOGY**

*In the ---- Class*

Vice Chancellor

Senate House
Course Structure and Syllabus for
4-year, 8-semester B. Tech. Course
in
Chemical Technology

DEPARTMENT OF CHEMICAL
TECHNOLOGY
UNIVERSITY OF CALCUTTA
### CURRICULUM
B. Tech. in Chemical Technology (Ceramic Engineering/Oil Technology/Petrochemicals & Petroleum Refinery Engineering/Pharmaceutical & Fine Chemical Technology)  
(With effect from Academic year 2019 – 2020)

#### 1st Semester

<table>
<thead>
<tr>
<th>Paper No</th>
<th>Sub Code</th>
<th>Subject</th>
<th>Periods</th>
<th>Cr</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>Theory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1.</td>
<td>HU101</td>
<td>Communication English, Management and Social Sciences</td>
<td>2</td>
<td>1</td>
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<tr>
<td>2.</td>
<td>PH102</td>
<td>Physics-I</td>
<td>2</td>
<td>1</td>
<td>-</td>
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<tr>
<td>3.</td>
<td>CH103</td>
<td>Chemistry-I</td>
<td>2</td>
<td>1</td>
<td>-</td>
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<tr>
<td>4.</td>
<td>MA104</td>
<td>Engineering Mathematics-I</td>
<td>2</td>
<td>1</td>
<td>-</td>
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<tr>
<td>5.</td>
<td>EE105</td>
<td>Basic Electrical Engineering</td>
<td>2</td>
<td>1</td>
<td>-</td>
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<tr>
<td>Practical</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>HU106</td>
<td>Language Lab</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>PH107</td>
<td>Physics Lab –I</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>CH108</td>
<td>Chemistry Lab –I</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>9.</td>
<td>EE109</td>
<td>Basic Electrical Engineering Lab</td>
<td>-</td>
<td>-</td>
<td>3</td>
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<tr>
<td>Total</td>
<td></td>
<td></td>
<td>10</td>
<td>5</td>
<td>12</td>
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</table>

#### 2nd Semester

<table>
<thead>
<tr>
<th>Paper No</th>
<th>Sub Code</th>
<th>Subject</th>
<th>Periods</th>
<th>Cr</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>Theory</td>
<td></td>
<td></td>
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<tr>
<td>10.</td>
<td>CH201</td>
<td>Chemistry-II#</td>
<td>2</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>11.</td>
<td>MA202</td>
<td>Engineering Mathematics-II</td>
<td>2</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>12.</td>
<td>ME203</td>
<td>Engineering Mechanics</td>
<td>2</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>13.</td>
<td>CS 204</td>
<td>Basic computer Science and Engineering</td>
<td>2</td>
<td>1</td>
<td>-</td>
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<tr>
<td>14.</td>
<td>BE205</td>
<td>Basic Electronics</td>
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<td>1</td>
<td>-</td>
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<td>Practical</td>
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<tr>
<td>15.</td>
<td>CH206</td>
<td>Chemistry Lab–II#</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>16.</td>
<td>ME 207</td>
<td>Workshop Practice</td>
<td>-</td>
<td>-</td>
<td>3</td>
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<tr>
<td>17.</td>
<td>ME 208</td>
<td>Engineering Drawing</td>
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<td>-</td>
<td>3</td>
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<tr>
<td>18.</td>
<td>CS 209</td>
<td>Computer Programming Lab</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>19.</td>
<td>BE210</td>
<td>Basic Programming Lab</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>10</td>
<td>5</td>
<td>14</td>
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<tr>
<td>Paper No</td>
<td>Sub Code</td>
<td>Subject</td>
<td>Periods</td>
<td>Cr</td>
<td>Marks</td>
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<td>T</td>
<td>P</td>
</tr>
<tr>
<td>Theory</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>20.</td>
<td>CT301</td>
<td>Chemical Technology–I</td>
<td>2</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Module I</td>
<td>Process Calculation</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Module II</td>
<td>Introduction to Statistical Analysis</td>
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</tr>
<tr>
<td>21.</td>
<td>CT302</td>
<td>Chemical Technology–II</td>
<td>2</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Module I</td>
<td>Organic Technology</td>
<td></td>
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</tr>
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<td></td>
<td>Module II</td>
<td>Inorganic Technology</td>
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<tr>
<td>22.</td>
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<td>1</td>
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<tr>
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<td>Biotechnology</td>
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<tr>
<td>23.</td>
<td>CT304</td>
<td>Chemical Engineering–I</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Practical</td>
<td></td>
<td></td>
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<tr>
<td>24.</td>
<td>CT305</td>
<td>Organic Technology Lab.</td>
<td>-</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>25.</td>
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*Special Paper–I: Ceramic Engineering I/ Oil Technology I/ Petrochemicals & Petroleum Refinery Engineering I/ Pharmaceutical and Fine Chemical Technology I

#Special Lab–I: Ceramic Engineering Lab I/ Oil Technology Lab I/ Petrochemicals & Petroleum Refinery Engineering Lab. I/ Pharmaceutical and Fine Chemical Technology Lab I

^Special Lab–II: Ceramic Engineering Lab II/ Oil Technology Lab. II/ Petrochemicals & Petroleum Refinery Engineering Lab II/ Pharmaceutical and Fine Chemical Technology Lab II
## 5th Semester

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*Elective –I:  
A) Safety & Hazard Analysis  
B) Industrial Pollution: Control & Management  
C) Project Engineering

#Special Paper–II: Ceramic Engineering II/ Oil Technology II/ Petrochemicals & Petroleum Refinery Engineering II/ Pharmaceutical and Fine Chemical Technology II

^Special Lab.–III: Ceramic Engineering Lab. III/ Oil Technology Lab. III/ Petrochemicals & Petroleum Refinery Engineering Lab. III/ Pharmaceutical and Fine Chemical Technology Lab. III

$Special Lab.–IV: Ceramic Engineering Lab. IV/ Oil Technology Lab. IV/ Petrochemicals & Petroleum Refinery Engineering Lab. IV/ Pharmaceutical and Fine Chemical Technology Lab. IV
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*Elective –II: A) Nanotechnology  
B) Sol-Gel Technology

#Special Paper–III: Ceramic Engineering III/ Oil Technology III/ Petrochemicals & Petroleum Refinery Engineering III/ Pharmaceutical and Fine Chemical Technology III.

^Special Lab–V: Ceramic Engineering Lab V/ Oil Technology Lab V/ Petrochemicals & Petroleum Refinery Engineering Lab. V/ Pharmaceutical and Fine Chemical Technology Lab V.

$Special Lab–VI: Ceramic Engineering Lab VI/ Oil Technology Lab VI/ Petrochemicals & Petroleum Refinery Engineering Lab VI/ Pharmaceutical and Fine Chemical Technology Lab VI.
7th Semester

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*Elective –III: A) Numerical Analysis
   B) Optimization method in Chemical Technology

#Special Paper–IV: Ceramic Engineering IV/ Oil Technology IV/ Petrochemicals & Petroleum Refinery Engineering IV/ Pharmaceutical and Fine Chemical Technology IV
# 8th Semester

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*Special Paper–V: Ceramic Engineering V/ Oil Technology V/ Petrochemicals & Petroleum Refinery Engineering V/ Pharmaceutical and Fine Chemical Technology V

Total Credit Point: 21 + 22+ (24x4) + 24 + 17 = 180

(IA: Internal Assessment; UE: University Examination; TM: Total Marks)
Semester I
(Theory)

Paper 1
Course HU101 100 marks /3 Credits
Communication English, Management and Social Sciences

1.1 Communicative English (Grammar):
Course Objective: The objective of the course is to enhance the understanding of the students on the principles, techniques and application of grammar and to acquire appropriate proficiency and skills in reading, writing, speaking and comprehension.

Module 1: Sentences: Clauses, Phrases, Types of Sentences, Sentence Structures and Transformation, Correction of Errors in Sentences.
Module 2: Misplaced Modifiers and Modals.
Module 3: Vocabulary Building and Usage: Word Formations (by adding suffixes and prefixes), Root words from foreign languages and their use in English; Synonyms; Antonyms; One Word Substitution/Single Word for a group of Words, Standard abbreviations; Redundant Words/Redundancies/Redundantism; Clichés.
Module 4: Remedial Grammar: Noun Pronoun Agreement, Articles, Prepositions, Agreement of Subject and Verb; Fill in the blanks using correct Words.
Module 5: Précis Writing.
Module 6: Essay, Paragraph Writing.
Module 7: Comprehension Passage.
Module 8: Rapid reading- ‘Bill Moss, Tentmaker’ by Robert Gannon.
Module 9: Taking notes: Dictation.

1.2 Communicative English (Technical Communication):
Course Objective: The objective of the course is to enhance the understanding of the students on the principles of effective technical communication and their application in official or professional communication.

Module 1: The Theory of Communication – Definition & Scope; Barriers of Communication; Effective Communication (Verbal / Nonverbal).
Module 2: Job Application Letter; C.V./Bio-data/Resume.

1.3 Management And Social Sciences:
Course Objective: To understand the principles of management and their application to the functioning of an organization.

Module 3: Principles of management and their application to the functioning of an organization
Contents: Definition of management, science or art.
Module 4: Manager vs entrepreneur; Types of managers- managerial roles and skills.
Module 5: Evolution of management- scientific, human relations, system and contingency approaches.
Module 6: Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises.
Module 7: Organization culture and environment.
Module 8: Current trends and issues in management.
Module 9: Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies.
Module 11: Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning.
Module 13: Directing, individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment.
Module 14: Leadership, types & theories of leadership, effective communication.
Module 15: Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.

Course Outcomes:
1. The students will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.
2. The students will acquire proficiency in formal official communication skills.
3. Upon completion of this course, the students will get a clear understanding of management functions in an organization.

Reference Books:
1. Effective English Communication, by V. Syamala.
4. Pronunciation Practice Activities – Martin Hewings – Cambridge University Press
   1. Concise Oxford Dictionary
   4. English For All edited by Nilanjana Gupta
7. . David F. Beer and David McMurrey, Guide to writing as an Engineer, John Willey. New York, 2004

Paper 2
Course PH102 100 marks /3 Credits
Physics-I
Course objectives:
The objective of the course is to enhance the understanding of the Students’ on some basic philosophies and corresponding application based reasoning of Physics. To help the students in acquiring the necessary skills to solve the application based problems useful for almost all branches of physics and engineering, on the basic of theoretical understanding.
2.1. Optics:
Module 1: Introduction to interference and examples -Young’s double slit experiment, Newton’s rings (qualitative).
Module 2: Diffraction: Introduction to diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction due to single slit and plane diffraction grating, characteristics of diffraction grating and its applications. The Rayleigh criterion for limit of resolution and resolving power of Diffraction gratings.
Module 3: Polarization– Polarisation by reflection, Brewster's law, polarisation by double refraction, polaroids, Malus Law, linearly, circularly and elliptically polarized light (qualitative), half wave and quarter wave plates, Optical activity
Module 4: Fibre Optics: Introduction, total internal reflection, numerical aperture and various fibre parameters, stepand graded index fibres, application of optical fibres.
Module 5: Lasers: Principles and working of Laser: population inversion, pumping, various modes, types of Laser (qualitative), application of Laser
2.2. Thermodynamics:
Module 1: Degrees of freedom and Equipartition of energy, Energy and Work, First Law of Thermodynamics.
2.3. Quantum Mechanics- 1:
Module 1: Black body radiation, Planck’s radiation law and its uniqueness, Compton effect and its significance- wavelength shift and recoil of electrons

Module 2: Wave nature of Particles, De-Broglie hypothesis, Matter wave, Born interpretation of wave function, Uncertainty principle, Operators-Eigen value and Eigen function, operators and expectation values of some dynamical variables like momentum, total energy, angular momentum etc.

Module 3: Schroodinger wave equation in three dimension and one dimension and its’ significance, Time-dependent and time independent form, Application of Schroodinger wave equation in case of particle in one dimensional box (qualitative).

2.4. Dielectric and Magnetic Properties of Materials:

Module 1: Divergence and Curl of electrostatic field, Gauss's law and its application, Laplace’s and Poisson’s equations for electrostatic potential

Module 2: Dipole moments, electric field and potential due to dipole, Bound charges and Dielectric polarization, polar and non-polar dielectrics, Electric displacement vector, dielectric susceptibility, permittivity and dielectric constant, Boundary conditions, simple electrostatics problems in presence of dielectrics

Module 3: Magnetisation, magnetic field $B$ and $H$, permeability and susceptibility, classification of magnetic materials, discussion of magnetic field in presence of magnetic materials(qualitative).

Course Outcomes:

I. Students will be enriched with some basic thoughts of Physics needed for advancement in Technology.

II. Development of the idea about the basic concepts of mechanics required for all branches of the engineering.

III. Students will be familiar with the idea about the most important physical phenomena corresponds to different wings of Physics and also will be knowledgeable about the logic behind those phenomena.

IV. Students will be able to utilize the concept which they gather in solving the problem having technological aspects.

Reference books:

1. Introduction to Optics by Hecht E. Addison-Wesley.
4. Geometrical and Physical Optics by B K. Mathur
5. Principles of Optics by M. Born and E. Wolf, Cambridge University Press
6. Introduction to Electro dynamics by David Griffiths, Prentice Hall
10. Thermodynamics in Materials Science by Robert DeHoff, CRC Press.
16. Introduction to Electrodynamics by David Griffiths, Prentice Hall.
19. Web Platform: NPTEL, SWAYAM, Archive.org etc

Paper 3
Course CH103
Chemistry-I

Course Objective: The objective is to Impart in depth understanding of fundamental concepts in chemistry that have been introduced at the 10+2 levels in school and to develop analytical skill among students necessary to design and solve the new problems. The course will familiarize students with different analytical techniques used in present day chemistry and explore the relevance in engineering applications.

Module I: Atomic and molecular structure: Introduction to quantum theory: Schrodinger equation. Origin of quantization. Particle in a box and its applications with respect to conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations.
Band structure of solids and the role of doping on band structures.

Module II: Intermolecular forces and real gases: Ionic, dipolar and van der Waals interactions. Deviation of real gas from ideal behavior. Equations of state of real gases and critical phenomena.


Module VI: Organic reactions: Electronic influencing effects, Reactive intermediates. Aromaticity. Introduction to reactions involving rearrangement, substitution, addition,

**Course Outcome:**
The students will be able to
1. Understand and apply the concepts of basic quantum chemistry and chemical bonding to explain the molecular structure and physical/electronic properties of molecules.
2. Apply fundamental principles of electronic, vibrational, rotational and nuclear magnetic resonance spectroscopy towards identifying the structure of organic molecule.
3. Understand and apply fundamental concepts of electrochemistry.
4. Apply basic principles of organic chemistry for analyzing reaction mechanism and to develop methodology for synthesis.

