



# K. K. Wagh Institute of Engineering Education and Research, Nasik (Autonomous w.e.f. A.Y.2022-23)

## Pattern of Course Structure: Semester – III S.Y.B.Tech Chemical Engineering

| Course Code  | Course Type | Title of Course           | Teaching Scheme Hrs./week |          |           | Evaluation Scheme and Marks |            |            |           |            |           |           |            | Credits   |          |          |           |
|--------------|-------------|---------------------------|---------------------------|----------|-----------|-----------------------------|------------|------------|-----------|------------|-----------|-----------|------------|-----------|----------|----------|-----------|
|              |             |                           | TH                        | TU       | PR        | In Sem                      | End Sem    | CCE        | TU        | TW         | PR        | OR        | Total      | TH        | TU       | PR       | Total     |
| SMH222201    | BSC         | Applied Mathematics III   | 3                         | 1        | -         | 20                          | 60         | 20         | 25        |            | -         | -         | 125        | 3         | 1        | -        | 4         |
| CHE222002    | DCC         | Chemistry I               | 3                         | -        | -         | 20                          | 60         | 20         |           |            | -         | -         | 100        | 3         | -        | -        | 3         |
| CHE222003    | DCC         | Fluid Mechanics           | 3                         | -        | -         | 20                          | 60         | 20         |           |            | -         | -         | 100        | 3         | -        | -        | 3         |
| CHE222004    | ESC         | Engineering Materials     | 3                         | -        | -         | 20                          | 60         | 20         |           |            | -         | -         | 100        | 3         | -        | -        | 3         |
| CHE222005    | DCC         | Process Calculations      | 3                         | -        | -         | 20                          | 60         | 20         |           |            | -         | -         | 100        | 3         | -        | -        | 3         |
| CHE222006    | LHSM        | Organizational Behavior   | 1                         | -        | -         | -                           | -          | -          |           | 25         | -         | -         | 25         | 1*        | -        | -        | 1         |
| CHE222007    | DCC         | Chemistry I Lab           | -                         | -        | 4         | -                           | -          | -          |           | 25         | 50        | -         | 75         | -         | -        | 2        | 2         |
| CHE222008    | DCC         | Fluid Mechanics Lab       | -                         | -        | 2         | -                           | -          | -          |           | 25         |           | 25        | 50         | -         | -        | 1        | 1         |
| CHE222009    | ESC         | Engineering Materials Lab | -                         | -        | 2         | -                           | -          | -          |           | 25         |           | 25        | 50         | -         | -        | 1        | 1         |
| CHE222010    | PSI         | Skill Development Course  | -                         | -        | 2         | -                           | -          | -          |           | 25#        | -         | -         | 25         | -         | -        | 1        | 1         |
| <b>Total</b> |             |                           | <b>16</b>                 | <b>1</b> | <b>10</b> | <b>100</b>                  | <b>300</b> | <b>100</b> | <b>25</b> | <b>125</b> | <b>50</b> | <b>50</b> | <b>750</b> | <b>16</b> | <b>1</b> | <b>5</b> | <b>22</b> |

# Assessment of 25 marks will be done considering consistent progress of work throughout the semester

Credit for 'PR' head are linked with 'TW' and 'OR' marks

\*This Credit will be assessed as a TW.



**K. K. Wagh Institute of Engineering Education and Research, Nasik (Autonomous w.e.f. A.Y.2022-23)**  
**Pattern of Course Structure: Semester – IV S.Y.B.Tech Chemical Engineering**

| Course Code  | Course Type | Title of Course                | Teaching Scheme Hrs./week |          |           | Assessment Scheme of Marks |            |            |            |           |           |            | Credits   |          |          |           |
|--------------|-------------|--------------------------------|---------------------------|----------|-----------|----------------------------|------------|------------|------------|-----------|-----------|------------|-----------|----------|----------|-----------|
|              |             |                                | TH                        | TU       | PR        | In Sem                     | End Sem    | CCE        | TW         | PR        | OR        | Total      | TH        | TU       | PR       | Total     |
| CHE222011    | DCC         | Chemistry II                   | 3                         | -        | -         | 20                         | 60         | 20         |            | -         | -         | 100        | 3         | -        | -        | 3         |
| CHE222012    | DCC         | Heat Transfer                  | 3                         | -        | -         | 20                         | 60         | 20         |            | -         | -         | 100        | 3         | -        | -        | 3         |
| CHE222013    | DCC         | Mechanical Operations          | 3                         | -        | -         | 20                         | 60         | 20         |            | -         | -         | 100        | 3         | -        | -        | 3         |
| CHE222014    | DCC         | Thermodynamics                 | 3                         | -        | -         | 20                         | 60         | 20         |            | -         | -         | 100        | 3         | -        | -        | 3         |
| CHE222015    | LHSM        | Soft Skills                    | 3                         | -        | -         | 20                         | 60         | 20         |            | -         | -         | 100        | 3         | -        | -        | 3         |
| CHE222016    | ASM         | Process Simulation using DWSIM | 1                         | -        | -         | -                          | -          | -          |            | -         | -         | -          | -         | -        | -        | -         |
| CHE222017    | DCC         | Chemistry II Lab               | -                         | -        | 4         | -                          | -          | -          | 25         | 50        | -         | 75         | -         | -        | 2        | 2         |
| CHE222018    | DCC         | Heat Transfer Lab              | -                         | -        | 2         | -                          | -          | -          | 25         |           | 25        | 50         | -         | -        | 1        | 1         |
| CHE222019    | DCC         | Mechanical Operations Lab      | -                         | -        | 2         | -                          | -          | -          | 25         | 25        |           | 50         | -         | -        | 1        | 1         |
| CHE222020    | PSI         | Project Based Learning         | -                         | -        | 2         | -                          | -          | -          | 25 #       | -         | -         | 25         | -         | -        | 1        | 1         |
| <b>Total</b> |             |                                | <b>16</b>                 | <b>-</b> | <b>10</b> | <b>100</b>                 | <b>300</b> | <b>100</b> | <b>100</b> | <b>75</b> | <b>25</b> | <b>700</b> | <b>15</b> | <b>-</b> | <b>5</b> | <b>20</b> |

# Assessment of 25 marks will be done considering consistent progress of work throughout the semester.  
 Credit for 'PR' head are linked with 'TW' and 'OR' marks





**K. K. Wagh Institute of Engineering Education and Research, Nasik (Autonomous w.e.f. A.Y.2022-23)**  
**Details of Course Structure: S.Y. B.Tech Chemical Engineering**

• **Summary of Credits and Total Marks for U.G. Programme:**

| Semester     | S.Y. B.Tech Chemical Engineering |             |
|--------------|----------------------------------|-------------|
|              | Total Credits<br>(TH+PR/OR/TU)   | Total Marks |
| III          | 22                               | 750         |
| IV           | 20                               | 700         |
| <b>Total</b> | <b>42</b>                        | <b>1450</b> |

• **Description of various Courses:**

| Type of Course | Description                                                                         | Type of Course | Description                                                                              |
|----------------|-------------------------------------------------------------------------------------|----------------|------------------------------------------------------------------------------------------|
| ESC            | Engineering Science Course - Workshop - Drawing- Fundamentals of different branches | DCC            | Department Core Course                                                                   |
| BSC            | Basic Science Courses                                                               | DEC            | Department Elective Course                                                               |
| LHSM           | Liberal arts, Humanities, Social Sciences and Management courses                    | OEC            | Open Elective Courses of other technical or emerging areas /Courses designed by Industry |
| PSI            | Project work, Seminar, Internship, PBL                                              | IMC            | Induction and Mandatory Courses                                                          |
| NC/AC          | Non Credit Courses /Audit Courses                                                   | ASM            | Additional Specialized / MOOCs                                                           |



**K. K. Wagh Institute of Engineering Education and Research,  
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**(Autonomous from Academic Year 2022-23)**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                      |                                                                                                                                                         |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p align="center"><b>S. Y. B. Tech. Chemical Engineering</b></p> <p align="center"><b>Pattern 2022 Semester: III</b></p> <p align="center"><b>SMH222201: Applied Mathematics III</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                      |                                                                                                                                                         |
| <b>Teaching Scheme:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Credit Scheme:</b>                                                                                                                                                                                | <b>Examination Scheme:</b>                                                                                                                              |
| <b>Theory :03hrs/week</b><br><b>Tutorial:01hr/week</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>03</b><br><b>01</b>                                                                                                                                                                               | <b>Continuous Comprehensive Evaluation: 20Marks</b><br><b>InSem Exam: 20Marks</b><br><b>EndSem Exam: 60Marks</b><br><b>Tutorial / Termwork: 25Marks</b> |
| <b>Prerequisite Courses:</b> -Higher Secondary Mathematics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                      |                                                                                                                                                         |
| <b>Course Objectives:</b> <ul style="list-style-type: none"> <li>Find general solution of higher-order linear differential equation with constant &amp; Variable coefficient using different Methods.</li> <li>Find Laplace transform of functions using definition &amp; properties &amp; solve Ordinary D.E. using L.T.</li> <li>Recognize nature of vector fields ,use different vector differential operators&amp; able to evaluate Line, surface &amp;Volume integrals&amp; its application</li> <li>Solve boundary value problems for Numerical Methods, Laplace's equation, heat equation, the wave equation by separation of variables.</li> </ul> |                                                                                                                                                                                                      |                                                                                                                                                         |
| <b>Course Outcomes:</b> On completion of the course, students will be able to–                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                      |                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Course Outcomes</b>                                                                                                                                                                               | <b>Bloom's Level</b>                                                                                                                                    |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Identify nature of vector field, understand basic concept of L.D.E., Numerical techniques, Laplace transform.                                                                                        | 2-Understanding                                                                                                                                         |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Solve Laplace transform, Numerical Methods, Directional Derivative, Line Integral and solve L.D.E. using different Methods.                                                                          | 2-Understanding                                                                                                                                         |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Apply concept of Laplace transform & Differential equations, Numerical techniques in Fluid Mechanics, Continuity equations, Stream lines, Equations of motion, Bernoulli's equations, Heat Transfer. | 3- Apply                                                                                                                                                |
| <b>CO4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Apply & Solve mass spring system, P.D.E. & Evaluate Surface, Volume Integral.                                                                                                                        | 3- Apply                                                                                                                                                |
| <b>CO5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Apply Concept of Differential equations, Numerical techniques, Vector Calculus to various applications including real life problem.                                                                  | 3 – Apply                                                                                                                                               |

| COURSE CONTENTS                                                                                                                                                                                                                                                                                                      |                                                                                           |                                |                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|--------------------------------|----------------------------------------|
| <b>Unit I</b>                                                                                                                                                                                                                                                                                                        | <b>Linear Differential Equations with Constant Coefficient</b>                            | <b>(08hrs+ 2hrs Tutorial)</b>  | <b>COs Mapped - CO1, CO2, CO3, CO5</b> |
| LDE of nth order with constant coefficients, Complementary Function, Particular Integral, General method, Short methods, Method of variation of parameters, Cauchy's and Legendre's DE, Simultaneous and Symmetric simultaneous DE.                                                                                  |                                                                                           |                                |                                        |
| <b>Unit II</b>                                                                                                                                                                                                                                                                                                       | <b>Applications of Linear Differential Equations &amp; Partial Differential Equations</b> | <b>(08hrs+ 2hrs Tutorial)</b>  | <b>COs Mapped - CO3, CO4, CO5</b>      |
| Applications of LDE to chemical engineering problems and mass spring system. Basic concepts, modeling of Vibrating string, Wave equation, one and two dimensional Heat flow equations, method of separation of variables, use of Fourier series. Applications of PDE to problems of Chemical and allied engineering. |                                                                                           |                                |                                        |
| <b>Unit III</b>                                                                                                                                                                                                                                                                                                      | <b>Laplace Transform (LT) and Applications</b>                                            | <b>(08hrs + 2hrs Tutorial)</b> | <b>COs Mapped - CO1, CO2, CO3</b>      |
| Definition of LT, Inverse LT, Properties & theorems, LT of standard functions, LT of some special functions viz. Periodic, Unit Step, <b>Dirac delta</b> Unit Impulse, Applications of LT for solving Linear differential equations.                                                                                 |                                                                                           |                                |                                        |
| <b>Unit IV</b>                                                                                                                                                                                                                                                                                                       | <b>Numerical Methods</b>                                                                  | <b>(08hrs + 2hrs Tutorial)</b> | <b>COs Mapped - CO1, CO2, CO3, CO5</b> |
| Numerical Solution of Algebraic and Transcendental equation: Bisection, Secant, Regula-Falsi, Newton-Raphson and Successive Approximation Methods,<br><br>Numerical Solution of System of linear equations: Gauss elimination, Gauss-Jordon Elimination LU Decomposition, Cholesky, Jacobi and Gauss-Seidel Methods. |                                                                                           |                                |                                        |
| <b>Unit V</b>                                                                                                                                                                                                                                                                                                        | <b>Vector Calculus</b>                                                                    | <b>(08hrs+ 2hrs Tutorial)</b>  | <b>COs Mapped -CO1, CO2, CO4, CO5</b>  |
| Vector differentiation, Gradient, Divergence & Curl, Directional derivative, Solenoid, Irrotational and Conservative fields, Scalar potential, Vector identities. Line, Surface and Volume integrals, Work-done, Green's Lemma, Gauss's Divergence theorem, Stoke's theorem.                                         |                                                                                           |                                |                                        |
| Text Books                                                                                                                                                                                                                                                                                                           |                                                                                           |                                |                                        |
| 1. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw-Hill.<br>2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publication, Delhi.<br>3. Advanced Engineering Mathematics, 7 <sup>th</sup> Edition, by peter V. O'Neil(Thomson Learning)                                                           |                                                                                           |                                |                                        |

| Reference Books                                                                                                                                                                                                                                                                 |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Eastern Ltd.<br>2. P. N. Wartikar and J. N. Wartikar, "Applied Mathematics" (Volumes I and II), Pune Vidyarthi Griha Prakashan, Pune.<br>3. Advanced Engineering Mathematics, M. D. Greenberg (Pearson Education). |  |

| Guidelines for Continuous Comprehensive Evaluation of Theory Course |                                                                                                                                                         |                |
|---------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Sr. No.                                                             | Components for Continuous Comprehensive Evaluation                                                                                                      | Marks Allotted |
| 1                                                                   | Assignments<br><br>( Total 3 Assignment, Unit I and II 20 marks, Unit III and IV 20 marks and Unit V 10 marks & 50 marks will be converted to 10 Marks) | 10             |
| 2                                                                   | Tests on each unit using LearniCo<br><br>( Each test for 15 M and total will be converted out of 10 M)                                                  | 10             |