**Reference Books:**
2. Concise Inorganic Chemistry by J.D. Lee
4. Physical Chemistry by P. W. Atkins and J. de Paula
5. Fundamentals of Molecular Spectroscopy by C. N. Banwell
7. Organic Chemistry by I. L. Finar
8. Organic Chemistry by J. Clayden and N. Greeves
11. A Guidebook to Mechanism in Organic Chemistry by P. Sykes
12. Engineering Chemistry (NPTEL Web book) by B. L. Tembe, Kamaluddin and M. S. Krishnan
13. Engineering Chemistry by Prasanth Rath

**Paper 4**
Course MA104 100 marks /3 Credits
**Engineering Mathematics-I**
**Course Objective:**
The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate analysis and vector algebra. At the end of this course students will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.
**Module 1: Differential calculus:**
**Differential calculus:** Successive differentiation, Leibnitz Rule. Rolle’s Theorem, Mean value theorems, Taylor’s and Maclaurin theorems with remainders; indeterminate forms and L’Hospital’s rule; Maxima and minima.
Multivariable Calculus: Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers.

Module 2: Sequences and series: Convergence of sequence and series, tests for convergence; Power series, Taylor’s series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval’s theorem.

Module 3: Vector Algebra: Vector calculus: Brief review of vector algebra, scalar and vector triple products, Directional derivatives, gradient, divergence, curl, vector integration, statements and applications of Gauss’s theorem, Green’s theorem, Stokes’ theorem, examples

Module 4: Integral Calculus (Integration): Int. Calculus: Properties of definite integrals, Quadrature, Rectification, Double integral, Triple integrals, change of order of integration, change of variables, determination of length, area, volume. Applications of definite integrals to evaluate surface areas and volumes of revolutions

Course Outcome:
The students will learn:
- To Use Leibnitz Theorem to determine the nth derivative of product of functions. They will develop series expansion by Taylor’s and Maclaurin’s series. They will be examine the function for maxima and minima and discover its extreme value.
- To use the tool of power series and Fourier series for learning advanced Engineering Mathematics.
- To deal with functions of several variables that are essential in most branches of engineering.
- To recognize scalar and vector functions. They will evaluate Gradient, Divergence and Curl of a point function depending upon its nature.
- To apply the integral formulae to estimate length, surface area and volume of revolution of a curve.

Reference Books

Paper 5
Course EE105 100 marks /3 Credits

Basic Electrical Engineering
Course Objective: The objective of the course is to enhance the understanding of the Students’ on the basics of AC & DC circuits along with basics of three phase circuits and to help the
students to understand the basics of basic electrical machines, also helps the students understand
the necessity of power system components.

**Module 1: D.C. Circuits:** Network theorems – Superposition theorem, Thevenin’s theorem, Norton’s theorem, Maximum power transfer theorem. Star-Delta & Delta-Star transformation.


**Module 3: A.C. Fundamentals:** Sinusoidal quantities, phase & phase difference, average & RMS values, form factor & peak factor, concept of Sinusoids, impedance & admittance, power & power factor.

**Module 4: A.C. Circuits:** Series and parallel R-L-C Circuits, Form Factor, Peak Factor, Phasor concept of Sinusoids. Impedance and Admittance. Power, Power Factor, VA, VAR.

**Module 5: Balanced 3-phase:** 3-phase AC balanced circuits. Phase-sequence, Star and Delta connections. Connection of wattmeter in 1-ph circuit for power measurement & Connection of two watt meters in 3-ph circuit for power measurement.

**Module 6: Power Factor Improvement:** Causes & effect of low power factor, advantages of power factor improvement, methods of power factor improvement.

**Module 7: DC Machines:** Construction, working, different types, EMF equation, characteristic (Generator & Motor), starting and speed control.

**Module 8: 1-Phase Transformer:** Construction. EMF equation. Phasor diagram. Equivalent circuits. Open circuit and Short circuit test. Losses and Efficiency

**Module 9: 3-Phase Induction Machine:** Types of induction machines. Rotating magnetic field, slip, torque equation, torque speed curve. DOL starting and reduced voltage starting.

**Module 10: Power System Structure:** Single line diagram of a power system structure.

**Course Outcome:**
1) The students will be able to understand the basic laws of electrical engineering & its application
2) Students knowledge will be enhanced about the basics of AC & DC circuits
3) Students will get an idea about the three phase system
4) Students will be able to analyse the basic electrical machines with the help of basic concepts of electrical engineering gathered.
5) Get an idea about the components of power system.

**Reference Books:**
2. Basic Electrical Engineering By T. K. Nagsarkar & M. S. Sukhija, Oxford University Press
3. Electrical & Electronics Technology By Hughes, Dorling Kindersley India, New Delhi
4. Electrical Technology By H. Cotton, CBS Publisher, New Delhi
5. A course in Electrical Engineering Vol-I & II By C. L. Dawes Publisher: McGraw-Hill Book Co. Inc

**(Practical)**

**Paper 6**

**Course HU106**

**50 marks /1.5 Credits**

**Language Lab**

**Course Objective:** The objective of the practical classes is to make the students familiar with the applied aspects of the English language, pronunciation, behavioural strategies and realistic
dimensions of interpersonal interaction in the context of organizational communication. The practical exercises include the following topics:

EXERCISES:
- Group Discussion –Principle & Practice [Courtesy- Teaching Cohesion and Coherence strategies for handling criticism and adverse remarks. Teaching strategies of Turn-taking, timing, effective and creative intervention, formal and informal language, kinesics (use of body language), politeness and courtesies and all components of soft skills].
- Mock/Job Interview.
- Role Play/Conversation.
- Formal Presentation [power point presentation/extempore/ public speaking skills, Elementary Phonetics (theory): Pronunciation/ Stress/Intonation/ Rhythm/ Voice modulation/ Pitch and Accent of connected speech].
- Listening Comprehension: Audio File Analysis/Video File Analysis.

Course Outcomes:
1. The students will acquire skills on conflict management, presentation, decorum, grooming, courtesy, appropriate pronunciation.
2. The students will also acquire better verbal ability in Spoken English.

Reference:
The manual corresponding to all the exercises will be provided to the students.

Paper 7
Course PH107 50 marks /1.5 Credits
Physics-I Lab
Course objectives:
The objective of the practical classes is to make the students familiar with the technological features of theory as well as to provide hand-on experience of corroboration between model theory and it’s practical aspect.

Experiments:
Experiments are based on modern optics-Lasers, general properties of matter, mechanics with advanced measurement techniques and Virtual lab

Reference:
The manual corresponds to all experiments will be provided to the students.

Paper 8
Course CH108 50 marks /1.5 Credits
Chemistry-I Lab
Choice of eight to ten experiments from the following:
- Titrations: Acid –base, Conductometric, pH-metric, Complexometric titrations.
- Estimation of hardness of water.
- Determination of chloride content of water
- Colligative properties using freezing point depression
- Determination of the rate constant of are action
- Determination of cell constant and conductance of solutions
- Potentiometry determination of redox potentials and emfs
- Determination of the partition coefficient of a substance between two immiscible liquids
Paper 9
Course EE109 50 marks /1.5 Credits
Course Objective:
The objective of this practical course is to familiarize the students to the various instruments & devices & its hand on use, to run the rotating electrical machines & to familiarize with the construction & use of single phase transformer.

Experiments on the following topic:
- Familiarization experiments (Variac, Potential divider, MCV, MIV, MCA, MIA & Wattmeter)
- Characteristics of Tungsten and Carbon filament lamps
- Experiments on DC circuits and DC machines
- Study of AC series R-L-C series circuit
- Experiments on Single phase Transformer
- Calibration of voltmeter, ammeter and energy meter
- Experiments on magnetic circuit principles

Course Outcome:
The students will be able to learn-
1) The use of different instruments & devices in a circuits
2) How to make an electrical circuit & the safety measures.
3) The practical application of basics of electrical engineering like AC/DC circuits.
4) The practical use of rotating & static electrical machines.

Semester- II
(Theory)

Paper 10
Course CH201 100 marks /3 Credits
Chemistry - II
Course objective:
The objective is to develop understanding of the concepts and applications of chemical kinetics and different analytical techniques. Course will impart knowledge of physical/chemical behavior and applications of various engineering materials and explore water chemistry, green chemistry and non-conventional energy sources.

Module 1: Analytical techniques

**Module 2: Kinetics of Chemical Reactions**

**Module 3: Metals and Alloys:**
Phase rule and applications to one, two and multi-component systems. Iron-carbon phase diagram. Types of alloys, carbon steel, alloy steel, alloys of Cu, Al, Pb.

**Module 4: Polymers**

**Module 5: Surfactants and lubricants**

**Module 6: Nanomaterials**
Properties of nanomaterials, size dependent properties, general methods of synthesis, bottom-up and top-down approach, characterization of nanomaterials, electron microscopy, self-assembly, nanoscale materials, Applications of nanomaterials.

**Module 7: Environmental and green chemistry**

**Module 8: Energy science**

**Course Outcome:**
The students will be able to
1. Appreciate the usefulness of new analytical techniques for elucidating the structure of chemical systems.
2. Apply the basic principle of chemical kinetics in order to analyze and develop chemical reactors and reaction systems.
3. Use the knowledge on compounds of interest like polymers, surfactants, nanomaterials and appreciate their engineering applications.
4. Able to apply the principles of green chemistry in designing alternative reaction methodologies to minimize hazards and environmental degradation.

**Reference Books**
1. Fundamentals of Analytical Chemistry by S. Crouch, D. West, F. Holler, D. A. Skoog
3. Physical Chemistry by P. W. Atkins and J. de Paula
4. Chemical Kinetics, by K. Laidler
Course Objective:
The objective of this course is to know the use of mathematical techniques in Linear algebra that are needed by engineers for practical applications, familiarize with differential equation with its application in Laplace transform, introduction to the concepts of improper integrals, Gamma, Beta function which are needed in engineering applications, and finally to acquaint with numerical methods in evaluating polynomial equations, differential equation and integration.

Module 1: Linear Algebra: Matrices, Vectors, Determinants, Linear Systems:

Module 2: Convergence of improper integrals:
Convergence of improper integrals, tests of convergence, Beta and Gamma functions elementary properties.

Module 3: Differential Equation:
First order equations, Exact, linear and Bernoulli’s equations, Euler’s equations, Equations not of first degree: equations, solvable for p, equations solvable for y, equations solvable for x and Clairaut’s type.
Second order linear differential equations with variable coefficients; Method of variation of parameters; Wronskian

Module 4: Integral transform:

Module 5: Numerical Methods:

Course Outcomes
The students will learn:
- to solve mathematical tools for the solutions of differential equations that model physical processes.
- the essential tools of matrices and linear algebra including linear transformations, eigenvalues, diagonalization and orthogonalization.
to familiarize with techniques in improper integrals. They will have a basic understanding of Beta and Gamma functions.

- the different tools of Laplace and Fourier transform for learning advanced Engineering Mathematics.
- To deal with techniques in Numerical Analysis that are essential in most branches of engineering.

**Text / Reference Books:**
9. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984

**Paper 12**
**Course ME203**

**Engineering Mechanics**

**Course Objectives**
The main objective of a course Mechanics should be build a strong foundation, to acquaint the students with as many general methods of attack as possible, and to illustrate the application of these methods to practical engineering into consideration. The basic essence of this subject resolves around the concept of statics as well as dynamic equilibrium. Modern day engineering mechanics idealizes the practical problems. Engineering Mechanics deals with the Mechanics of rigid bodies. -Statics and Dynamics- without taking the effect of their deformation structures separately. Therefore to meet the present -day needs, the focus of teaching engineering mechanics turned to the knowledge of proper conceptualization and modeling, assuming that rest of the things will be carried out using standard techniques.

**Module 1:** Statics: Basic concepts, Scalars and vectors, parallelogram law, Lami’s theorem,
**Module 2:** Application of Vectors in Mechanics, Force Systems in two Dimensions;
**Module 3:** Moments and Couples; Resultants and Components in concurrent coplanar, forces, parallel forces in a plane, Free Body Diagram Concept
**Module 4:** Fundamentals of Friction, Limiting angle of Friction, Applications to wedges.
**Module 5:** Centroid, Moment of Inertia.
**Module 6:** Plane Trusses; Frames and Machines.
**Module 7:** Dynamics: Introduction to vector calculus, Definition of vectors in Dynamics.
**Module 8:** Two dimensional Kinematics in Rectangular Co-ordinates, Rectilinear Motion, Curvilinear motion of particle and description of different coordinate systems, Kinetics.
Module 9: Newton's Law and D'Alembert's principle, and application to rectilinear and curvilinear motion, constrained motion.
Module 10: Energy and Momentum methods. Linear Impulse; Angular Impulse and Momentum – Central Force Motion.
Module 11: Concept of Stress and Strain, Stress-Strain Diagram of Ductile and Brittle Material, Normal stress, shear stress etc., Relevant numerical.

Course Outcomes:
On successful completion at the End of Course, students will be able to understand and capable of answering in the following areas.
1. Drawing Free Body diagrams and determination of Resultant of forces and/or Moments.
2. Determination of the centroid and Second Moment of areas of different sections.
3. Analysis of Statically Determinate plane frame.
5. Application of Newton’s Laws of motion of the moving bodies.
7. Analysis of Plane Curvilinear motion.
8. Basic concept of Strength of materials, Understanding of Stress-Strain Diagram and related numerical.

Reference Books:
11. NPTEL online courses relevant to your topic; Source: onlinecourses.nptel.ac.in

Paper 13
Course CS204 100 marks / 3 Credits
Basic Computer Science and Engineering
Course objectives:
The objective of this course is to give the introduction of computing systems to the students. The students will also learn the basics of programming languages. In order to solve good programming problems data structure is also taught.

Module 2: Introduction to Programming: Variables, Assignments; Expressions; Input/Output; Conditionals and Branching; Iteration; Functions; Recursion; Arrays; Pointers; Structures;

Module 3: Introduction to Data Structure: Array, Stack, Queue, Linked List Searching: Linear Search, Binary Search, Sorting: Bubble, Insertion, Selection

Course Outcome:
1. The students will have the fundamental knowledge about the computing system.
2. Students will learn different type of data structures, their basic operations and applications.
3. Students will come to know about the basic features of programming language.
4. They will learn to write basic to advanced program.

Reference Books:
1. Computer Fundamentals by P.K.Sinha
2. Data Structures by Seymour Lipschutz
3. Fundamentals of Data Structures in C by E.Horowitz, Sartaj Sahni
4. Data Structures Using C by Reema Thareja
5. The C programming Language by Brian W. Kernighan and Dennis M. Ritchie
6. Programming with C by Byron Gottfried
7. Programming in ANSI C by E. Balagurusamy
8. Understanding Pointers in C by Kanetkar Yashavant P.

Paper 14
Course BE205 100 marks /3 Credits
Basic Electronics

Course Objective:
The objective of this course is to acquaint to the students initially the basic concepts of semiconductors and semiconductor devices which are widely used in electronics engineering. Further the electronic circuits used in electronics engineering, comprising of analog electronic and digital electronic circuits will also be introduced in this course. Lastly, the important application areas of electronics engineering, namely communication engineering and sensor and actuators will also be introduced.