| List of Tutorial Assignments |                                                                                                       |                    |
|------------------------------|-------------------------------------------------------------------------------------------------------|--------------------|
| Sr. No.                      | Title                                                                                                 | CO Mapped          |
| 1                            | Examples on LDE of nth order with constant coefficients.                                              | CO1, CO2, CO3, CO5 |
| 2                            | Examples on Method of variation of parameters, Cauchy's & Legendre's DE, Simultaneous DE.             | CO1, CO2, CO3, CO5 |
| 3                            | Examples on Applications of LDE to chemical engineering problems and mass spring system.              | CO3, CO4, CO5      |
| 4                            | Examples on modeling of Vibrating string, Wave equation, one and two dimensional Heat flow equations. | CO3, CO4, CO5      |
| 5                            | Solve problems on matrices using MATLAB.                                                              | CO1, CO2, CO3      |
| 6                            | Solve system of equations using MATLAB.                                                               | CO1, CO2, CO3      |
| 7                            | Examples on Laplace transform properties and theorems.                                                | CO1, CO2, CO3      |
| 8                            | Examples on Inverse Laplace transform properties and theorems.                                        | CO1, CO2, CO3      |
| 9                            | Examples on Numerical Methods                                                                         | CO1, CO2, CO3, CO5 |
| 10                           | Examples on Numerical Methods                                                                         | CO1, CO2, CO3, CO5 |
| 11                           | Examples on Vector differentiation.                                                                   | CO1, CO2,          |

|    |                                 |                       |
|----|---------------------------------|-----------------------|
|    |                                 | CO4, CO5              |
| 12 | Examples on Vector Integration. | CO1, CO2,<br>CO4, CO5 |

| <b>Guidelines for Tutorial / Termwork Assessment</b> |                                                         |                       |
|------------------------------------------------------|---------------------------------------------------------|-----------------------|
| <b>Sr. No.</b>                                       | <b>Components for Tutorial / Termwork Assessment</b>    | <b>Marks Allotted</b> |
| 1                                                    | Assignment on computational software                    | 5                     |
| 2                                                    | Tutorial (Each tutorial carries 15 marks)               | 15                    |
| 3                                                    | Attendance (Above 95 % : 05 Marks, below 75% : 0 Marks) | 5                     |





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| <b>S. Y. B. Tech. Chemical Engineering</b>                                                                                                                                                                                                                                                       |                                                                                                              |                                                                                                      |
| <b>Pattern 2022 Semester: III</b>                                                                                                                                                                                                                                                                |                                                                                                              |                                                                                                      |
| <b>CHE222002: Chemistry- I</b>                                                                                                                                                                                                                                                                   |                                                                                                              |                                                                                                      |
| <b>Teaching Scheme:</b>                                                                                                                                                                                                                                                                          | <b>Credit Scheme:</b>                                                                                        | <b>Examination Scheme:</b>                                                                           |
| <b>Theory :03 hrs/week</b>                                                                                                                                                                                                                                                                       | <b>03</b>                                                                                                    | <b>Continuous Comprehensive Evaluation: 20Marks<br/>InSem Exam: 20Marks<br/>EndSem Exam: 60Marks</b> |
| <b>Prerequisite Courses, if any:</b> Knowledge of fundamental Chemistry up to XII standard and first year Engineering Chemistry.                                                                                                                                                                 |                                                                                                              |                                                                                                      |
| <b>Course Objectives:</b> <ul style="list-style-type: none"><li>• To impart the basic concepts of organic chemistry</li><li>• To develop understanding about concepts of organic reactions for analysis of unit</li><li>• To study the different analytical instrumentation techniques</li></ul> |                                                                                                              |                                                                                                      |
| <b>Course Outcomes:</b> On completion of the course, students will be able to–                                                                                                                                                                                                                   |                                                                                                              |                                                                                                      |
|                                                                                                                                                                                                                                                                                                  | <b>Course Outcomes</b>                                                                                       | <b>Bloom's Level</b>                                                                                 |
| <b>CO1</b>                                                                                                                                                                                                                                                                                       | Analyze the type of forces and synthesize the materials based on their properties                            | 2 Understand                                                                                         |
| <b>CO2</b>                                                                                                                                                                                                                                                                                       | Estimate the kinetics of reaction and analyze the factors controlling the rate of reactions.                 | 3 Apply                                                                                              |
| <b>CO3</b>                                                                                                                                                                                                                                                                                       | Analyze the given chemical substance by different Instrumentation techniques.                                | 3 Apply                                                                                              |
| <b>CO4</b>                                                                                                                                                                                                                                                                                       | Estimate the quantity of solute and synthesize the solution based on the properties.                         | 3 Apply                                                                                              |
| <b>CO5</b>                                                                                                                                                                                                                                                                                       | Evaluate the mechanism of reactions and apply proper factor for increasing the yield of the desired product. | 4 Analyze                                                                                            |

| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                   |         |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|---------|-----|
| Unit I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Bonding and Reactivity            | (08hrs) | CO1 |
| Covalent Bonding- Introduction to VBT, Molecular orbital theory, MO structures of s-s, s-p , p-p overlaps , molecular orbital structure of butadiene, benzene, MO energy diagrams for diatomic molecules N <sub>2</sub> , O <sub>2</sub> , CO <sub>2</sub> , H <sub>2</sub> , CO. Aromaticity-conditions necessary for delocalization of electrons, resonance structures stability rules, resonance in benzene, phenol, aniline, benzaldehyde, nitrobenzene molecules, Inductive effect, steric effect and Resonance effect on pKa and pKb values of acids and bases. |                                   |         |     |
| Unit II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Reaction Dynamics &Photochemistry | (08hrs) | CO2 |
| Kinetics: Rate of reaction, rate constant, order of reaction, kinetics of first and second order reactions, numerical on above, Activated complex theory of reaction rates kinetics of complex reactions. Photochemistry: Introduction and importance, Stark-Einstein law, photochemical rate law, examples of photochemical reactions kinetics of i) H <sub>2</sub> , Cl <sub>2</sub> reaction ii) dimerisation of anthracene. Types of Photochemical Organic reactions, Laws of photochemistry and quantum yields-problems, Photosensitized reactions.              |                                   |         |     |
| Unit III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Instrumental methods of Analysis  | (8hrs)  | CO3 |
| Chromatography: Adsorption and partition principles, Study of TLC, column, HPLC, Gas Chromatography and their applications. b) Optical methods: UV, Lambert-Beer law, IR spectroscopy-introduction (FTIR), instrumentation, applications. Flame photometry- principle, instrumentation and applications.                                                                                                                                                                                                                                                              |                                   |         |     |
| Unit IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Solution                          | (8hrs)  | CO4 |
| Solution :-definition, solution of gas in gas, gases in liquid, Henry's law, the ideal solution, Raoult's law of ideal solution, solutions of liquids in liquids, theory of dilute solution. Colligative properties, osmosis, osmotic pressure, Colligative properties of dilute solution- lowering of vapor pressure, elevation of boiling point and thermodynamic derivation, depression in freezing point and thermodynamic derivation. Abnormal behavior of solutions of electrolytes, Van't Hoff factor. Numerical on all above.                                 |                                   |         |     |
| Unit V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Reaction Mechanisms               | (8hrs)  | CO5 |
| Substitution at saturated carbon (SN <sup>1</sup> ,SN <sup>2</sup> ) - mechanism, kinetics, stereochemistry, factors favoring it. Electrophilic aromatic substitution in benzene and mono substituted benzenes, activating and deactivating groups, nitration, Friedel-Craft reactions, sulphonation, and diazotization. Nucleophilic substitution on carbonyl carbon. Addition of HX on C=C, 1, 2Eliminations- E1 mechanism, E2,                                                                                                                                     |                                   |         |     |

(Saytzeff, Hoffman products), factors favoring it. Rearrangements- Beckmann, Claisen, Favorskii, Sonochemical reaction

#### **Text Books**

1. Inorganic chemistry - J.D. Lee
2. Inorganic chemistry - Cotton and Wilkinson's
3. Physical chemistry -P L Soni
4. Physical Chemistry- Atkins
5. Physical Chemistry - MaronPruton
6. Instrumental methods of chemical analysis Chatwal -Anand

#### **Reference Books**

1. Analytical chemistry- Skooge and West
2. Reaction mechanism - Jerry March
3. Organic Chemistry - Morrison and Boyd
4. Instrumental Methods of Analysis, H.H.Willard, L.L. Merritt and J.A. Dean & F.A Settle, CBS Publishers, 7th Edition, 1988

#### **Guidelines for Continuous Assessment of Theory Course**

| <b>Sr. No.</b> | <b>Components for Continuous Comprehensive Evaluation</b> | <b>Marks Allotted</b> |
|----------------|-----------------------------------------------------------|-----------------------|
| 1              | Assignment on 1,2,3,4,Unit                                | <b>10</b>             |
| 2              | Group presentations on Unit 5                             | <b>05</b>             |
| 3              | Learnico test on each unit                                | <b>05</b>             |



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| <b>S. Y. B. Tech. Chemical Engineering</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                     |                                                                                                                  |
| <b>Pattern 2022 Semester: III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                     |                                                                                                                  |
| <b>CHE222003: Fluid Mechanics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                     |                                                                                                                  |
| <b>Teaching Scheme:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Credit Scheme:</b>                                                                                                                               | <b>Examination Scheme:</b>                                                                                       |
| <b>Theory :03 hrs/week</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>03</b>                                                                                                                                           | <b>Continuous Comprehensive Evaluation: 20Marks</b><br><b>InSem Exam: 20Marks</b><br><b>EndSem Exam: 60Marks</b> |
| <b>Prerequisite Courses, if any:</b> -Courses of Engineering Mathematics, Engineering Mechanics, Physics and Chemistry                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                     |                                                                                                                  |
| <b>Course Objectives:</b> <ul style="list-style-type: none"><li>• To introduce basic concepts of fluid mechanics, fluid properties, types of fluids and classification of flows.</li><li>• To understand fluid statics, basic equations of fluid flow and applications to determine losses occurring through pipelines.</li><li>• To develop relationships among process or system variables using dimensional analysis and fluidization and applications of different valves and pumps.</li></ul> |                                                                                                                                                     |                                                                                                                  |
| <b>Course Outcomes:</b> On completion of the course, students will be able to–                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                     |                                                                                                                  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Course Outcomes</b>                                                                                                                              | <b>Bloom's Level</b>                                                                                             |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Explain different fluid properties, types of fluids and flows.                                                                                      | 1-Knowledge                                                                                                      |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Understand fluid statics and its applications related to pressure measuring devices in chemical industry.                                           | 2-Understand                                                                                                     |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Apply basic equations of fluid flow to determine fluid flow rate by different devices.                                                              | 3-Apply                                                                                                          |
| <b>CO4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Apply theorems to form mathematical equations and determine energy losses for flow of fluid through different system.                               | 3-Apply                                                                                                          |
| <b>CO5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Understand concepts of boundary layer and fluidization and applications of different valves and pumps for transportation of fluid through pipelines | 3-Apply                                                                                                          |

| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                           |                                                          |                |                         |
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| <b>Unit I</b>                                                                                                                                                                                                                                                                                                                                                                                             | Introduction                                             | <b>(08hrs)</b> | <b>COs Mapped - CO1</b> |
| Fluid, branches of fluid mechanics, properties of fluid, classification of fluids, different types of viscometers, Newton's law of viscosity, numericals, non-Newtonian fluids, types of flow, lines to describe the flow                                                                                                                                                                                 |                                                          |                |                         |
| <b>Unit II</b>                                                                                                                                                                                                                                                                                                                                                                                            | Fluid Pressure and Measurement                           | <b>(08hrs)</b> | <b>COs Mapped - CO2</b> |
| Pascal's law, Hydrostatic law, concept of atmospheric, gauge, vacuum and absolute pressure, manometers, and pressure measurement by simple and differential manometer, Numericals based on manometers                                                                                                                                                                                                     |                                                          |                |                         |
| <b>Unit III</b>                                                                                                                                                                                                                                                                                                                                                                                           | Basic Equations of Fluid Flow and Flow Measuring Devices | <b>(08hrs)</b> | <b>COs Mapped – CO3</b> |
| Basic equations of fluid flow: continuity equation and equation of motion, flow measurement using venturimeter, orifice meter, pitot tube, rotameter, Mass flowmeters, Numericals based on different flow measuring devices                                                                                                                                                                               |                                                          |                |                         |
| <b>Unit IV</b>                                                                                                                                                                                                                                                                                                                                                                                            | Fluid flow through pipelines and dimensional analysis    | <b>(08hrs)</b> | <b>COs Mapped – CO4</b> |
| Laminar flow through circular pipe: Hagen Poiseuille equation, major and minor losses, Darcy-Weisbach equation, Numericals, dimensionless numbers in fluid mechanics, dimensional homogeneity, types of similarities, model and prototype, dimensional analysis by Rayleigh's method and Buckingham's method                                                                                              |                                                          |                |                         |
| <b>Unit V</b>                                                                                                                                                                                                                                                                                                                                                                                             | Boundary Layer and fluid transportation                  | <b>(08hrs)</b> | <b>COs Mapped – CO5</b> |
| Concept of hydrodynamic boundary layer, growth over a flat plate, different thickness of boundary layer, numerical based on boundary layer, types of fluidization, different types of valves and pumps, centrifugal pump working and characteristics, numericals based on centrifugal pump                                                                                                                |                                                          |                |                         |
| <b>Text Books</b>                                                                                                                                                                                                                                                                                                                                                                                         |                                                          |                |                         |
| 1. Modi, L.P., Seth, S.M., "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi.<br>2. Bansal, R. K., "A Textbook of Fluid Mechanics and Hydraulic Machines", Laxmi Publications.                                                                                                                                                                                                             |                                                          |                |                         |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                    |                                                          |                |                         |
| 1. McCabe, W. L, J. Smith, and P. Harriot, Unit Operations of Chemical Engineering, McGraw-Hill International Edition, Seventh edition.<br>2. Noel de Nevers; Fluid Mechanics for Chemical Engineers, Third Edition; McGraw Hill.<br>3. M. Coulson, J.F. Richardson, with J.R. Backhurst and J.H. Harker, Coulson, Richardson Chemical Engineering, Volume-1, 6 <sup>th</sup> ed., Butterworth-Heinemann. |                                                          |                |                         |

| <b>Guidelines for Continuous Comprehensive Evaluation of Theory Course</b> |                                                           |                       |
|----------------------------------------------------------------------------|-----------------------------------------------------------|-----------------------|
| <b>Sr. No.</b>                                                             | <b>Components for Continuous Comprehensive Evaluation</b> | <b>Marks Allotted</b> |
| 1                                                                          | Three Assignments on unit-1, Unit-2, Unit-3 & 4           | 10                    |
| 2                                                                          | Group Presentation on Unit-5                              | 05                    |
| 3                                                                          | LearnCo Test on Each Unit                                 | 05                    |
|                                                                            | <b>Total</b>                                              | <b>20</b>             |