Module 1: Concepts of Semiconductors
Basic ideas of electronics, charged particles, review of atomic energy levels, elementary concepts of energy bands in crystals, conduction band and valence band, distinction between metal, semiconductor and insulator, Fermi-Dirac Distribution and definition of Fermi level, intrinsic and extrinsic semiconductors, concepts of majority and minority carries in semiconductors, current flow in semiconductors.

Module 2: Semiconductor Devices
P-N Junction and Diode, Concept of space charge, effects of forward and reverse bias, current-voltage characteristics of P-N junction diode, concept of breakdown, Zener diode principle and applications, equivalent circuit of diodes, concepts of rectifiers, principle of LED. Bipolar junction transistor, mechanism of transistor action, current components in a bipolar transistor, modes of
transistor operation, I-V characteristics of a bipolar transistor, transistor biasing, introduction to field effect transistor, principle of junction field effect transistor, concept of metal semiconductor field effect transistor, p-channel and n-channel, current flow in field effect transistors and I-V characteristic curves.

Module 3: Analog Electronics using Operational Amplifier
Concept of Analog Signal and Analog Electronics, Basic concept of positive and negative feedback, Basic information of operational amplifier, ideal characteristics, 741- OPAMP, Basic OPAMP applications using ideal model: inverting amplifier, non-inverting amplifier, summing amplifier, difference amplifier, differentiation and integration using operational amplifier, comparator circuit using operational amplifier.

Module 4: Digital Electronics using Gates

Module 5: Electronics Applications
Introduction to communication systems. Principle of modulation including amplitude and frequency modulation. Transmitter and receiver system.

Course Outcome:
As outcome of this course, the students will be trained with the fundamentals of semiconductor devices and circuits and important application areas of electronics engineering.

Reference Books:
3. Linear Integrated Circuits, D.Roychoudhury and S.Jain

(Practical)

Paper 15
Course CH206
Chemistry Lab- II
Experiments:
1. Study of kinetics of chemical reactions.
2. Redox titrations: Dichromatometry, Permanganometry, Iodometry and Iodimetry.
3. Experiments based on Chromatography (paper, thin layer, column chromatography)
4. Detection of different functional groups in known and unknown organic samples.

Course Outcome:
The students will be able to
1. Understand the principles of chemical kinetics through experimentation.
2. Understand the fundamental principle of different analytical methods and instruments.
3. Systematically identify organic functional groups.

Paper 16
Course ME207
Workshop Practice
Course Objectives:
Designed for the core course on Workshop Practice offered to all first-year degree level students of engineering, Workshop Practice presents clear and concise explanation of the basic principles of manufacturing processes and equips students with overall knowledge of engineering materials, tools and equipment commonly used in the engineering field. The curriculum describes the general principles of different workshop processes such as primary and secondary shaping processes, metal joining methods. The workshop processes covered also include the hand-working processes such as bench work, fitting, welding, sheet metal work, and carpentry. It also explains the importance of safety measures to be followed in workshop processes and details the procedure of writing the records of the practices. The tools and equipment used in each hand-working process are enumerated before elaborating the process.

Fitting Shop: Introduction to different hand tools, equipment and measuring devices, sawing, filing & drilling process. Practice Jobs on Mild Steel Plate, Production of nuts and bolts.
Carpentry Shop: Specification of wood and wood products, Introduction to Tools and equipment, different wood joints. Practice jobs on Dove Tail Notch or Dovetail Bridle Joint or Cross Joint
Forging Shop: Demonstration of forging a Octagonal Chisel.
Welding Shop: Metal joining process, Arc welding practice.
Sheet metal work: Sheet metal work through, production of funnel.

Course Outcomes:
At the End of Course, students will able to understand as well as familiar with carpentry, fitting, forging, welding and sheet metal work through the following areas.
1. Nomenclature, application use of different hand tools.
2. To get familiarized with the properties of different engineering materials- metals & alloys and non metals.
3. To learn about the various measuring devices and to know about the importance of sequential plans of action in manufacturing through practice in various sections.
4. Acquire knowledge about, different measuring instruments their working principle, application areas and able to handle the same.
5. Hands on practice of simple job related to Fitting shop
7. Overview of Forging Shop.
8. Sheet metal working, through Construction of Funnel.
9. Introduction to welding Process-through practice job using MMAW.

Reference Books:

Paper 17
Course ME208
Engineering Drawing
Course Objectives
Primary objective of the course of Engineering Drawing is to understand the language of engineers which is very much essential for engineering career. Students of all engineering disciplines to develop a spatial bent of mind to observe, visualize and understand the structure of objects from different perspectives.

**Module1:** Engineering Lettering, Numbering
**Module2:** Types of Lines and Dimensioning methods.
**Module 3:** Construction of Plane Scales, Diagonal Scales & Venier Scales.
**Module 4:** Engineering Curves – Parabola, Ellipse, Involute
**Module 5:** Orthographic Projection of Points, Lines, Surfaces, Solids and Section of solids.
**Module 6:** Introduction of Isometric projection.
**Module 7:** Introduction to CAD tools – basics; Introduction of Development and Intersection of surfaces.

**Course Outcomes:**
Course Outcomes at the End of Course, students will able to solve the problems in the following areas.
I. Construction and Interpretation of drawing scales as per the situation.
II. Generation of simple Curves like ellipse, cycloid and Involute of circle, square.
III. Visualization and generation of Orthographic projections of points, lines and planes.
IV. Visualization and generation of Orthographic projections of solids like cylinders, cones, prisms and pyramids.
V. Layout development of solids for practical situations.
VI. Development of isometric projections of simple objects.

**Reference Books**
1. Engineering Drawing By N.D. Bhatt Pvt. Ltd.,
2. Engineering Drawing By N S Parthasarathy and Vela Murali, Oxford University press

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**Paper 18**  
**Course CS209**  
**50 marks /1.5 Credits**  
**Computer Programming Lab**

**Course Objective:**
The objective of this practical course is to conceptualize the basic features of programming language. The students will learn how to write the different programs for simple to advanced problems using C language.

**Experiments on the following topic:**
The assignments will be given based on the topics covered in Module-II and Module-III of CS 204. They will write the programs using C.

**Course Outcome:**
1. The students will learn how to analyze a given problem.
2. They can identify what types of the variables, data structure are required to solve a problem.
3. Students can write program for a given problem.
4. They will understand how to prepare test set for a given problem.

**Reference Books:**
1. The C programming Language by Brian W. Kernighan and Dennis M. Ritchie
2. Programming with C by Byron Gottfried
3. Programming in ANSI C by E. Balagurusamy
4. Understanding Pointers in C by Kanetkar Yashavant P.

Paper 19
Course BE210
Basic Electronics Lab
Course Objective:
The objective of this course is to train the students on the working of semiconductor diodes and transistor circuits, analog electronic circuits using operational amplifiers, digital logic circuits using Gates through hands-on-experiments.
Each experiment should be carried over bread boards and/or kits. Experimental observations should be properly tabulated and/or represented graphically. The derived results from experimental data should be compared with theoretical models and errors should be properly reported. Conclusion should be scientifically drawn. Each experiment should be preceded with a theoretical discussion of the concerned topic and identification of the associated circuit components and/or measuring instruments.

Experiment 1: Identification of Circuit Components
Study of resistors, capacitors and inductors. Determination of values and comparison of the same with measurement by multi meters/ LCR meters.

Experiment 2: Semiconductor Diodes
(a): Identification of Ordinary P-N diode and Zener Diode.
(b): Study the Forward Bias V-I Characteristics of P-N Junction Diode and determination of impedance.
(c): Forward and Reverse Characteristics of Zener Diode, Load Voltage and Line Voltage Regulation.

Experiment 3: Bipolar Transistors
(a): Identification of NPN and PNP Bipolar Transistors.
(b): Study input & output characteristics of transistor in CE & CB modes and determination of hybrid parameters.

Experiment 4: MOSFET
(a): Identification of MOSFET
(b): Study V (DS) vs. I (D) characteristics and Study V (GS) vs. I (D) characteristics and hence to calculate the MOFET parameters.

Experiment 5: Analog Electronics using Operational Amplifiers
(a): Identification of 741C OPAMP, pin diagram and power supply requirements. Concept of positive and negative supply.
(b): Study of inverting and non-inverting amplifier configurations.
(c): To use integrating and differentiating circuits with 741C OPAMP and study with C.R.O. Measurement of phase and frequency with C.R.O.

Experiment 6: Digital Electronics using Logic Gates
(a): Identification of various digital logic gates.
(b): Study of NOT, OR, AND, NAND, NOR & XOR gates and verification of truth tables.

Course Outcome:
As outcome of this course, the students will develop a mindset to verify the principles of electronics using practical devices and components. The practical utilities and performance of basic electronic devices and circuits will thus be clearly demonstrated.

Semester III
(Theory)

Paper 20
Course CT301
Chemical Technology –I

Module I: Process Calculation

50 marks /2 Credits

Units and Dimensions: Basic and derived Units, Different ways of expressing units of quantities and physical constants. Dimensional analysis and representation of results.
Stoichiometric principles: Properties of gases, liquids and solids, Critical properties.
Properties of mixtures and solutions and phase equilibria, vaporisation, drying, condensation.
Wet and dry bulb thermometry. Concept of relative humidity, molal humidity, dew point, partial saturation.
Material Balance: Recycle, purging, bypass in batch, stage wise and continuous operations in systems with and without chemical reactions.
Thermochemistry – heat of formation, combustion, solution, dilution and the effects of pressure on them.
Calculation of theoretical and actual flame temperature during combustion of fuels.
Energy balance of systems with and without chemical reactions, unsteady state material and energy balances.
Combined material and energy balances for nuclear, electrochemical, photochemical and biochemical and less conventional separation processes.
Typical industrial applications.

Recommended Books :
1. Basic Principles And Calculations in Chemical Engineering - D. M. Himmelblau, PHI Learning Pvt. Ltd.
3. Introduction to Process Calculations Stoichiometry - KA. Gavhane, Nirali Prakashan

Module II: Introduction to Statistical Analysis

50 marks /2 Credits
Review of elementary probability theory, Bayes theorem, Random variables, Functions of random variables, probability distribution functions, expectation, moments and moment generating functions, Joint probability distributions, binomial, Poisson, and Normal distribution. Sampling distributions, Point and interval estimations, Statistical hypothesis tests, t-tests for one and two samples, F-test, $\chi^2$-test, tests of hypothesis for proportion, Simple Applications. Statistical Methods for Data Fitting: Linear, multi-linear, non-linear regression, ANOVA
Differential Calculus: Review and Concepts, Higher order differentiation and Leibnitz Rule for the derivative, Rolle’s and Mean Value theorems, Taylor’s and Maclaurin’s theorems, Maxima/Minima, convexity of functions, Asymptotes, Radius of curvature; Nonparametric statistics; wilcoxon rank, friedman analysis

Recommended Books:
1. Fundamentals of statistics, volume 1 - Gun Gupta and Das Gupta, World Press
2. Statistical Methods - N G Das, M Das co
3. Textbook of Differential Calculus - Akhtar and Ahsan, PHI learning

Paper 21
Course CT302
Chemical Technology – II

Module I: Organic Technology 50 marks /2 Credits
Spectroscopic analysis of organic compounds involving UV, NMR and MS.
Heterocyclic chemistry of compounds of industrial importance.
Dyes and pigments – chemistry and applications
Feedstock sources for the organic chemical industries and uses of principal organic chemicals in industries based on these chemicals.
Principal organic chemical industries manufacturing Polymers, Adhesives, Paints and Varnishes, Printing Inks, Dyes, Products by Fermentation, Synthetic fibres, Sugars, Paper and Explosives – Production statistics, raw materials, processes employed, safety and pollution aspects.
Studies of the principles of unit processes viz., Nitration, Sulphonation, Halogenation, Hydrogenation and the application of these processes for the manufacture of principal organic chemicals.
Stereospecific synthesis, stereochemical analysis and structure elucidation.
Concepts of combinatorial chemistry.

Recommended Books:

Module II: Inorganic Technology 50 marks /2 Credits
Water treatment and conditioning, Scale and sludge formation, Desalination of water, Membrane process, Piezodialysis and Reverse Osmosis.
Chemistry and applications of rare earth elements and their oxides.
Selected chemical industries – Fertilizers, caustic soda, chlorine, soda ash.
Electrochemical Industries and important products.
Electrothermal Industries - Artificial abrasives, Calcium Carbide, Graphite.
Nuclear Fuels, Nuclear Reactor.
Important industrial gases – CO\textsubscript{2}, H\textsubscript{2}, O\textsubscript{2}, He.
Production of important mineral acids – H\textsubscript{3}PO\textsubscript{4}, H\textsubscript{2}SO\textsubscript{4}, HCl and HNO\textsubscript{3}.
Commercial Production of Dichromate, Permanganate and Alum.

Recommended Books
1. Dryden's outlines of Chemical Technology for the 21st century
   M. Gopala Rao & Marshall Sittig
2. Manual of Chemical Technology
   Inorganic Products - D. Venkateswarlu

Paper 22
Course CT303
Chemical Technology –III

Module I: Energy Technology 50 marks /2 Credits

Recommended Books :
1. Fuels & Combustion, 3\textsuperscript{rd} edition, Dr. Samir Sarkar, Universities Press
2. Elements of Fuels, Furnaces & Refractories – Prof. O.P.Gupta, Khanna Publishers

Module II: Biotechnology 50 marks /2 Credits
Introduction to Biotechnology:
Classification of enzymes, sources and characteristics; Bioprocesses, whole cell and cell free systems. Kinetics of enzyme reactions, rapid reaction kinetics, kinetics in water rich and water deficient medium.
Bioreactors, types of bioreactors, bioreactor design and control parameters; Fermentation process technology; Biomaterial separation processes.
Industrial biotechnology for food, antibiotics, organic acids, enzymes, alcohols, perfumery chemicals and biodegradable polymers.
Biotechnology products and processes as applied in i) fats and oil technology, ii) pharmaceutical & fine chemical technology, iii) petrochemicals & petroleum refinery technology, iv) Ceramic technology, v) biomaterials and composites, vi) metallurgy and mineral dressing.
Environmental biotechnology concepts and application: Industrial waste management, air quality and control, bio-waste management.
Energy Biotechnology: Biogas, biodiesel, alternative energy sources like methane, hydrogen, biotransformations bioenergy economics.

Recommended Books:
2. Biotechnology for beginners by Reinhard Renneberg.

Paper 23
Course CT304  100 marks /4 Credits
Chemical Engineering I
(Fluid Mechanics)
Module I
Introduction to fluids, Forces on fluids, Normal & shear stresses
Fluid Statics: Pressure distribution, Manometry, Forces on submerged bodies, Buoyancy
Euler’s equation of motion, Bernoulli’s equation and applications, Fanning equation, Friction factor vs. Reynold’s plot, Concept of equivalent length; Boundary layer theory, Laminar and turbulent flow
Pressure drop and energy considerations in flow of fluids, Flow through packed bed, Settling of solids, Free settling, Hindered settling, Concept of fluidization

Module II
Flow measurement (Venturimeter, Orificemeter, Rotameter, Pitot Tube, Weir)
Fluid transportation equipment and accessories, Process pumps: reciprocating, rotary and centrifugal pumps, NPSH, Cavitation, Construction and application of valves, Blowers and compressors.