**K. K. Wagh Institute of Engineering Education and Research,  
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| S. Y. B. Tech. Chemical Engineering                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                        |                |                                                                                             |
| Pattern 2022 Semester: III                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                        |                |                                                                                             |
| CHE222004: Engineering Materials                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                        |                |                                                                                             |
| Teaching Scheme:                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                        | Credit Scheme: | Examination Scheme:                                                                         |
| Theory :03 hrs/week                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                        | 03             | Continuous Comprehensive Evaluation: 20Marks<br>InSem Exam: 20Marks<br>EndSem Exam: 60Marks |
| Prerequisite Courses, if any: - Basics of Physics, Chemistry, Engineering Mathematics.                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                        |                |                                                                                             |
| Course Objectives: <ul style="list-style-type: none"><li>To impart the basic concepts of material science.</li><li>To develop understanding selection of engineering materials based on properties.</li><li>To describe the applications of advance materials like nano materials.</li></ul>                                                                                                                                                                 |                                                                                                        |                |                                                                                             |
| Course Outcomes: On completion of the course, students will be able to–                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                        |                |                                                                                             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Course Outcomes                                                                                        |                | Bloom’s Level                                                                               |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                          | State the basic concepts of material science.                                                          |                | 1-State                                                                                     |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Select materials based on their properties for various applications.                                   |                | 2-Identify                                                                                  |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Describe metals and their alloys and selection process and analyze them according to their properties. |                | 3-Interpret                                                                                 |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Describe and analyze nano materials and their properties.                                              |                | 3-Interpret                                                                                 |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Identify electron microscope and their types.                                                          |                | 2-Identify                                                                                  |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                        |                |                                                                                             |
| Unit I                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Introduction                                                                                           | (08hrs)        | COs Mapped -CO1                                                                             |
| Introduction to materials and their principle properties; structure-property relationships in materials<br>Non-Metals: Introduction to Ceramics and Glass: Classification, Properties (Physical, Chemical, and Mechanical Properties), and Applications. Introduction to the determination of mechanical properties of materials using ASTM methods.<br>Heat Treatments: Methods for Fabrication, Rolling, Bending, Central Punching, Riveting, and Welding. |                                                                                                        |                |                                                                                             |
| Unit II                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Materials Testing                                                                                      | (08hrs)        | COs Mapped - CO2                                                                            |
| Testing of materials, destructive and non destructive tests<br>Structure of the atom: crystal structures and their influence on material properties deformation and slip                                                                                                                                                                                                                                                                                     |                                                                                                        |                |                                                                                             |

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| processes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                         |                |                         |
| <b>Unit III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Metals and their alloys | <b>(08hrs)</b> | <b>COs Mapped – CO3</b> |
| Introduction to Ferrous and nonferrous alloys.<br>Ferrous Alloys: Iron–Carbon Diagram, Mild Steel, Special Steels, Stainless Steels.<br>Nonferrous Alloys: Brass, Aluminum Alloys, and Titanium Alloys, Basics of corrosion and preventive measures. High- and Low-Temperature Materials, Insulators, Refractories.                                                                                                                                                                                                                               |                         |                |                         |
| <b>Unit IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Nano materials          | <b>(08hrs)</b> | <b>COs Mapped – CO4</b> |
| Classification, synthesis, characterization, and application of Nano materials. Fullerenes, Bucky balls, carbon nano tubes, fullerites. Nano particles – silver nano particles. Applications of Nano materials in Chemical Industry                                                                                                                                                                                                                                                                                                               |                         |                |                         |
| <b>Unit V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Experimental techniques | <b>(08hrs)</b> | <b>COs Mapped – CO5</b> |
| Introduction to Electron Microscopes<br>Study of Scanning electron microscopy SEM (Basics, Principal Elements, working), study of Transmission electron microscopy TEM (Basics, Principal Elements, working).<br>Scanning probe microscopes: Study of scanning tunneling microscopy, atomic force microscopy, X-ray diffraction                                                                                                                                                                                                                   |                         |                |                         |
| <b>Textbooks</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                         |                |                         |
| 1. A textbook of machine design, Khurmi R.S. and Gupta J.K.<br>2. Material Science & Metallurgy for Engineers, Dr. V. D. Kodgire, Everest Publishing House                                                                                                                                                                                                                                                                                                                                                                                        |                         |                |                         |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                         |                |                         |
| 1. James F. Shackelford, introduction to material science, McMillan publishing company,<br>2. D.Z. Jestrzebaski, properties of Engg. Materials, 3rd Ed. Toppers. Co. Ltd<br>3. J.L. Lee and Evans, Selecting Engineering materials for chemical and process plants, Business Works 1978<br>4. Introduction to Nano Technology, John Wiley & Sons by Charles P Poole, Frank J Owens.<br>5. Nano materials, synthesis, properties and applications, Institute of physics publishing, Bristol and Philadelphia, by A.S. Edelstein and R.C. Kamarhati |                         |                |                         |

| <b>Guidelines for Continuous Comprehensive Evaluation of Theory Course</b> |                                                           |                       |
|----------------------------------------------------------------------------|-----------------------------------------------------------|-----------------------|
| <b>Sr. No.</b>                                                             | <b>Components for Continuous Comprehensive Evaluation</b> | <b>Marks Allotted</b> |
| 1                                                                          | Three Assignments on unit-1, Unit-2, Unit-3 & 4           | 10                    |
| 2                                                                          | Group Presentation on Unit-5                              | 05                    |
| 3                                                                          | LearnCo Test on Each Unit                                 | 05                    |
|                                                                            | <b>Total</b>                                              | <b>20</b>             |





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| S. Y. B. Tech. Chemical Engineering                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                   |                |                                                                                             |
| Pattern 2022 Semester: III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                   |                |                                                                                             |
| CHE222005: Process Calculations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                   |                |                                                                                             |
| Teaching Scheme:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                   | Credit Scheme: | Examination Scheme:                                                                         |
| Theory:03 hrs/week                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                   | 03             | Continuous Comprehensive Evaluation: 20Marks<br>InSem Exam: 20Marks<br>EndSem Exam: 60Marks |
| Prerequisite Courses, if any: -Courses of Engineering Mathematics, Engineering Mechanics, Physics and Chemistry.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                   |                |                                                                                             |
| <b>Course Objectives:</b> <ul style="list-style-type: none"><li>To learn the various unit operations and unit processes performed in a chemical industry.</li><li>To impart knowledge on concepts of Material balance for unit operations and unit process.</li><li>To enable students to learn the application of the general energy balance equation and precisely to calculate the energy requirements for unit operations.</li><li>To study basic concepts of Humidification operation.</li><li>To study different types of fuels and understand the combustion calculations.</li></ul> |                                                                                                   |                |                                                                                             |
| <b>Course Outcomes:</b> On completion of the course, students will be able to–                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                   |                |                                                                                             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Course Outcomes                                                                                   |                | Bloom's Level                                                                               |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Determine the composition of the materials.                                                       |                | 3-Apply                                                                                     |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Apply the various laws governing solid, liquid and gas phases                                     |                | 3-Apply                                                                                     |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Calculate the amount of materials required to carry out the suitable unit operation and process.  |                | 3-Apply                                                                                     |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Evaluate the energy requirement for various unit operations and processes in chemical industries. |                | 3-Apply                                                                                     |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Understand the basics of Humidification and combustion Process.                                   |                | 2-Understand                                                                                |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                   |                |                                                                                             |
| Unit I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Units and Basic Chemical Principle                                                                | (08hrs)        | COs Mapped - CO1, CO2                                                                       |
| Introduction to unit operations, Units and dimensions: fundamental and derived units, conversions, ideal and real gas laws. Mole fractions and partial pressures, Average molecular weight, application of Dalton's, Amagat's, concept of vapor pressure, Raoult's law and its applications, gas & gaseous mixture.                                                                                                                                                                                                                                                                         |                                                                                                   |                |                                                                                             |

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| <b>Unit II</b>                                                                                                                                                                                                                                                                                                | Material Balance without Chemical Reactions | <b>(08hrs)</b> | <b>COs Mapped - CO1, CO2, CO3</b>  |
| Basic Concepts and Introduction to first law of thermodynamics, material balance calculations for distillation, Filtration, Extraction, Mixing, crystallization. Bypass and Recycling operations                                                                                                              |                                             |                |                                    |
| <b>Unit III</b>                                                                                                                                                                                                                                                                                               | Material Balance with chemical reactions    | <b>(08hrs)</b> | <b>COs Mapped - CO1, CO2, CO3,</b> |
| Concept of limiting and excess reactants, percentage conversion, yield and selectivity. Material balance of unsteady state processes involving chemical reaction.                                                                                                                                             |                                             |                |                                    |
| <b>Unit IV</b>                                                                                                                                                                                                                                                                                                | Energy Balance                              | <b>(08hrs)</b> | <b>COs Mapped - CO1, CO2, CO4,</b> |
| Basic Concept, Sensible Heat, latent heats of Phase change, energy balances, heat capacity of pure substances and mixtures, enthalpy of pure substances and mixtures, Hess's law, Standard Heat of Formation and combustion, Heat of reaction, adiabatic reactions, adiabatic flame temperature calculations. |                                             |                |                                    |
| <b>Unit V</b>                                                                                                                                                                                                                                                                                                 | Humidification and Combustion               | <b>(08hrs)</b> | <b>COs Mapped - CO1, CO5</b>       |
| Humidity and saturation: Molal humidity, absolute molal humidity, relative humidity, saturation humidity, psychrometric chart. Types of Fuel, Calorific values, Orsat Analysis, combustion calculations.                                                                                                      |                                             |                |                                    |
| <b>Text Books</b>                                                                                                                                                                                                                                                                                             |                                             |                |                                    |
| 1. Narayanan. K.V. and Lakshmikutty.B, "Stoichiometry and Process Calculations" PHI Publication.<br>2. David M. Himmelblau, "Basic Principles and Calculations in Chemical Engineering", Pearson Publication.                                                                                                 |                                             |                |                                    |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                        |                                             |                |                                    |
| 1. Bhatt B.I. and Vora S.M., "Stoichiometry", Tata McGraw Hill.<br>2. Richard M. Felder, Ronald W. Rousseau, "Elementary Principles of Chemical Processes", John Wiley & Sons.                                                                                                                                |                                             |                |                                    |

| <b>Guidelines for Continuous Comprehensive Evaluation of Theory Course</b> |                                                           |                       |
|----------------------------------------------------------------------------|-----------------------------------------------------------|-----------------------|
| <b>Sr. No.</b>                                                             | <b>Components for Continuous Comprehensive Evaluation</b> | <b>Marks Allotted</b> |
| 1                                                                          | Assignments on unit-1, Unit-2, Unit-3 &Unit-4, 5          | 10                    |
| 2                                                                          | Group Presentation on Unit-5                              | 05                    |
| 3                                                                          | LearnCo Test on Each Unit                                 | 05                    |
|                                                                            | <b>Total</b>                                              | <b>20</b>             |



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| S. Y. B. Tech. Chemical Engineering                                                                                                                                                                                                                                                                                          |                                                                                                                 |                |                     |
| Pattern 2022 Semester: III                                                                                                                                                                                                                                                                                                   |                                                                                                                 |                |                     |
| CHE222006: Organizational Behavior                                                                                                                                                                                                                                                                                           |                                                                                                                 |                |                     |
| Teaching Scheme:                                                                                                                                                                                                                                                                                                             |                                                                                                                 | Credit Scheme: | Examination Scheme: |
| Theory :01 hr/week                                                                                                                                                                                                                                                                                                           |                                                                                                                 | 01             | Term work: 25 Marks |
| Prerequisite Courses, if any: -                                                                                                                                                                                                                                                                                              |                                                                                                                 |                |                     |
| Course Objectives: <ul style="list-style-type: none"><li>• To present a problem oriented in depth knowledge of behavior in organization.</li><li>• To address the underlying concepts, methods of organization.</li><li>• To give an idea about different areas of organizational behavior in Chemical Industries.</li></ul> |                                                                                                                 |                |                     |
| Course Outcomes: On completion of the course, students will be able to–                                                                                                                                                                                                                                                      |                                                                                                                 |                |                     |
|                                                                                                                                                                                                                                                                                                                              | Course Outcomes                                                                                                 |                | Bloom’s Level       |
| CO1                                                                                                                                                                                                                                                                                                                          | To understand various methods and terms used different organizational behavior model                            |                | 1-Knowledge         |
| CO2                                                                                                                                                                                                                                                                                                                          | To understand Individual Behavior like attitude, perception, motivation, personality, misbehavior and emotions. |                | 2-Understand        |
| CO3                                                                                                                                                                                                                                                                                                                          | To understand group behavior, leadership and power                                                              |                | 2-Understand        |
| CO4                                                                                                                                                                                                                                                                                                                          | To understand dynamics of organizational behavior and managing change.                                          |                | 3-Apply             |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                              |                                                                                                                 |                |                     |
|                                                                                                                                                                                                                                                                                                                              | Module-1                                                                                                        | (03hrs)        | COs Mapped - CO1    |
| Organizational Behavior (OB): Learning objectives, Definition & Meaning, Why to study OB, an OB model, New challenges for OB Manager , Learning: Nature of learning, How learning occurs, Learning & OB, Case Study Analysis                                                                                                 |                                                                                                                 |                |                     |
|                                                                                                                                                                                                                                                                                                                              | Module-2                                                                                                        | (03hrs)        | COs Mapped - CO2    |
| Personality: Meaning & Definition, Determinants of Personality, Personality Traits, Personality & OB                                                                                                                                                                                                                         |                                                                                                                 |                |                     |

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| <p>Perception: Meaning &amp; Definition, Perceptual process, Importance of Perception in OB</p> <p>Motivation: Nature &amp; Importance, Herzberg's Two Factor theory, Maslow's Need Hierarchy theory, Alderfer's ERG theory</p> <p>Case Study Analysis</p>                                                                                                                                                                                                                                                                                                                                                                                               |                 |                |                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Module-3</b> | <b>(03hrs)</b> | <b>COs Mapped – CO3</b> |
| <p>Communication: Importance, Types, Barriers to communication, Communication as a tool for improving Interpersonal Effectiveness, Groups In Organization: Nature, Types, Why do people join groups, Group Cohesiveness &amp; Group Decision Making- managerial Implications, Effective Team Building</p> <p>Leadership: Leadership &amp; management, Theories of leadership- Trait theory, Behavioral Theory, Contingency Theory, Leadership &amp; Followership, How to be an Effective Leader</p> <p>Conflict: Nature of Conflict &amp; Conflict Resolution Transactional Analysis: An Introduction to Transactional Analysis, Case Study Analysis</p> |                 |                |                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Module-4</b> | <b>(03hrs)</b> | <b>COs Mapped – CO4</b> |
| <p>Organizational Culture: Meaning &amp; Definition, Culture &amp; Organizational Effectiveness Human Resource Management: Introduction to HRM, Selection, Orientation, Training &amp; Development, Performance Appraisal, and Incentives Organizational_Change: Importance of Change, Planned Change &amp; OB Techniques International QB: An Introduction to Individual &amp; Interpersonal Behavior in Global Perspectives, Case Study Analysis</p>                                                                                                                                                                                                   |                 |                |                         |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                 |                |                         |
| <ol style="list-style-type: none"> <li>1. Stephen P. Robbins, Timothy A. Judge, Neharika Vohra, Organizational Behavior, Pearson Education</li> <li>2. Udai Pareek, Understanding Organizational Behaviour, Oxford Higher Education</li> <li>3. Margi Parikh and Rajan Gupta, Organizational Behaviour, McGraw Hill Education</li> <li>4. Fred Luthans, Organizational Behavior, McGraw Hill</li> <li>5. Schermerhorn, Hunt and Osborn, Organizational behavior, John Wiley</li> </ol>                                                                                                                                                                   |                 |                |                         |

| <b>Guidelines for Guidelines for Term work Assessment</b> |                                                           |                       |
|-----------------------------------------------------------|-----------------------------------------------------------|-----------------------|
| <b>Sr. No.</b>                                            | <b>Components for Continuous Comprehensive Evaluation</b> | <b>Marks Allotted</b> |
| 1                                                         | Two Assignments on Module-1, Module-2, Module-3           | 15                    |
| 2                                                         | Group Presentation on Module-4                            | 10                    |
|                                                           | <b>Total</b>                                              | <b>25</b>             |