Recommended Books :

(Practical)

Paper 24
Course CT305
50 marks /2 Credits
Organic Technology Lab.
1. Calibration of thermometers for, the determination of melting points and boiling points.
2. Complete qualitative analysis and identification of single organic compound having one or more functional groups.
3. Preparation of organic compounds involving some typical organic reactions and separation and purification techniques.
4. Isolation of some natural products.
5. Estimation of organic compounds via functional groups.

Recommended Books:

Paper 25
Course CT306
50 marks /2 Credits
Inorganic Technology Lab
1. Water analysis, Hardness, chlorides, TDS
2. Application of Hg₂(NO₃)₂ in estimation of Fe³⁺ in inorganic materials
3. Complexometric method of determination of cations using EDTA: Mg²⁺, Ca²⁺, Ba²⁺, Zn²⁺, Cd²⁺, Fe³⁺, Al³⁺, Bi³⁺, Mn²⁺, Cr³⁺, Cu²⁺, Ni²⁺, Co²⁺ and some of their mixtures.
5. Standardization of HCl and KMnO₄ by EDTA.
6. Estimation of some trace elements in inorganic materials by colorimetric, flame photometric titration.
7. Application of atomic absorption spectroscopy for analysis of trace elements.
8. Differential Thermal analysis of some inorganic minerals and ores

Recommended Books :
1. Quantitative Inorganic Analysis – A. I. Vogel
Paper 26
Course CT307  
Physical Chemistry Lab  
1. Determination of viscosity coefficient  
2. Determination of surface tension  
3. Determination of distribution coefficient  
4. Determination of equilibrium constant (homogeneous)  
5. Determination of phase diagram (ternary system)  
6. Determination of adsorption isotherm.

Recommended Books :  
1. Advanced Practical Chemistry – Subhas C. Das

Paper 27
Course CT308  
Instrumental Method of Analysis  
1. Basic Principles, Instrumentation and application of  
   a. GC  
   b. HPLC  
   c. UV and VIS spectrophotometers  
   d. IR  
   e. DTA and  
   f. TGA.  
2. Instrumentation and Application of  
   a. Conductometry and  
   b. Potentiometry.

Semester IV  
(Theory)

Paper 28
Course CT401  
Engineering Thermodynamics  
Module I

Introduction- scope of thermodynamics, Dimensions and Units, Temperature, Pressure, Work, Energy, Heat. Energy conservation & first law of thermodynamics; State functions; Equilibrium; Phase Rule; Reversible process; Constant P,V, T processes; Mass and energy balances for open systems .

Phases, phase transitions, PVT behavior; description of materials – Ideal gas law, van der Waals, virial and cubic equations of state; Reduced conditions & corresponding states theories;
correlations in description of material properties and behavior. Heat effects-latent heat, sensible heat, standard heats of formation, reaction and combustion.

Statements of the second law; Heat engines, Carnot’s theorem,; Thermodynamic Temperature Scales; Entropy; Entropy changes of an ideal gas; Mathematical statement of the second law; Entropy balance for open systems; Calculation of ideal work, Lost work.

Thermodynamic property of fluids, Maxwell relations, 2-phase systems, graphs and tables of thermodynamic properties. Application of thermodynamics to flow processes-pumps, compressors and turbines.

Thermodynamic analysis of steam power plants; Rankine cycle; Internal combustion engine, Otto engine; Diesel engine; Jet engine. The Carnot refrigerator; Vapor-compression cycle; Absorption refrigeration; Heat pump, Liquefaction processes.

Vapor-liquid equilibrium: phase rule, simple models for VLE; VLE by modified Raoult’s law; VLE from K-value correlations; G-D Equation, VLE for non-ideal solution (Van Laar equation), Flash calculations.

Module II

Solution Thermodynamics: fundamental property relationships, free energy and chemical potential, partial properties, definition of fugacity and fugacity coefficient of pure species and species in solution, the ideal solution and excess properties.

Liquid phase properties from VLE, Models for excess Gibbs energy, heat effects and property change on mixing. Liquid-Liquid Equilibria; Vapor-Liquid-Liquid Equilibria; Solid-Liquid Equilibria; Solid-Gas Equilibria.

Chemical reaction equilibria: equilibrium criterion, equilibrium constant, evaluation of equilibrium constant at different temperatures, equilibrium conversion of single reactions, multireaction equilibria.

Introduction to molecular/statistical thermodynamics

Recommended Books

2. A Text Book of Chemical Engineering Thermodynamics, Narayanan, PHI

Paper 29
Course CT402
Chemical Engineering II (Process Heat Transfer)
Module I
Heat transfer fundamentals: Modes of heat transfer
Conductive heat transfer: Conduction mechanism of heat transfer, Fourier’s law, Steady state of heat transfer through composite slabs and composite cylinders, Heat transfer from extended surfaces, Concept of unsteady state heat transfer
Convective heat transfer: Heat flow mechanism by convection, Individual and overall heat transfer coefficient, Log-mean temperature difference, Forced convection inside tubes and ducts – Dittus-Boelter equation, Reynold’s analogy, Natural convection
Design of heat transfer equipment: Types of heat exchange equipment and design of heat exchangers –shell and tube heat exchangers, double pipe heat exchangers
Basics of heat transfer with phase change: Introduction to boiling, Introduction to condensation, Condensers and reboilers

Module II
Introduction to radiative heat transfer: Concept of black body and laws of black body radiation, Kirchoff’s law, Emissivity, Radiant heat transfer between surfaces separated by non-absorbing media
Evaporation: Mechanism of vaporization, Single and multiple effect evaporator, Calculations for optimum number of effects

Recommended Books
1. Process Heat Transfer - D. Q. Kern, MGH.
2. Heat Transfer Principles and Application - B. K. Dutta, PHI.

Paper 30
Course CT403
Chemical Technology –IV
Module I: Process Instrumentation 50 marks/2 Credits
Transducer, signal conditioning and display devices with block diagram.
Errors and Lags associated with instruments. Calibration of instruments.
Temperature measurement: Temperature measurement using change in physical properties. Electrical type temperature sensors. Optical and radiation pyrometers.

Pressure measurement: Industrial manometers, elastic type pressure gauges, vacuum measuring gauges.

Flow measurement: Head flow and area flow meters, mass flow meters, solid flow measuring methods.

Liquid level measurement: Float type, displacer type devices, hydrostatic method, ultrasonic and nucleonic methods.

Instruments for viscosity, humidity, pH measurements. Instruments for gas analysis and composition analysis.

Module II: Process Dynamics & Control  
50 marks/2 Credits

Degrees of freedom, deviation variables, steady state gain, time constants, review of Laplace transform, input-output model, system response for first order and higher order systems, dynamics with dead time, inverse response.

Transfer function, 1\textsuperscript{st} order system, 2\textsuperscript{nd} order system, Examples of 1\textsuperscript{st} order system & 2\textsuperscript{nd} order system.

Introduction to chemical process control with examples, objectives of process control, control strategies and alternative control schemes, process stability, concept of optimum performance of chemical process.

Mathematical modeling of liquid level problems, stirred tank heater, mixing processes, CSTR, distillation column, absorption column, distributed parameter systems, linearization, SISO and MIMO systems.

Feedback control, P, PI, PID controllers and their response.

Control system instrumentation: sensors for liquid level, flow, pressure, temperature, and pH measurement, transmission line, comparator, controller, and final control elements, control valve sizing, pneumatic and electronic controllers.

Closed loop control systems, transfer function of individual elements, servo and regulator problems, dynamics of P, PI and PID controllers.

Stability of closed loop control systems, Routz-Hurwitz test, root locus analysis.

Feedback controller design, controller tuning, Ziegler-Nichols rules, Cohen and Coon rules, Integral error criteria, controller selection, process identification.

Frequency response, Bode plot and Nyquist diagram.

Introduction to advance control strategies: feed forward, control, cascade control, ratio control, adaptive control and inferential control.

Digital computer control, Z-transformation, discrete time dynamics, digital feedback controller design. Design of control system for complete process plants.

Recommended Books


Paper 31
Course CT404 CER/OLT/PPR/PFC  
100 marks /4 Credits

CER: Ceramics Engineering I
Module I: Ceramic Fabrication Process
Introduction to ceramic raw materials – their availability, geology and microstructure.
Hand moulding, ramming, extrusion, injection moulding.
Fabrication by pressure: classification according to water content. Dry and semi-dry pressing.
Hot pressing and reactive hot pressing, cold and hot isostatic pressing.
Application of different types of monolithics and gunning materials.
Fusion casting: Different types of moulds and presses.
Slip casting processes of clay based systems and non-plastic bodies: properties of the slip,
mechanism of slip casting, nature of plaster moulder.
Fabrication processes used in forming of glass articles:
Blowing, pressing, drawing and sheet making.
Sintering and controlled vitrification of shaped bodies.
Particle packing – Westman diagram.
Drying: Critical moisture content, different types of dryers.
Firing: Physicochemical changes, different kilns.

Recommended Books:

1. Introduction to the principles of ceramic processing - J. S. Reed
2. Industrial Ceramics: Singer and Singer
3. Ceramic Processing and Sintering – M. N. Rahaman
4. Rheology of Ceramic systems: F. Moore
5. The Chemistry and Physics of clays and other ceramic materials: Rex W. Grimshaw
6. Ceramic Processing before firing : Onoda and Hench

Module II: Physics and Chemistry of Ceramic Clays
Introduction to different types of clays used in ceramic industries – the availability and applications. Origin and classification of clays – geological aspects. Influence of different internal and external factors on the attributes of clays.
Basic features of silicate structures.
Structural classification of clay minerals.
Atomic disposition and charge distribution in different layer lattice minerals.
Physico-chemical relationship in clay-water system. Rheological properties and their applications. Plasticity of clays.
Methods of identification of clay minerals.
Effect of heat treatment on the phase transformation of clay minerals.
Differential thermal analysis of clay minerals. Ion exchange properties - its importance and methods of measurement. Colloidal properties of clay-water systems. Particle size, shapes and their distribution in relation to properties. Suitability of clay for particular industries.
Processing and beneficiation of some commercial clays and conversion to mono-ionic forms.

Recommended Books:

1. The Chemistry and Physics of clays and other ceramic materials: Rex W. Grimshaw
2. Clays and ceramic raw materials: W. E. Worral
3. Properties of ceramic raw materials: W. Ryan
4. Industrial Ceramics: F. Singer and S. S. Singer

OLT: Oil Technology I
Module I
Chemistry & Analysis of Fats, Oils and Waxes
Introduction to molecular nature and uses pattern of fats & oils; demand and supply position of edible and non-edible oils. Source and availability of fats and oils; vegetable source, marine and land animal source and microbial source.
Physical properties of fats and oils: thermal rheology, polymorphism, surface active, spectral and optical properties.
Chemical composition of fats and oils; fatty acids, triglycerides, non-triglycerides, minor constituents. Nomenclature; Basic reactions of fats and oils base on double bonds & ester bonds; Hydrogenation, oxidation and auto -oxidation, polymerization, hydrolysis, esterification, interesterification, sulphonation,amidation, on, pyrolysis etc. Frying reactions.
Fats and oils analysis : Basics of various methods of analysis; physical and chemical methods of analysis; chromatographic methods of analysis( TLC, GLC, HPLC): spectroscopic methods of analysis (UV, IR, NMR, MS): detection of adulteration by chemical, spectroscopic, colour and other instrumental methods.
Bio-availability and digestibility of fats & oils; Fats in nutrition, health and disease and dietary guidelines.

Module II: Introduction to Polymer Basics and Surface Coating Technology
Definition and classification of coatings, present Status of coatings, coating ingredients and coating applications.
Corrosion & its prevention
Fundamentals of clear coatings
Drying oils: their modification, mechanism of film formation and film deterioration on ageing
Solvents and Plasticizers: Their characteristics and classifications.
Manufacturing of varnishes: types of equipments, composition and uses, faults and defects of varnishes and varnish films. Manufacture of lacquers and their applications.

Recommended Books:

1. Chemistry & Technology of Oils & Fats – M. M. Chakraborty
2. Principles of Polymer Chemistry – P. J. Flory
4. The Chemical Constitution of Natural Fats- T. P. Hilditch and P. N. Williams
5. Paint and Surface Coatings - R. Lambourne and T. A. Strivens
Module I: Natural Gas, Crude Oil & Petroleum Products overview
Natural Gas & Crude Oil Exploration, Production & Transportation – Properties of Natural Gas, Shale Gas, Shale Oil, Gas Hydrates & Crude Oil and various methods of exploration. Cross-country transfer of crude oil & gas to refineries & petrochemical plant.
Crude Oil Evaluation, Analysis – Crude assay, Four cut method
Petroleum Products overview with Specifications and Standard Test methods – BIS specification, Euro specification, IP test methods

Module II: Refinery Operations I
ASTM & TBP Distillation- preparation of EFV & TBP curves
Atmospheric and Vacuum Distillation, Absorber, Stripper, Splitter, Prefractionator; Distillation with Valve trays & Packed bed, Divided wall column
Desalting – theory, operating conditions, technology & application.
Gas Plant operations – objectives, process & application.

Recommended Books


PFC: Pharmaceutical and Fine Chemical Technology I

Module I: Pharmaceutical Chemistry
Principles of pharmacopoeial analysis, Source of pharmaceuticals and impurities concepts, API and excipients studies.
Source, biogenesis, extraction techniques and chemistry of alkaloids, terpenoids, steroids, glycosides and polyphenols.
Instrumental techniques in drug analysis including UV-Vis, FTIR, NMR, AAS, Flourimetry, HPLC and HPTLC. Principles and applications of Tracer techniques and Imaging analysis in optical microscopy, SEM, TEM, AFM.

Module II: Biochemistry & Microbiology
Classification of microbes, identification, isolation, preservation, growth and kinetics. Sterilization techniques and disinfection. Principles of cell based studies like flow cytometry and confocal microscopy.
Recommended Books:
1. D. A. Skoog: Principles of Instrumental Analysis (Saunders College Publishing Philadelphia)
2. M. Orchin and H. H. Jaffe – Theory and applications of ultra violet spectroscopy (John Wiley and Sons, N. Y.)
3. Silverstein, Basserler, Moril – Spectrometric identification of organic compounds (John Wiley and Sons, N. Y.)
4. Willard, Merritt, Dean – Instrumental Methods of Analysis (CBS Publishers and Distributors, Delhi)
7. Higuchi: Instrumental Methods of Analysis (CBS Publishers)
8. Analytical Chemistry by open learning series
11. Indian Pharmacopoeia, VIIth Ed, 2014, Indian Pharmacopoeia Commission
Biotechnology Lab

1. Microbial culture. Microbial cell growth and kinetics, Staining and microscopy study of microorganisms.
3. Production of metabolites in synthetic and complex media, Monod equation, Estimation of monod parameters in batch, fed-batch and continuous cultures and solid state fermentation.
4. Sterilization of medium, sterilization cycle. Inoculation and microbial preservation techniques.
5. Stirred Tank Reactor operation for controlled bacterial growth; Study of rheology of fermentation broth in batch bioreactor.