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| <b>S. Y. B. Tech. Chemical Engineering</b>                                                                                                                                                                                                                                                                                                          |                                                                                              |                                             |
| <b>Pattern 2022 Semester: III</b>                                                                                                                                                                                                                                                                                                                   |                                                                                              |                                             |
| <b>CHE222007: Chemistry I Lab</b>                                                                                                                                                                                                                                                                                                                   |                                                                                              |                                             |
| <b>Teaching Scheme:</b>                                                                                                                                                                                                                                                                                                                             | <b>Credit Scheme:</b>                                                                        | <b>Examination Scheme:</b>                  |
| <b>Practical: 04 hrs/week</b>                                                                                                                                                                                                                                                                                                                       | <b>02</b>                                                                                    | <b>Practical: 50 Marks<br/>TW: 25 Marks</b> |
| <b>Prerequisite Courses, if any:</b> - Knowledge of fundamental Chemistry up to XII standard and first year Engineering Chemistry.                                                                                                                                                                                                                  |                                                                                              |                                             |
| <b>Course Objectives:</b> <ul style="list-style-type: none"><li>To impart the basic concepts of organic, inorganic and physical chemistry</li><li>To develop understanding about concepts of organic reactions for analysis of unit Processes</li><li>To study the different analytical instrumentation techniques and their applications</li></ul> |                                                                                              |                                             |
| <b>Course Outcomes:</b> On completion of the course, students will be able to–                                                                                                                                                                                                                                                                      |                                                                                              |                                             |
|                                                                                                                                                                                                                                                                                                                                                     | <b>Course Outcomes</b>                                                                       | <b>Bloom's Level</b>                        |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                                          | Analyze the strength of forces and evaluate the size and molecular weight of the molecule.   | 2-Understand                                |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                                                          | Estimate the kinetics of reaction and analyze the factors controlling the rate of reactions. | 3-Apply                                     |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                                                          | Analyze the given chemical substance by different Instrumentation techniques.                | 3-Apply                                     |
| <b>CO4</b>                                                                                                                                                                                                                                                                                                                                          | Prepare and analyze the quality of organic compounds by different kinds of test.             | 3-Apply                                     |

| <b>List of Laboratory Experiments</b> |                                                                                          |                  |
|---------------------------------------|------------------------------------------------------------------------------------------|------------------|
| <b>Sr. No.</b>                        | <b>Laboratory Experiments</b>                                                            | <b>CO Mapped</b> |
| 1                                     | To determine diameter of solute molecule by viscosity measurements.                      | CO1              |
| 2                                     | To determine rate constant of first order reaction of acid catalyzed hydrolysis of ester | CO2              |
| 3                                     | Preparation of benzoic acid from benzamide, crystallization and purity checking by TLC.  | CO4              |
| 4                                     | To find molecular wt. of solute by depression in freezing point of solvent               | CO1              |

|                                                                                                                                                                                                                                                                 |                                                            |     |
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| 5                                                                                                                                                                                                                                                               | Estimation of $\text{Cu}^{++}$ ions by spectrophotometer   | CO3 |
| 6                                                                                                                                                                                                                                                               | Identification of given organic compound (Acid)            | CO4 |
| 7                                                                                                                                                                                                                                                               | Identification of given organic compound (Base)            | CO4 |
| 8                                                                                                                                                                                                                                                               | Identification of given organic compound (Phenol)          | CO4 |
| 9                                                                                                                                                                                                                                                               | Identification of given organic compound (Neutral)         | CO4 |
| 10                                                                                                                                                                                                                                                              | To determine molecular weight of solid by Elevation in B.P | CO1 |
| <b>Text Books</b>                                                                                                                                                                                                                                               |                                                            |     |
| 1. Laboratory manual on general and applied chemistry by Dr. S. K. Bhasin, Dhanpatrai publication.<br>2. Laboratory manual on engineering chemistry by Dr. S. K. Bhasin, Dhanpatrai publication.<br>3. Instrumental methods of chemical analysis Chatwal -Anand |                                                            |     |
| <b>Reference Books</b>                                                                                                                                                                                                                                          |                                                            |     |
| 1. Instrumental Methods of Analysis, H.H. Willard, L.L. Merritt and J.A. Dean & F.A. Settle, CBS Publishers, 7 <sup>th</sup> Edition, 1988<br>2. Vogel's analytical chemistry                                                                                   |                                                            |     |

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| <b>Guidelines for Laboratory Conduction</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 1. Teacher will brief the given experiment to students its procedure, observations calculation, and outcome of this experiment.<br>2. Apparatus and equipments required for the allotted experiment will be provided by the lab assistants using SOP.<br>3. Students will perform the allotted experiment in a group (two students in each group) under the supervision of faculty and lab assistant.<br>4. After performing the experiment students will check their readings, calculations from the teacher.<br>5. After checking they have to write the conclusion of the final result. |
| <b>Guidelines for Student's Lab Journal</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Write-up should include title, aim, and diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Guidelines for Termwork Assessment</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 1. Each experiment from lab journal is assessed for thirty marks based on three rubrics.<br>2. Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journal writing where each rubric carries ten marks.                                                                                                                                                                                                                                                                                                                                                       |



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| <b>S. Y. B. Tech. Chemical Engineering</b>                                                                                                                                                                                                                                             |                                                                                                          |                                               |
| <b>Pattern 2022 Semester: III</b>                                                                                                                                                                                                                                                      |                                                                                                          |                                               |
| <b>CHE222008: Fluid Mechanics Lab</b>                                                                                                                                                                                                                                                  |                                                                                                          |                                               |
| <b>Teaching Scheme:</b>                                                                                                                                                                                                                                                                | <b>Credit Scheme:</b>                                                                                    | <b>Examination Scheme:</b>                    |
| <b>Practical: 02 hrs/week</b>                                                                                                                                                                                                                                                          | <b>01</b>                                                                                                | <b>Oral: 25 Marks<br/>Term work: 25 Marks</b> |
| <b>Prerequisite Courses, if any:</b> - Courses of Engineering Mathematics, Engineering Mechanics, Physics and Chemistry                                                                                                                                                                |                                                                                                          |                                               |
| <b>Course Objectives:</b> <ul style="list-style-type: none"><li>• To get knowledge of viscosity measuring device.</li><li>• To get knowledge pressure measuring devices.</li><li>• To apply basic equations of fluid flow to determine fluid flow rate by different devices.</li></ul> |                                                                                                          |                                               |
| <b>Course Outcomes:</b> On completion of the course, students will be able to–                                                                                                                                                                                                         |                                                                                                          |                                               |
|                                                                                                                                                                                                                                                                                        | <b>Course Outcomes</b>                                                                                   | <b>Bloom's Level</b>                          |
| <b>CO1</b>                                                                                                                                                                                                                                                                             | Determine viscosity of fluid using viscometer and predict its variation.                                 | 2-Understand                                  |
| <b>CO2</b>                                                                                                                                                                                                                                                                             | Identify type of flow through pipeline.                                                                  | 1-Knowledge                                   |
| <b>CO3</b>                                                                                                                                                                                                                                                                             | Describe different pressure measuring devices.                                                           | 1-Knowledge                                   |
| <b>CO4</b>                                                                                                                                                                                                                                                                             | Apply basic equations of fluid flow to determine fluid flow rate and energy losses by different devices. | 3-Apply                                       |
| <b>CO5</b>                                                                                                                                                                                                                                                                             | Explain different centrifugal pump characteristics.                                                      | 1-Knowledge                                   |