Recommended Books:


Energy Technology Lab

Sampling techniques for solid, liquid and gaseous fuels for analysis.


Tests of liquid fuels: viscosity, flash point, fire point, water content, carbon residue, ash, calorific value, aniline point.

Tests of gaseous fuels: Orsat analysis, calorific value.

Calibration of thermocouples.

Thermal conductivity of insulating materials.

Recommended Books:

1. Fuels & Combustion, 3rd edition, Dr. Samir Sarkar, Universities Press


3. Elements of Fuel Technology, Himus
Special Lab I

CER : Ceramic Engineering Lab I  (at least 5)

Chemical Analysis of Ceramic Raw Materials and Products:
Opening of different types of ores and minerals by chemical interaction.
Chemical analysis of water and acid soluble materials:
Water glass, Borax, Portland cement (complete analysis and insoluble residue), Zeolites, Blast furnace slag, Magnesite, Dolomite, Limestone.
Analysis of materials by fusion method:
Refractories: Bauxite, Kyanite, Sillimanite, Chromite, Quarzite.
Fluxes: Feldspar, Slags, Nepheline Syenite
Clays: China clay, Fire clay, Bentonite, Mica and Vermiculite.
Miscellaneous: Rock phosphate, Gypsum, Hematite, Ilmanite, Talc and Cryolite.
Direct estimation of CaO, Fe$_2$O$_3$ and SiO$_2$ in Portland cement.
Estimation of some special constituents in:
Zircon, Chromite, Lepidolite, Fluorapatite, Synthetic mullite.

OLT: Oil Technology Lab I

Analysis of oils & meals
Analysis Oils: Physical tests- density, refractive index, slip point, cloud point, cooling curve, solubility – tests in solvents, color measurements, etc. Fatty acid composition analysis by GLC. Conjugated diene, triene content by UV method.
Chemical tests – acid value, peroxide & anisidine values, saponification and iodine values, hydroxyl values, oxirane values, Reichert-Meissl, Reichert-Polenske, Kirchner values, unsaponifiable matter, gum (phospholipids) content, wax content, acetone and benzene insolubles, color reactions of oils. Detection of adulterants.

Recommended Books

1. Official Methods and Recommended Practices AOCS of the AOCS

PPR: Petrochemicals & Petroleum Refinery Engineering Lab I

Evaluation of Crude Oil
Fractionation of Crude Oil
Evaluation of Crude oil & Crude Assay.
Construction of Mid percent and Yield curves

Recommended Books

PFC: Pharmaceutical and Fine Chemical Technology Lab – I

Pharmaceutical Chemistry I

1. Pharmacopoeial tests and assay of representative organic and inorganic compounds like sodium chloride, sodium benzoate, aluminium hydroxide gel etc.
2. Limit tests for arsenic, heavy metals and anions.
3. Laboratory preparation for Pharmacopoeial compounds in one or two step: aluminium hydroxide gel, sodium benzoate, sodium chloride.

Recommended Books:

2. Indian Pharmacopoeia, VII Ed, 2014, Indian Pharmacopoeia Commission

Paper 35
Course CT408 CER/OLT/PPR/PFC 50 marks /2 Credits

Special Lab II

CER: Ceramics Engineering Lab II (at least 5)

Chemical Analysis of Ceramic Raw Materials and Products by Instrumental Techniques:
Analysis of some redox systems.
Alkalis in feldspar and glass.
Boric Oxide in glass.
Estimation of ceramic material by atomic absorption spectroscopy:
   \( \text{Fe}^{3+}, \text{Ti}^{4+}, \text{Co}^{2+}, \text{Ni}^{2+} \) and \( \text{Mn}^{2+} \).
Identification of phases in ceramic raw materials and products by:
   Microscopic technology, XRD, DTA & TGA.
Evaluation of some solid industrial waste materials and their utilization.

Recommended Books:

Quantitative Inorganic Analysis – A. I. Vogel
Analysis of ceramic raw materials – S. Kumar and D. Ganguli

OLT: Oil Technology Lab II

Fats and Oil Processing
Practical on oilseeds and Oils/Fats etc.; Pretreatment and storage of oil-bearing materials; Extraction of oils and fats from vegetable and animal sources: pressing, solvent rendering; Analysis of seed cakes; Extraction of protein and other non-oil components such as dietary fibre, carbohydrate etc.
Detection of adulteration

Recommended Books

1. Official Methods and Recommended Practices AOCS of the AOCS
PPR: Petrochemicals & Petroleum Refinery Engineering Lab II
Testing of Crude Oil & Petroleum Products
ASTM Distillation of Crude oil & Petroleum products.
Standard ASTM/IP tests of different products – flash point, pour point, carbon residue, burning quality, sulfur content, water content, sediment, smoke point, softening point, drop point, cone penetration, needle penetration etc.

Recommended Books:


PFC: Pharmaceutical and Fine Chemical Technology Lab II

Microbiology I
1. Different media preparations
2. Sterilization by dry heat, moist heat and filtration.
3. Validation of sterilization
4. Environmental control tests
5. Microbial staining
6. Identification and isolation from soil sources.
7. Tests and quantification for proteins, carbohydrates, fats and amino acids.

Recommended Books:


Semester V
(Theory)

Paper 36
Course CT501

Chemical Engineering III
Mass Transfer Operations: General principles of diffusion and mass transfer, Molecular and eddy diffusion of fluids, Diffusivities,
Convective mass transfer: Mass transfer coefficients and their relationships, Interphase mass transfer, N.T.U., H.T.U. methods.
Mass transfer theories and models
Distillation: Vapour-liquid equilibria, batch and equilibrium distillation, Steam distillation, azeotropic and extractive distillation, Enthalpy concentration diagram, Rectification column design, McCabe – Thiele method, Ponchon – Savarit method.
Simultaneous heat and mass transfer operations: Humidification and Dehumidification principles, psychometric chart, Drying principles and driers.
Recommended Books:


Paper 37
Course CT502 100 marks /4 Credits
Reaction Engineering

Module I
Effects of process variables on rate of reaction, interpretation of kinetic data in batch and flow systems.
General feature and design equation for batch, plug flow, semi batch, stirred tank reactors.
Elementary problems in the design of homogeneous reactors, batch and flow tubular and stirred tank reactors.
Multiple reactions – conversion, selectivity, yield, series, parallel and mixed series –parallel reactions.
Combination of reactors
RTD theory and analysis of non-ideal reactors.

Module II
Introduction to Catalysis, homogeneous and heterogeneous catalysis, preparation and characterization of catalysts
Physical & chemical adsorption, Adsorption Isotherms, measurement of catalyst surface area and catalyst porosity
Mass transfer, Diffusion and chemical reactions in catalysts, Effects of external mass transfer and heat transfer, Effectiveness factor. Design aspects of catalytic reactors.
Laboratory reactors for gas-solid reactions, design concepts.
Gas liquid reactions, film & penetration theories and gas-liquid reactors.

Recommended Books:
3. H. S. Fogler, Elements of Chemical Reaction Engineering
A. Safety & Hazard Analysis
Introduction: Safety program, engineering ethics, accident and loss statistics, acceptable risk, public perception. Material safety data sheet (msds), storage, handling and use of hazardous chemicals, occupational health hazards.
Toxicology: How toxicants enter & eliminate from biological system.
Industrial hygiene: Government regulations, identification, evaluation, control
Fires and explosions: The fire triangle, distinction between fire and explosions; definitions, flammability characteristics of liquids and vapors, loc and inerting, ignition energy, auto ignition, auto oxidation, adiabatic compression, explosions.
Designs to prevent fires and explosions: Inerting, explosion proof equipment and instruments, ventilation, sprinkler systems.
Introduction to reliefs: Relief concepts, definitions, location of reliefs, relief types, relief systems.
Hazards identification: Process hazards checklists, hazard surveys, hazop & hazan study.
QRA, Logic trees, FTA, ETA, Boolean notation.
Safety Audit, Legal aspects of Safety (Factory’s Act), on site Emergency plan.

Recommended Books:
2. Elements of Industrial Hazards: Health, Safety, Environment and Loss Prevention, by Ratan Raj Tatiya, CRC Press.

B. Industrial Pollution: Control and Management
Environmental pollution from Industries with special reference to Process Industries. Pollutants- nature, types and sources; consequences.
Air and Water Pollution, Solid wastes. Episodes of Industrial hazards and pollution: Minamata, Love Canal, Flixborough, Bhopal and Chernobyl.
Elements of Ecology and Environment. Atmosphere, Hydrosphere and Lithosphere. Short and long term Ecosystem and Biosystem impacts of Pollution. Bioaccumulation and Biomagnification, Ecotoxicity, Carcinogens, Hormone disruptors, Radiation Hazards
Water as Environmental Resource, Criteria of Water Pollution: Physical, Chemical and Biological Criteria-Suspended and Dissolved matter; Organics-Biodegradable and Non-biodegradable; Heavy metals and other inorganic pollutants.


Sound Pollution, Intensity Levels and Control.


Industrial Processes and Pollution- Case studies-Cement, Paper, Fertilizer, Paint, Pharmaceuticals, Petrochemicals.


Sustainability Concepts, Ecosystem approach.

Green Chemistry Principles and Practices

Recommended Books:

1. Introduction to Environmental Management, Mary K Theodore, SOAS, Univ of London
2. Wastewater Engineering (Including Air Pollution), B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain
3. Air Pollution Control Engineering - Noel De Nevers (McGraw-Hill)

C. Project Engineering

Module I
Role of a project engineer, Development of project- Laboratory bench scale experiment to pilot & semi-commercial plant operation, scale up and scale down techniques, pre-design cost estimation, fixed capital and working capital, Manufacturing cost, plant location factors, selection of plant site, process design development, plant lay-out.

Module II
Time value of money, simple interest, Nominal & effective interest rates, continuous interest, present worth & discount, Annuities, perpetuities and capitalized cost, Depreciation.
depreciation, Depletion, Concepts of service life, Salvage value and Book value; Depreciation calculation by straight line method, Text book and double declining balance method, sum-of-the-years digit method and sinking fund method.

Profitability analysis method: Return on investment (ROI), payout period, Optimum design, Break-even point, Optimum production rate, Optimum conditions in cyclic operations, optimum economic pipe diameters, optimum flow rate, & cooling water.

**Module III**

Project scheduling: Bar chart, Milestone chart, Concept of network analysis: PERT, CPM, statistical distribution associated with PERT network, Earliest expected time, and latest allowable occurrence time calculation, Slack, determination of critical path, concept of float.

**Module IV**

Inventory and Quality Systems: Function of Inventories, Category of Stocks, Procurement costs, Inventory Holding costs, Inventory Control, ABC analysis, Inventory control, EOQ, Inventory control modelling, Re Order Point, Lot Sizing and Analysis. Current Approaches: Concepts of MRP and JIT-based production systems, Concept of zero inventory, Computerization of inventory and production management systems.

Managing for Quality: Total quality emphasis, Quality circles, Quality analysis and control, Control Charts, UCL, LCL.

Recommended Books:

1. Projects, 8th Ed. by Prasanna Chandra, McGraw Hill Education
2. Production and Operation Management: Concepts, Models, and Behavior by Everett E Adam, Ronald J Ebert, Prentice Hall
3. Plant design and Economics for Chemical Engineers by Max S Peters, Klaus D Timmerhaus, Ronald E. West, McGraw-Hill Education
4. NPTEL lectures on Project Engineering and Management, https://nptel.ac.in

**Paper 39**

Course CT504 CER/OLT/PPR/PFC 100 marks /4 Credits

Special Paper II

CER: Ceramics Engineering II

**Module I: Refractories: Processing and Properties**


Preliminary concept of binary and ternary phase diagrams related to important ceramic systems. Different types of shaping processes: Mould materials, design, evaluation of the shaped compacts.

Drying of the shaped materials. Different types of driers, controlling factors influencing drying efficiency.
Forming. Selecting the different types of intermittent and continuous kilns. Temperature measurement in kilns.
Specification of different types of refractories.
Refractory properties and testing: Fusion point, Load bearing capacity (RUL, MOR, Creep). Thermal, mechanical and structural spalling, slag resistance, thermal expansion, CO disintegration, BD, AP and PLCAR.

**Module II: Glass & Vitreous Coating**

**Glass:**

Concept of Glassy state, Structural requirement, Role of different glass forming oxides. Silicate and non-silicate glasses. Structure of Glass – XRD, SAXS and other methods of determining glass structure.
Different types of commercial glasses and their compositions.
Raw materials for glasses – their availability, processing and batch calculation.

Design of the glass tank furnace and physicochemical considerations involved in the melting operations and refining. Batch melting reactions. Melting operations.
Properties imparted by different constituents.
Finishing, annealing of glasses. Strains, its detection, measurement and remedial measures, Devitrification of glass.
Viscosity of glass, measurement at different temperatures, its importance in different stages of glass melting, rheology of glass, elastic and visco-elastic properties of glasses.
Physical properties of glass – Density, refractive index of glass, thermal expansion, specific heat of glass, electrical conductivity of glass, dielectric properties, mechanical properties, surface properties.

**Vitreous Coating:**

Concept of glassy coatings on metals. Characterization of different types of metals: Cast iron, steel, aluminum and various alloys used for enameling. Preparation of metal and non-metal surfaces for enameling.
Properties of enamel melts: Thermal, Mechanical, optical and chemical.
Enamel defects: Their cause and remedies.
Opacity and adherence mechanism of enamel with metal.
Enameling of Aluminium and De-enameling
Application of enamel article in different field.

**Recommended Books:**

1. Introduction to Ceramics – W. D. Kingery, H. K. Bowen, D. R. Uholmann
2. The Technology of Ceramics and Refractories – P. P. Budnikov
4. Properties of Glass – F. Moorey
5. Introduction to glass science and technology – J. H. Shelby
6. Fundamental of inorganic glasses – A. K. Vershneya
8. Technology of enamels – V. V. Vargin

OLT: Oil Technology II

Module I : Extraction & Purification of Fats & Oils

Extraction
Handling, storage, grading and pretreatments (Mechanical and Heat Treatments) of oil-bearing materials: Extraction of fats and oils (Theory and Practice): extraction by pressing (Expeller, Extruder) solvents (polar and nonpolar) and biorenewable solvents (super critical gases, alcohols, acetone, water). Extraction by biotechnology process, extraction technology for recovery of starch, protein, dietary fibre and other constituents from seeds, cakes and meals for food, feed and industrial processes.
Rendering technology for recovering animal fats and marine oils
Utilisation of oil cakes; Desolventisation and utilization of oil meals

Purification
An overview on different undesirable components and need for purification etc.; subsequent purification techniques, Removal of fat insoluble impurities (filtration, sedimentation, centrifugation etc.)
Removal of fat soluble impurities: degumming (chemical and enzymatic), deacidification (chemical refining, physical refining, esterification, miscella – single & mixed solvent refining, etc.), bleaching (chemical, adsorptive & enzymatic), deodorization, winterization, dewaxing etc.
Utilization of refinery by-products (gums, soap stocks, deodorizer distillates, fatty acid distillates, waxes, spent bleaching earth, etc.)

Module II : Paints & Pigments
Mechanism of polymerization and kinetics of polymerization process
Polymer structures, molecular weights, mechanical properties, glass transition temperate & crystallinity of polymers in relation to molecular weight, kinetics of free radical and addition polymerization, thermodynamics of polymerization
Fundamentals of pigmented coatings; Principles of paint colour matching; Pigment- binder geometry, oil absorption, critical pigment volume concentration (CPVC) and its relation with paint properties.
Recommended Books:

1. Baileys’s Industrial Oil and Fat Products
2. Physical Chemistry of Polymers - A Tager
3. Organic Coatings - Zeno W. Wicks, Jr. Frank N. Jones, S. Peter Pappas, Douglas A. Wicks

**PPR: Petrochemicals & Petroleum Refinery Engineering II**

**Module I: Refinery Operations II**

Processing of Light Distillates: Alkylation, Isomerization, Catalytic Reforming, Polymerization, Sweetening by Merox treatment or Hydrodesulfurization – stoichiometry and process technologies covering operating conditions & application, role of catalyst in reaction mechanism & catalyst selection.

Thermal and Catalytic Cracking: Visbreaking, Coking, FCC, DCC

Hydrotreatment & Hydrocracking: hydrodesulfurization, hydrodenitrification, olefin saturation, aromatic saturation; hydrocracking of crude and vacuum distillate

Resid hydrotreatment & cracking: desulfurization of residue, hydrocracking of residue – theory, process technologies covering operating conditions, catalyst use and application.

**Module II: Petrochemicals Fundamentals**

Petrochemical Industries Overview.

Feedstocks for Petrochemical Industries: Natural gas, Refinery Off gas LPG, Naphtha, Gas oil – yield, product slate cost etc.

Basic Petrochemicals such as Synthesis Gas, Olefins, Aromatics, Naphthenes & Dienes – manufacture, thermodynamic and kinetic aspects.

Recommended Books

PFC: Pharmaceutical and Fine Chemical Technology II

Module I: Medicinal Chemistry-I
Concepts of pharmacokinetics, pharmacodynamics and bioavailability.
Medicinal Chemistry of drugs acting on cardiovascular systems like cardiac glycosides, vasodialators, anti-anginal, anti-hypertensives. Local anaesthetics and NSAIDs.

Module II: Industrial Pharmacy and Biotechnology I
Unit 1: Manufacturing techniques of different solid dosage forms, like tablets, capsules, powders and granules. Testing techniques and compliance for different solid oral dosage forms. Machinery requirements.
Manufacturing techniques and formulation concepts for different semisolid dosage forms including emulsions, suspensions, ointments, lotions, creams and suppositories. Testing techniques and compliance for semisolid dosage forms. Machinery requirements.

Unit 2: Bacterial Genetics. Recombinant DNA Technology and applications.
Types of Immunity, Application principles and manufacturing techniques for different immunological products.

Recommended Books:
5. Medicinal Chemistry, Ashutosh Kar, New Age International
8. Remington: The Science and Practice of Pharmacy, David B. Troy, Paul Bering, Lippincott Williams & Wilkins, 2006
10. Aulton's Pharmaceutics: The Design and Manufacture of Medicines, Michael E. Aulton, Kevin Taylo, Elsevier Health Sciences, 2013


**Paper 40**

**Course CT505**

**Chemical Engineering Lab. I**

Experiments on

1. Flow of fluid through packed beds
2. Fluidization
3. Elutriation
4. Flowmeters
5. Pumps
6. Heat transfer coefficients
7. Mass transfer coefficients
8. Evaporation
9. Leaching
10. Valves and fillings
11. Verify Bernoulli’s equation
12. Terminal velocity.

**Recommended Books :**


**Paper 41**

**Course CT506**

**Environment Technology Lab**
**Tutorial:**
Introduction to all prevailing international standards of Health, Safety, and Environment (HSE); Environmental laws and regulations; Standards (air quality, noise, water) Environmental impact assessment, Life cycle assessment (LCA) Pollution – Definition & types (1. Air pollution, 2. Water pollution, 3. Soil pollution, 4. Marine pollution, 5. Noise pollution, 6. Thermal pollution, 7. Nuclear hazards) Air pollution; Air pollutants: sources (specific pollutants), effects, and dispersion modeling, air pollution, air quality, pollutants minimisation and control, fugitive emissions (source and control) Wastewater treatment; Groundwater and surface water pollution, removal of specific water contaminants; Solid waste; Hazardous waste Pollution prevention in chemical manufacturing, effluent treatments

**Practical:**
1. Classification of chemically hazard compounds and MSDS. BOD, COD and TOC studies
2. Analysis of heavy metal including arsenic and anions like fluorides, dye and pesticides in water and soil.
3. Estimation of sulphur compounds and carbon monoxide in air

Recommended Books:


**Paper 42**
Course CT507 CER/OLT/PPR/PFC 50 marks /2 Credits
Special Lab III

**CER: Ceramics Engineering Lab III  (at least 5)**

*Physical Testing of Ceramic Raw Materials and Products- I:*
Raw materials: Hardness, texture, thermal analysis - DTA and TGA, FTIR, XRD. Refractories: Fusion range, Refractoriness under load, Porosity, Modulus of rupture, Thermal expansion, reheat shrinkage, Thermal spalling, Thermal conductivity. Glass: Viscosity, density, strain. Preparation of Soda-lime-silica glass with different coloring oxides, e.g. cobalt and iron oxides; Borosilicate glass with alkali and alkaline earth oxides; opal glass with different opacifying agents, e.g. fluoride and phosphate; low melting Phosphate glass in various systems. Fine ceramics: Mechanical, thermal and electrical properties.

Recommended Books:-

1. Quantitative Inorganic Analysis – A. I. Vogel
2. Analysis of ceramic raw materials – S. Kumar and D. Ganguli
OLT: Oil Technology Lab III
Fats and Oil Processing

Refining (degumming, deacidification, bleaching, deodorisation and physical refining) of fats/oils; Modification (hydrogenation, interesterification, fractionation, blending) of fats/oils for edible and industrial products; Hydrolysis of oils/fats (chemical and biochemical); Esterification, epoxidation and hydroxylation of oils. Edible fat products like margarine and cocoabutter substitute. Preparation and analysis of biodiesel.

Recommended Books

1. Official Methods and Recommended Practices AOCS of the AOCS

PPR: Petrochemicals & Petroleum Refinery Engineering Lab III
Solvent Extraction
Aromatic Separation by Solvent Extraction and Construction of Equilibrium Curve

Recommended Books:

PFC: Pharmaceutical and Fine Chemical Technology Lab II
Pharmaceutical Chemistry II

1. Pharmacognostic studies of crude drugs and constituents.
2. Extraction and estimation of alkaloids.
3. Tests and quantification of natural products like alkaloids, steroids, terpinoids, polyphenolics.
5. Standardization of fats and oils.
6. Analysis of vitamins.

Books Recommended:
3. Indian Pharmacopoeia, VIIth Ed, 2014, Indian Pharmacopoeia Commission
4. The Analysis of Fats and Oils, V. C. Mehlenbacher, Garrard Press

Paper 43
Course CT508 CER/OLT/PPR/PFC 50 marks /2 Credits
Special Lab IV

CER: Ceramics Engineering Lab IV (at least 5)
Physical Testing of Ceramic Raw Materials and Products- II:
Thermal shock test on glass wares, density of glass.
Physical testing of cement: initial and final setting time
Soundness, compressive and tensile strength, surface area.
Clay testing: Particle size distribution by Andreasen pipette method.
Water of plasticity, Atterberg plasticity Index.
PH titration curves.
Physical texture and hardness testing.

Recommended Books:
1. Bureau of Indian Standard (BIS) manuals

OLT: Oil Technology Lab IV
Surface Coating I
Preparation, analysis and testing of stand oil, blown oil, double boiled oil, dehydrated castor oil, and chemically modified drying oils.
Preparation, analysis and testing of Linoleate, rosinate, octoate, and naphthenate of Lead, Cobalt, Manganese and Zinc;
Analysis and testing of solvents;
Preparation, analysis and testing of ester gum, limed rosin, phenolics, oleoresinous varnish and spirit varnish

Recommended Books
1. Official Methods and Recommended Practices AOCS of the AOCS

PPR: Petrochemicals & Petroleum Refinery Engineering Lab IV
Catalyst preparation and Hydrodesulphurisation & Hydrocracking operations
Catalysts Preparation for Hydrodesulphurization and Hydrocracking
Hydrodesulphurization and Hydrocracking operation in High Pressure Batch Reactor.

Recommended Books:

PFC: Pharmaceutical and Fine Chemical Technology Lab IV
Microbiology II
1. Differential staining
2. Isolation of lipase, amylase and protease producing organism and quantitative analysis.
3. Environmental studies like BOD, COD determination
4. CFU of bacteria
5. Pathogenicity testing of E. coli, Salmonella, Staphylococcus and Pseudomonas

Recommended Books:
Paper 44  
Course CT601  
Material Science & Technology  
Module-I

Atomic structure and bonding in materials. Crystal structure of materials. Crystal systems, unit cells and space lattices, miller indices of planes and directions, packing geometry and close packed structures.  
Concept of amorphous, single and polycrystalline structures, Nucleation and grain growth.  
Non-crystalline materials: silicate glasses, glass transition temperature, viscoelasticity.  
Imperfections in crystalline solids: point, line, surface and volume defects, non-stoichiometry.  
Phases in metallic system, solid solutions, phase rule, binary phase diagrams, iron-iron carbide phase diagram and its application in iron and steel metallurgy, isothermal transformation, T-T-T diagram, martensite formation, continuous cooling transformation.  
Basic principles of powder metallurgy.

Module-II

Polymerization, classification of polymers – thermoplasts, thermosets, elastomers – structure, properties, processing and applications.  
Mechanical properties: Stress-strain diagram of metallic, ceramic and polymeric materials, modulus of elasticity, tensile strength, yield strength, toughness, plastic deformation, hardness, ductile and brittle fracture, creep, fatigue, role of reinforcement-matrix interface strength on composite behavior.  
Electronic properties: Band theory of metals, conductors, semiconductors, insulators, electrical conductivity, dielectric properties.  
Fundamentals of thermal, electrical, optical and magnetic properties.  
Corrosion and oxidation of materials, principles and prevention.  
Introduction to experimental techniques for materials characterization: XRD, NMR, PSA etc.; relationship between molecular structure and macroscopic properties.
Recommended Books:

1. Elements of Materials Science and Engineering – L. H. Van Vlack
2. Materials Science and Engineering: A First Course – V. Raghavan
5. The Science and Engineering of Materials – D. R. Askeland

Paper 45
Course CT602
100 marks /4 Credits

Chemical Engineering IV

Module I: Separation Process
Modern separation processes: Membrane processes, Ion-exchange, Molecular sieve

Module II: Mechanical Operations

Recommended Books:


Paper 46
Course CT603
100 marks /4 Credits

Elective II (Nanotechnology/ Sol-Gel Technology)

A. Nanotechnology

Module-I
Concepts in nanoscale; Time and length scale in structures; Dimensionality and size dependent phenomena; 0D, 1D, 2D structures- size effects; Specific surface energy and surface stress; Effect
on the lattice parameter; Material properties in nanoscale (optical, mechanical, electronic, magnetic and biological).
Nanoscale phenomenon; Quantum confinement of superlattices and quantum wells; Plasmonic response; Magnetic moment in clusters – Magnetocrystalline anisotropy – Dielectric constant in nanoscale silicon;

**Module-II**
Nanomaterials for electronics, nanophotonics, nanofluidics, nanocomposites etc. Special materials in nanoscale – Carbon materials, fullerenes, graphene, nanotubes; Metals and metal oxides, Quantum wire, Quantum well, Quantum dots, Biomacromolecules.
Nanoscale devices for different applications (electronics, photovoltaics, medical diagnostics etc). Nanotechnology and environment.
Principles of analysis in Dynamic Light Scattering (DLS); Atomic Force Microscopy (AFM); Field Emission Scanning Electron Microscopy (FESEM), Environmental Scanning Electron Microscopy (ESEM); Transmission Electron Microscopy (TEM), High Resolution Transmission Electron Microscope (HRTEM), Scanning Tunneling Microscope (STM)- Raman Spectroscopy, Nano-litography.

Recommended Books:
1. Introduction to Nanotechnology – C. P. Poole Jr. and F. J. Owens

**B. Sol-Gel Technology**

**Module 1**
The colloidal state, Sol and Gel, Basic ideas on kinetic, optical and electrical properties, Colloidal stability, Structure of double layer, DLVO theory, Polymeric and particulate gels. Synthesis of simple sol–gel precursors of silica, alumina, titania, zirconia etc, fabrication of ceramics via sol gel, gelation, ageing, drying and heat treatment. Preliminary idea on clay colloids.

**Module 2**
Sol-gel coating techniques e.g. dip, spin, drain and meniscus coatings. Techniques for characterization of sol-gel materials. Applications of sol gel glass, coatings, powders, fibres, monoliths, porous gel, membranes, catalysts, gas sensors, novel sol-gel materials, future prospects.
Recommended Books:-

1. Sol-Gel Science: The Physics and Chemistry of Sol-Gel Processing : C. Jeffrey Brinker, George W. Scherer
2. Handbook of Sol-Gel Science and Technology: Processing, Characterization and Applications : Sumio Sakka

Paper 47
Course CT604 CER/OLT/PPR/PFC 100 marks /4 Credits

CER: Ceramic Engineering III
Module I: Refractories – Applications

Introduction to various high temperature process and refractory materials.
Details of silica, semi-silica, aluminosilicate, spinel, magnesite, dolomite, chromite, chrom-magnesite, high alumina and zirconia refractories.
Fusion cast, thermal insulating, carbon and carbon bearing refractories, refractory composites, non-oxide refractories. Crystalline phases and microstructure of refractories.
Selection of refractories for different applications – Iron and Steel Industry, Non-ferrous industries, Cement, Glass and hydrocarbon processing industries.
Monolithics: Ramming mass, Gunning materials; Castables – low cement, ultra low cement, zero cement, self flow castables. Carbon containing and nano-bonded refractory castables.
Basic castables. Different bonding mechanism in refractory castables e.g. hydraulic, coagulation and chemical bonding.

Module II: Glass Technology

Different types of furnaces, refractories and fuel required for glass melting.
Different types of glass forming processes: Blowing, pressing, drawing by semiautomatic and automatic process. Sheet glass by different methods, fabrication of glass ware.
Glass fibre. Toughened glass.
Optical Glass: Methods of manufacture, defects. Optical fibre.
Coloured glasses: Colour forming constituents, redox equilibria, solarisation, photosensitive and photo-chromic glass, opal glass, chalcogenide glass, IR absorption glass, colloidal colours.
Chemical durability of glass: Glass aqueous phase reaction, controlling factors and methods of measurement, improvement of durability.
Different types of glass defects and their elimination.

Recommended Books:-

1. Steel plant refractories – J. H. Chester
2. The Technology of Ceramics and Refractories – P.P. Budnikov
4. Fundamental of inorganic glasses – A. K. Vershneya
5. Chemistry of glasses – A. K. Paul
6. Introduction to glass science and technology – J. H. Shelby
OLT: Oil Technology III

Module I: Technology of Soaps and Synthetic detergents

Definitions of soaps & detergents and their classifications; Present status of soap and detergent industries; Raw materials for soap industry and their selection; Kinetics and Phase reactions in soap boiling.

Physico-chemical properties of soap solutions; Plants and Processes employed in soap manufacture. Recovery of by-products, various households and industrial soaps, soap additives, metallic soaps, miscellaneous application of soap-based products; Testing and evaluation of soaps. Chemistry and Technology of production synthetic detergents (anionic, cationic, non-ionic, and amphoteric), detergent additives. Formulations and processing of detergent powders, tablets, liquid and pastes for household and industrial applications; Bio-surfactants and enzyme detergents, dry cleaning systems; Natural saponin based surfactants.

Bio-degradation and life cycle of surfactants, Eutrophication and Ecological aspects, Eco-friendly washing systems.

Modern trends in detergent formulations; Testing and evaluation of synthetic surfactants

Module II: Chemistry & Technology of Paints and Paint additives

Pigments & Extenders
Technology of natural resins; rosin, copal, damar, shellac, asphalts, pitches, bitumens, their modifications.
Technology of phenolic, maleic, coumarone-indene, and petroleum resins, CNSL and BNSL, their modifications.
Technology of synthetic resins like alkyds and other polyesters, polyurethanes, UF, MF, epoxy, silicones, rubber resins, etc.
Types and mechanism of polymerization reactions; concepts of functionality, polymeric resins like NC, acrylics, vinyls, etc. Methods of different polymerization systems, viz., bulk, solution, suspension and emulsion and their mechanisms
Kinetics of Emulsion Polymerization, Suspension Polymerization, Ionic Polymerization and Methods of Determination of Polymer Molecular Weight, Gel Permeation Chromatography, Osmometry
Metallic driers and auxiliaries: technology of linoleates, rosinate, napthenates and octoates of lead, cobalt, manganese, zinc, iron, calcium and rare earth metals.

Functions and uses of additives like anti-skinning agents, anti-mildew agents, flatting agents etc

Recommended Books:
1. Surface Active Agents and Detergents - Schwartz & Perry
2. Gemini Surfactants - Raoul Zana & Jiding Xia
3. Textbook of polymer science - Fred W. Billmeyer
5. Macromolecules, an introduction to polymer science, F. A. Bovey and F. H. Winslow
6. Handbook of Surfactant Analysis - Chemical, Physico-chemical and Physical Methods - Dietrich O. Hummel

**PPR: Petrochemicals & Petroleum Refinery Engineering III**

**Module I: Refinery Operations III**

Lube base oil processing – solvent deasphalting, solvent aromatic extraction, solvent dewaxing, hydrofinishing, catalytic hydrotreatment and dewaxing.

Blending of Products – Octane blending, Flash point blending, Viscosity blending, Penetration blending etc.: calculation method, nomographs, application

Lube blending and Grease manufacture – formulation, operating condition and application.

**Module II: Petrochemical manufacturing processes and Important Individual Petrochemicals**

Oxo synthesis, Polymerization etc.

Individual Petrochemicals viz. Methanol, Urea, Acrylonitrile, Styrene, Phenol, Ethylene & Propylene oxide, Vinyl Acetate, Caprolactum, Purified Terephthalic Acid etc. – manufacture, operating conditions, catalyst, properties and application.

**Recommended Books**


**PFC: Pharmaceutical and Fine Chemical Technology III**

**Module I: Quality Assurance & Regulatory Affairs**


GMP regulations; Air and water handling system, CGMP – Status and regulations, GLP, GCP, GDP concepts. Quality audit. Documentation and records. Approval Process.

Principles and techniques in validation, Analytical Method Validation and Process validation.

**Module II: Industrial Pharmacy and Biotechnology II**

Unit 1: Manufacturing techniques and formulation of liquid and sterile dosage forms and aerosol preparations. Testing techniques and compliance for sterile dosage forms and aerosols. Machinery requirements.

Unit 2: Pharmaceuticals from cellular origin, examples and applications. Principles of fermentation Technology and reactor design. Antibiotics manufacturing in fermentation and
semi-synthetic pathways. Examples for fermentative production of alcohols, vitamins, dextrans, probiotics and food products.

Recommended Books:
1. Drugs and Cosmetics Act – Schedule M, Schedule L1, Schedule Y; www.cdsco.nic.in
2. Quality Assurance of Pharmaceuticals Volume 1, Volume 2. published by WHO
3. WHO Technical Reports; TRS 992, TRS 986.
   www.who.int/biologicals/technical_report_series
7. Pharmaceutics: Formulations and dispensing pharmacy, S. Bharath, 2013

(PRACTICAL)

Paper 48
Course CT605
Chemical Engineering Lab. II
Experiments on
1. Specific surface area of powders
2. Raleigh equation
3. Vapour-liquid equilibrium data
4. Spray drying
5. Crushing and grinding
6. Distillation
7. Liquid-liquid extraction
8. Absorption
9. Drying and
10. Filtration.

Recommended Books:

Paper 49
Course CT606

Process Equipment Design
Each student is required to submit two bound type-written copies of the design report on the complete design including drawing with specifications of process equipment reactors of a plant manufacturing product(s) related, to one's course / subject to be worked out under the guidance of a faculty member.
The design should be as far as practicable and be based on the consideration of optimum technical process operating condition and shall include proper instrumentation and control.
The examination shall include a viva-voce examination on the design report.

Paper 50
Course CT607

Special Lab V

CER: Ceramics Engineering Lab V (at least 5)

Synthesis, Fabrication and Characterization of Ceramics:
Preparation of silica gel, precipitated silica, microfine silica, alumino-silicate hydrogel.
Determination of alkali resistance of glass, alkalinity of glass, chemical durability.
Observations of strain in glassware by polariscope, demonstration of cord viewer.
Fabrication of some high alumina & basic bricks, fabrication and evaluation of refractory castables. Fabrication of refractory shapes by semi dry and dry process, drying and firing characteristics. Synthesis of aggregates, bonding materials and precursors by conventional and non-conventional method. Testing and evaluation of various important properties of refractories as per IS specification. Refractory corrosion test.

Recommended Books:-
1. Quantitative Inorganic Analysis – A. I. Vogel
2. Analysis of ceramic raw materials – S. Kumar and D. Ganguli

OLT: Oil Technology Lab V:

Soaps & Detergents
Technical analysis of soaps and synthetic detergents.
Preparation of different types of soaps and synthetic detergents and evaluation of their various physicochemical and performance characteristics. Identification, isolation and purification of surfactants from unknown mixtures. Surface tension, interfacial tension, CMC measurements

Recommended Books

1. Official Methods and Recommended Practices AOCS of the AOCS

PPR: Petrochemicals & Petroleum Refinery Engineering Lab V
Preparation & Testing of Petrochemical Products
Preparation & Testing of some petrochemical products by Polymerization, Alkylation, Disproportionation, Condensation etc.

Recommended Books:

PFC: Pharmaceutical and Fine Chemical Technology Lab V
Pharmaceutical Chemistry III

1. Synthesis of drugs, fine chemicals and drug intermediates using multistep reactions.
2. Applications of different name reactions in drug synthesis.
3. Synthesis, assay and pharmacopoeial compliance for representative compounds like diphenyl hydantoin, paracetamol, iso-nicotinic acid hydrazide (INH), indole acetic acid, xylocaine.

Recommended Books:
2. Advanced Practical Medicinal Chemistry, Ashutosh Kar, New Age International Publisher, 2007

Paper 51
Course CT608 50 marks /2 Credits
Special Lab VI

CER: Ceramics Engineering Lab VI (at least 5)

Preparation of Whiteware body, Milling of raw materials, rheological measurement of slip, fabrication of green body, by slip casting, pressing, drying & firing biscuit and glost firing.
Preparation of glazes & application of glaze on body, and firing. Determination of water absorption, True density, Bulk density & Modulus of rupture of various fired whiteware bodies. Determination of thermal shock resistance of fired white ware bodies. Measurement of glaze

Recommended Books:-
1. Bureau of Indian Standard (BIS) manuals

OLT: Oil Technology Lab VI
Surface Coating II
Preparation of alkyds, polyesters, acrylics etc.; Preparation of inorganic and organic pigments and their testing according to specifications.
Preparation of different types of paints like primer, ready mixed paints, synthetic enamels, stoving enamels, etc.
Preparation of panels. Testing of surface coating according to specifications. Examinations and reporting of weathered and defective surface coatings.
Preparation of paint additives like anti-settling agent, anti-skinning agent, dispersing agent, etc.

Recommended Books
1. Official Methods and Recommended Practices AOCS of the AOCS

PPR: Petrochemicals & Petroleum Refinery Engineering Lab VI
Preparation & Characterization of Resins
Phenol-formaldehyde, Urea-formaldehyde etc. and their characterization.

Recommended Books:

PFC: Pharmaceutical and Fine Chemical Technology Lab VI

Industrial Pharmacy
Formulation and testing of different dosage forms, like tablet, capsule, suspension, emulsion, ointment, granules, effervescent granules, syrup and invert syrup.
Recommended Books:  
Pharmaceutical Compounding and Dispensing, Christopher A. Langley, Dawn Belcher, Fasttrack 2012

Semester VII  
(Theory)

Paper 52  
Course CT701  
Modeling and Simulations  
100 Marks/ 4 Credits

Module I: Models and model building  
Introduction, principles of model formulation, fundamental laws - continuity equation, energy equation, equations of motion, transport equations, equations of state, equilibrium and kinetics, classification of mathematical models.  
Numerical solutions of model equations – Linear and non linear algebraic equations in one and more than one variables, ordinary differential equations in one and more than one variables.

Module II: Lumped Parameter Models  
Formulation and solution techniques to be discussed for Vapour liquid equilibrium models, dew point and flash calculations for multicomponent systems, boiling operations, batch and continuous distillation models, tank models, mixing tank, stirred tank with heating, CSTR with multiple reactions. Non-isothermal CSTR - mutiplicity and stability, control at the unsteady state. Non-ideal CSTR models - multi-parameter models with dead space and bypassing, staged operations.

Module III: Distributed Parameter Models (Steady State)  
Formulation and solution of split boundary value problems - shooting technique, quasilinearization techniques, counter current heat exchanger, tubular reactor with axial dispersion, counter current gas absorber, pipe line gas flow, tubular permeation process, pipe line flasher.

Module IV: Unsteady State Distributed Parameter Models  

Module V: Model Parameters Estimation  

Recommended Books:  
A. Numerical Analysis
Introduction, Approximation and Concept of Error & Error Analysis
Linear Algebraic Equations: Methods like Gauss elimination, LU decomposition and matrix inversion, Gauss-Siedel method, Chemical engineering problems involving solution of linear algebraic equations
Root finding methods for solution on non-linear algebraic equations: Bisection, Newton-Raphson and Secant methods, Chemical engineering problems involving solution of non-linear equations
Interpolation and Approximation, Newton's polynomials and Lagrange polynomials, spline interpolation, linear regression, polynomial regression, least square regression
Numerical integration: Trapezoidal rule, Simpson’s rule, integration with unequal segments, quadrature methods, Chemical engineering problems involving numerical differentiation and integration
Ordinary Differential Equations: Euler method, Runge-Kutta method, Adaptive Runge-Kutta method, Initial and boundary value problems, Chemical engineering problems involving single, and a system of ODEs
Introduction to Partial Differential Equations: Characterization of PDEs, Laplace equation, Heat conduction/diffusion equations, explicit, implicit, Crank-Nicholson method

Recommended Books:
1. Numerical Methods for Chemical Engineering: Applications in MATLAB,
3. Introduction to Numerical Methods in Chemical Engineering, Pradeep Ahuja, PHI publication.

B. Optimization method in Chemical Technology
(Module I) Nature and organization of optimization problems, fitting models to data, method of least squares, factorial experimental designs, formulation of objective functions.
(Module II) Optimization theory and methods - basic concepts of optimization, optimization of unconstrained functions, one dimensional search, multivariable optimization.
(Module III) Linear programming and applications, nonlinear programming with constraints, optimization of staged and discrete processes.
(Module IV) Optimum recovery of waste heat, optimum shell and tube heat exchanger design, optimization of heat exchanger networks, optimization of multistage evaporators, optimization of liquid liquid extraction processes, optimal design and operation of staged distillation columns.
(Module V) Optimal pipe diameter, minimum work of gas compression, economic operation of fixed bed filter, optimal design of gas transmission network, optimal design and operation of chemical reactors.
Recommended Books:


Paper 54
Course CT703 CER/OLT/PPR/PFC 100 marks /4 Credits

Special Paper IV
CER: Ceramics Engineering IV

Module I: Hydraulic Binders and Concrete

Different types of Hydraulic binders and their classification.
Introduction to different types of commercial cements

Module II: Fine Ceramics

Development and scope of fine ceramics. Characterisation and classification of different pottery wares and vitrification nature. Raw materials: evaluation, processing and availability, testing. Composition of different types of triaxial bodies. Incorporation of industrial solid wastes in triaxial composition. Classification of ceramic tiles, wall and floor ceramic tiles, concept on double charge body, twin press body, vitrified polished tiles, multifunctional coatings on ceramic/poecelain tiles.

Nature of high temperature reactions in triaxial systems and the related phase changes. Commercial kilns and furnaces and their operations.
Physical and chemical properties of pottery wares. Hard and soft porcelain, electrical insulator, hotel china, chemical porcelain, sanitary wares.


Optical and electronic ceramics, and piezo electric materials. Types of ferrites, soft and hard ferrites, process Technology. Microstructure and magnetic characteristics. Steatite and cordierite ceramics, titanate ceramics.

Recommended Books:

1. Chemistry of Cement – F. M. Lea
2. Cement Chemistry - F.W. H. Taylor
3. High Alumina Cement - T. D. Robson
4. Concrete Technology – A.M.Neville and J.J.Brooks
5. Ceramic Whitewares – Sudhir Sen
7. Fine Ceramics – F. H. Norton

OLT: Oil Technology IV

Module I: Technology and processing of Fats and other derivatives for edible purposes

Hydrogenation process technology of fats and oil (selectivity, catalyst, process parameters, hydrogenation techniques, low trans hydrogenation, hydrogen production, process control, product characteristics, Government regulations, costing, etc.); Interesterification processes of fats and oils (chemical and biochemical); Fractionation of fats (dry, solvent and detergent fractionation); Blending of fats (government regulations, nutritional aspects, shelf life, etc.); Production of Butter and Ghee; Margarine, low cost spread fats, shortenings, confectionery fats. Fat based structured molecules and Nutraceuticals production technology & applications. Plants and equipments associated with modification techniques.

Module II: Manufacturing & application of paints

Process steps and equipment required for paint manufacturing. Use of ball and pebble mills; sand, bead and shot mills; attritor and vibration mills. Paint mixing and dispersion equipments like HSD, High speed stone and colloid mills; Assessment of pigment dispersion, Mill base let down operations. Various Industrial (Automotive & Marine Coatings, etc.) and Architectural paints; Formulation of various solvent and water based coatings, specialized paint finishes like wrinkle, polychromatic, flame buoyant, hammertone, etc.

Recommended Books:

1. Lipid Technologies and Applications - Frank D. Gunstone & Fred B. Padley
2. Outlines of Paint Technology - W.M. Morgans
3. Baileys’s Industrial Oil and Fat Products
4. Coatings Materials and Surface Coatings - Arthur A. Tracton

PPR: Petrochemicals & Petroleum Refinery Engineering IV

Module I : Plants & Equipments in Refineries and Petrochemical Industries; Utilities, Offsite facilities & Environment control

Equipments viz. Pumps, compressors, Heat exchangers, Pipestill Heaters, Reactors – batch & continuous, fixed bed, fluidized bed, ebullated bed, single stage & multi stage, single stage once-through & with recycle, Distillation Columns, Extractors, Absorbers, PSA, TSA etc.

Corrosion & its prevention, Materials of Construction.

Refinery Utilities – Power & Steam generation, Plant air, Instrument air, Inert Gas system, Cooling water, DM water, Boiler Feed water, Service water, Treatment chemicals

Offsite facilities: Storage tanks – fixed roof, floating roof, Horton sphere, cryogenic storage tanks; Pipelines for feeding & dispatch; Classification of tank farms & safety guidelines; Various dispatch facilities of products – Tank-truck (road transport), tank-wagon; Fire water network & Fire fighting system

Environment control – Effluent treatment plant, Ambient air quality monitoring station, Furnace stack monitoring system, Storm water management, soil treatment, Incineration.

Module II: Preparation & Characterization of Important Polymers

Polyethylene, Polypolyethylene, PVC, Nylon, PET, Polyacrylates etc- stoichiometry, operating conditions, catalyst & application.

Synthetic rubber, Synthetic fibre, Synthetic resins, Synthetic detergents.

Moulding of Plastics, Vulcanization of Rubber.

Recommended Books:
1. Plastic Materials – J.A.Brydson
2. Principle of Polymer Chemistry – P J Flory
3. Textbook of Polymer Science – Fred W Billmeyer, JR
4. Rubber Technology & Manufacture – C M Blow

PFC: Pharmaceutical and Fine Chemical Technology IV

Module I: Pharmaceutical Technology

Preformulation studies. Stability analysis.

Novel drug delivery devices and sustained drug delivery. Transdermal drug delivery devices, design, formulation and evaluations.
Compartment models and bioequivalence studies.
Packaging requirements and regulatory requirements. Primary and secondary packaging materials types and quality testing. Bar coding, quarantine and identification.

**Module II: Medicinal Chemistry II**
Medicinal Chemistry of drugs acting on sympathetic and parasympathetic nervous systems. Drugs acting on central nervous systems like sedative hypnotics, anti-epileptics, and antimicrobial agents, like sulfa-drugs, antitubercular compounds, antifungals, antimalarials and other antiprotozoals.
Medicinal Chemistry of antihistaminics, diuretics, antiemetics and oral hypoglycemics. Classification and chemistry of vitamins.

Recommended Books:
5. Medicinal Chemistry, Ashutosh Kar, New Age International
8. Remington: The Science and Practice of Pharmacy, David B. Troy, Paul Bering, Lippincott Williams & Wilkins, 2006
10. Aulton's Pharmaceutics: The Design and Manufacture of Medicines, Michael E. Aulton, Kevin Taylo, Elsevier Health Sciences, 2013

(PRACTICAL)

**Paper 55**
**Course CT704**

**Design & Simulation Lab**
1. Introduction to Software Packages
2. Setting up models for simulation
3. Steady State simulation using ASPEN
4. Flow-sheeting concepts (sequential modular, equation oriented)
5. Dynamic simulation using MATLAB,
6. CFD simulations using FLUENT
7. Geometry & meshing

Paper 56
Course CT705
Project Assessment I
Each student shall be required to carry out under the supervision of Faculty member(s) and/or External member as the case may be, an original investigation on an industrial problem related to one’s course/subject. She/he shall submit two typewritten bound copies of a report on Research Work at least 15 days before the commencement of final semester examination and shall defend her/his report in a Viva-voce Examination.

Paper 57
Course CT706
Plant Design & Feasibility Studies
Each student shall be required to submit two bound type written copies of a project report on a proposed chemical plant manufacturing product/products related to one’s course/subject to be worked out under the supervision of a faculty member.
The report shall include mass and energy balances, type and capacity of equipment selected and recommended, plant layout, feasibility analysis highlighting market survey, pattern of assistance available from the central and state governmental agencies, banks and financial institutions. Assistance for technology, raw materials, finance.
Legal obligation.
The student has to appear at a viva voce examination.

Paper 58
Course CT707
In Plant Training / Institutional Training
Each student shall be required to undergo a course in ‘In plant Training’ for a specified period (4 - 6 weeks) in an industry related to one’s course/subject.
She/he shall submit one copy of training report within 30 days of completion of training and shall appear at a Viva-voce Examination.

Semester VIII
(Theory)

Paper 59
Course CT801
Chemical Technology V
Module I: Business Management
The historical background of industrial development in India. The management function, evolution of management thought, management and social responsibility.
Process of basic management decisions in industry. Fundamental consideration in Industry: basic management decisions.
Organisation development and types of organization: Co-ordination and morale.
Total Quality Management (TQM) ISO 9000/BIS 14000
Product development and research, simplification and standardization of product and materials, processes and materials inspection.
Plant location.
The factory building and plant layout, material handling, the maintenance department.
Motion and time study, establishing time value by time study, utilizing time study data.
The sale and purchase department, budget, managerial control and office administration, classification and identification.
Material and production control: routine, scheduling and mass production industries.
Business statistics, index numbers, charting, trend curves, management ratios, forecasting, trade indices, budgeting, statistical methods in industry, quality control.
Economic planning and policy in India.
Position and problems of chemical industries in India.
Treatment of the subject should have a bias in regard to chemical industry.

Recommended Books:
1. Management – Harold Koontz & Heinz Weihrich
3. Principles & Practice of Management – Shyamal Banerjee
4. Statistical Methods – N G Das
5. Financial Management – I M Pandey
6. Cost Accounting – B K Bhar
7. Personnel Management & Industrial Relations – P C Tripathi
8. Marketing Management – Philip Kotler

Module II: Industrial Economics  
50 marks/2 Credits
World resources: fuels, water, power, iron and steel, manganese steel alloys, non-ferrous metals, position of India in World Trade.
Industrial Revolution: The historical process, rise of the factory system, social effects of the Industrial Revolution, growth of monopoly capital, the development of machinery, the steel age, the age of electricity, the commercialization of inventions.
Price system and resource allocation; concepts of demand, marginal revenue, demand elasticity, consumer’s surplus and the interrelationships between them, concept of time in economics and short run and long run cost curves – total cost, marginal cost, average cost; forms of market and price determination of a commodity in different markets. Concepts of national income; theory of equilibrium national income determination, theory of investment; money market and theory of rate of interest; inflation theories – brief outline; commercial banking and central banking; fiscal policy; balance of trade and balance of payments; measures to correct balance of payments disequilibrium.

Recommended Books:
7. An Introduction to Microeconomics & Indian Economy – Anasuya Kar, S. Chand & Co.
CER: Ceramics Engineering V

Module I: Advanced Ceramics I

Advanced Processing Technologies of Ceramics: Chemical vapour deposition etc, Sol–gel, Microwave Processing, Sonochemical techniques, Spark Plasma sintering.
Superhard ceramic materials, diamond, BN, Si$_3$N$_4$, C$_3$N$_4$
Composites, Nanostructured materials, nano-ceramics, non-oxide ceramics, nano fibres and nanoclays.
Ceramic sensors, Solid Oxide Fuel Cell, Smart Ceramics, Semi conducting, Conducting & Super conducting Ceramics, Thin Films, Membranes, Optical, Dielectric and Magnetic materials.

Module II: Advanced Ceramics II

Ceramic gas and moisture sensors, optical sensors, micro sensors, actuators, Ceramics for heat engines, Ceramic for nuclear sectors, Ceramic microstructures.
Bioceramics - processing, properties and application.
Carbon nanotubes – single walled and multiwalled, nanolithography, molecular imprinting, Quantum dots and nanowires, CMOS – MEMS, patterning techniques in microelectronics.

Recommended Books:-

1. Introduction to Ceramics – W. D. Kingery, H. K. Bowen, D. R. Uholmann
2. Ceramic Materials for Electronics - R.C. Buchanan
3. Glass-Ceramic Technology - Wolfram Holand, George H. Beall
4. Introduction to Bioceramics – L. L. Hench and J. Wilson
5. Electroceramics –A. J. Moulson & J. M. Herbert
6. Ceramic Processing and Sintering: M. N. Rahaman
7. Fundamentals of Ceramics – M. W. Barsoum
OLT: Oil Technology V

Module II: Fat based Industrial Chemicals

An overview on oleochemicals: oleo chemicals raw materials, basic oleochemicals, oleochemical derivatives, etc.

Fat splitting (low, medium and high pressure splitting), recovery, purification and distillation of glycerol, separation of fatty acids, distillation of fatty acids.

Fatty alcohols and Fatty amines (raw materials, properties, processes and uses) and their derivatives;

Fat based chemicals in synthetic lubricants, plasticizer, Metallic soaps, biodiesel, etc.

Fat based and synthetic process auxiliary chemicals for application in different chemical industries like leather, paper, textile, rubber, plastics, metal working, etc.

Design considerations for various process equipment associated with oil processing like extractor, hydrogenator, reaction kettles, distillation equipments, milling equipments, micronizers, etc.

Biotechnology in basic and downstream oleochemicals production for food and industrial applications.

Module II: Advanced Paint Technology

Outline Of The Activities Of The Petrochemical Industries To Manufacture the Raw Materials for Paint, Like Solvents, Monomers, Additives and Production of LDPE, LLDPE, HDPE.

Modern trends in coating systems; waterborne paints;

Powder coatings; electro-deposited paints; high solid coatings

Nano technology and Biotechnology in paint industry for production of polymer materials and protection of coating surfaces.

Module III: Essential Oils and Cosmetic Technology

Chemistry & Technology of Natural Essential oils and of synthetics.

and their uses in food and personal care products

Technology of Production of cosmetics like various creams, shavings, lotions, hair oils, tooth paste, tooth powder, lipstick, face powders, herbal cosmetics.

Recommended Books:

1. Industrial uses of vegetable oils – Sevim Z. Erham
2. Paint and Surface Coatings - R. Lambourne and T.A. Strivens
3. The Essential Oils - Ernest Guenther
4. Perfumes, Cosmetics & Soaps - W.A. Poucher
5. Treaties on Fats, Fatty acids & Oleochemicals – Edited by O P Narula
6. Protective Coatings: Fundamentals of Chemistry and Composition - Clive H Hare

**PPR: Petrochemicals & Petroleum Refinery Engineering V**

*Module I: Management & Process Control of Refinery and Petrochemical Plants*
Instrumentation & DCS, Process simulation, LP modeling, Refinery scheduling, Product pricing, Profitability evaluation etc.
Safety Rules, Explosive Rules, OISD guidelines, Factories Act etc.
Energy Audit, Material Audit, Conservation Techniques etc.
HAZOP & HAZAN, Environmental Impact analysis, Disaster management

*Module II: Polymerization techniques, characterization & processing*
Polymerization reactions – Chain growth polymerization, Step growth polymerization, Copolymerization.
Polymerization practices – Bulk polymerization, Suspension polymerization, Emulsion polymerization etc.
Polymer properties, Polymer Characterization
Polymer Processing – Extrusion, Calendering, Moulding, Casting etc.

Recommended Books:
1. Principle of Polymer Chemistry – P J Flory
2. Textbook of Polymer Science – Fred W Billmeyer, JR

**PFC: Pharmaceutical and Fine Chemical Technology V**

*Module I: Medicinal Chemistry III*
Medicinal Chemistry of antineoplastic, antiviral agents, fluoroquinolones. Herbals & nutraceuticals formulation
Concepts of drug design and molecular modeling, Quantitative drug design techniques like Hansch analysis, Free Wilson techniques, 2D and 3D approach.
Biostatistics. Principles of drug actions and Receptor concepts, Drug receptor theories.

*Module II: Cosmetics and Fine Chemicals*
Unit 1: Classification of cosmetics and cosmetic products. Structure of skin, hair, nails, tooth and skin appendages and interactions with cosmetics. Cosmetics common ingredients and processes. Cosmetic formulation and performance. Packaging requirements of cosmetics. Primary and secondary packaging materials types and quality testing.
Unit 2: Chemistry of excipients. Synthesis and application techniques for dyes, dye intermediates, permitted colors, sweetening agents, flavoring agents. Pesticides, trace analysis for pesticides.

Recommended Books:
5. Medicinal Chemistry, Ashutosh Kar, New Age International
9. Remington: The Science and Practice of Pharmacy, David B. Troy, Paul Bering, Lippincott Williams & Wilkins, 2006

(PRACTICAL)

Paper 61
Course CT803

50 marks /2 Credits
Grand Viva
Each student shall be required to appear Grand Viva Voce Examination.

Paper 62
Course CT804
50 marks /3 Credits
Seminar
Each student shall be required to prepare and submit one typewritten bound copy of seminar paper on selected technological topic related to one’s course/subject under the supervision of a faculty member. She/he shall deliver a talk based on his seminar paper through power point presentation in an open seminar in presence of faculty members and external expert. The attendance in the seminar is compulsory for all the students. Technical report writing skills, basic communication skills, Power point presentation and Group discussions will be in the perspective

Paper 63
Course CT805
50 marks /4 Credits
Project Assessment II
Each student shall be required to carry out under the supervision of Faculty member (s) and/or External member as the case may be, an original investigation on an industrial problem to related to one’s course/subject. She/he shall submit two typewritten bound copies of a report on Research Work at least 15 days before the commencement of final semester examination and shall defend her/his report in a Viva-voce Examination.