| <b>List of Laboratory Experiments</b> |                                                            |                  |
|---------------------------------------|------------------------------------------------------------|------------------|
| <b>Sr. No.</b>                        | <b>Laboratory Experiments</b>                              | <b>CO Mapped</b> |
| 1                                     | Determination of viscosity of fluid using viscometer       | CO1              |
| 2                                     | Determination of type of flow using Reynolds Apparatus     | CO2              |
| 3                                     | Verification of Bernoulli's theorem                        | CO3, CO4         |
| 4                                     | Determination of coefficient of discharge of venturimeter  | CO4              |
| 5                                     | Determination of coefficient of discharge of orifice meter | CO4              |
| 6                                     | Determination of coefficient of discharge of rotameter     | CO4              |
| 7                                     | Determination of friction factor (Major losses)            | CO4              |

|                                                                                                                                                                                                                                                                                                                                                                                               |                                                    |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|-----|
| 8                                                                                                                                                                                                                                                                                                                                                                                             | Determination of minor losses                      | CO4 |
| 9                                                                                                                                                                                                                                                                                                                                                                                             | Determination of centrifugal pump characteristics. | CO5 |
| <b>Text Books</b>                                                                                                                                                                                                                                                                                                                                                                             |                                                    |     |
| 1. Modi, L.P., Seth, S.M., “Hydraulics and Fluid Mechanics”, Standard Book House, New Delhi.<br>2. Bansal, R. K., “A Textbook of Fluid Mechanics and Hydraulic Machines”, Laxmi Publications.                                                                                                                                                                                                 |                                                    |     |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                        |                                                    |     |
| 1. McCabe, W. L, J. Smith, and P. Harriot, Unit Operations of Chemical Engineering, McGraw-Hill International Edition, Seventh edition.<br>2. Noel de Nevers; Fluid Mechanics for Chemical Engineers, Third Edition; McGraw Hill.<br>3. M. Coulson, J.F. Richardson, with J.R. Backhurst and J.H. Harker, Coulson, Richardson Chemical Engineering, Volume-1, 6th ed., Butterworth-Heinemann. |                                                    |     |

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| <b>Guidelines for Laboratory Conduction</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <ul style="list-style-type: none"> <li>Teacher will brief the given experiment to students its procedure, observations calculation, and outcome of this experiment.</li> <li>Apparatus and equipments required for the allotted experiment will be provided by the lab assistants using SOP.</li> <li>Students will perform the allotted experiment in a group (two students in each group) under the supervision of faculty and lab assistant.</li> <li>After performing the experiment students will check their readings, calculations from the teacher.</li> <li>After checking they have to write the conclusion of the final result.</li> </ul> |
| <b>Guidelines for Student's Lab Journal</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Write-up should include title, aim, diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Guidelines for Termwork Assessment</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <ul style="list-style-type: none"> <li>Each experiment from lab journal is assessed for thirty marks based on three rubrics.</li> <li>Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journal writing where each rubric carries ten marks.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                |





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| <b>S. Y. B. Tech. Chemical Engineering</b>                                                                                                                                                                                                                               |                                                                           |                                        |
| <b>Pattern 2022 Semester: III</b>                                                                                                                                                                                                                                        |                                                                           |                                        |
| <b>CHE222009: Engineering Materials Lab</b>                                                                                                                                                                                                                              |                                                                           |                                        |
| <b>Teaching Scheme:</b>                                                                                                                                                                                                                                                  | <b>Credit Scheme:</b>                                                     | <b>Examination Scheme:</b>             |
| <b>Practical: 02 hrs/week</b>                                                                                                                                                                                                                                            | <b>01</b>                                                                 | <b>TW: 25 Marks<br/>Oral: 25 Marks</b> |
| <b>Prerequisite Courses, if any:</b> - Basics of Physics, Chemistry, Engineering Mathematics.                                                                                                                                                                            |                                                                           |                                        |
| <b>Course Objectives:</b> <ul style="list-style-type: none"><li>• To get knowledge mechanical properties of engineering materials.</li><li>• To get analyze the quality of engineering materials.</li><li>• To synthesize and characterize the nano materials.</li></ul> |                                                                           |                                        |
| <b>Course Outcomes:</b> On completion of the course, students will be able to–                                                                                                                                                                                           |                                                                           |                                        |
|                                                                                                                                                                                                                                                                          | <b>Course Outcomes</b>                                                    | <b>Bloom's Level</b>                   |
| <b>CO1</b>                                                                                                                                                                                                                                                               | Determine hardness of engineering materials by various instruments.       | 2-Understand                           |
| <b>CO2</b>                                                                                                                                                                                                                                                               | Determine toughness of engineering materials.                             | 2-Understand                           |
| <b>CO3</b>                                                                                                                                                                                                                                                               | Determine the defects present in the specimen by non-destructive testing. | 2-Understand                           |
| <b>CO4</b>                                                                                                                                                                                                                                                               | Describe and analyze nano materials and their properties.                 | 3-Interpret                            |
| <b>CO5</b>                                                                                                                                                                                                                                                               | Identify electron microscope and their types.                             | 2-Identify                             |

| <b>List of Laboratory Experiments</b> |                                                                                             |                  |
|---------------------------------------|---------------------------------------------------------------------------------------------|------------------|
| <b>Sr. No.</b>                        | <b>Laboratory Experiments</b>                                                               | <b>CO Mapped</b> |
| 1                                     | Determination of hardness of C.I, M.S, brass, aluminum specimen by Brinell's hardness test. | CO1              |
| 2                                     | Determination of hardness of C.I, M.S, brass, aluminum specimen by Rockwell hardness test   | CO2              |
| 3                                     | Determination of toughness of M.S, brass, aluminum by impact test.                          | CO3, CO4         |
| 4                                     | Study of Microstructure of ferrous material.                                                | CO4              |
| 5                                     | Study of Microstructure of non-ferrous material.                                            | CO4              |

|   |                                                                                                                                                              |     |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 6 | Determination of defects in material by dye penetration Test.                                                                                                | CO4 |
| 7 | Determination of defects in material by magnetic particle test.                                                                                              | CO4 |
| 8 | Synthesis of gold/silver (Au/Ag) nanoparticles and record the optical absorption spectra using simple absorption spectrometer.                               | CO4 |
| 9 | Synthesis of Fe <sub>2</sub> O <sub>3</sub> nanoparticles of different shapes and calculates the average size using scanning electron microscope SEM or TEM. | CO5 |

#### **Text Books**

1. A text book of machine design, Khurmi R.S. and Gupta J.K.
2. Material Science & Metallurgy for Engineers, Dr. V. D. Kodgire, Everest Publishing House.

#### **Reference Books**

1. James F. Shackelford, introduction to material science, McMillan publishing company,
2. D.Z. Jestrzebaski, properties of Engg. Materials, 3rd Ed. Toppers. Co. Ltd
3. J.L. Lee and Evans, Selecting Engineering materials for chemical and process plants, Business Works 1978
4. Introduction to Nano Technology, John Wiley & Sons by Charles P Poole, Frank J Owens.
5. Nano materials, synthesis, properties and applications, Institute of physics publishing, Bristol and Philadelphia, by A.S. Edelstein and R.C. Kamarhati

#### **Guidelines for Laboratory Conduction**

1. Teacher will brief the given experiment to students its procedure, observations calculation, and outcome of this experiment.
2. Apparatus and equipments required for the allotted experiment will be provided by the lab assistants using SOP.
3. Students will perform the allotted experiment in a group (two students in each group) under the supervision of faculty and lab assistant.
4. After performing the experiment students will check their readings, calculations from the teacher.
5. After checking they have to write the conclusion of the final result.

#### **Guidelines for Student's Lab Journal**

Write-up should include title, aim, diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.

#### **Guidelines for Termwork Assessment**

1. Each experiment from lab journal is assessed for thirty marks based on three rubrics.
2. Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journal writing where each rubric carries ten marks.



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| <b>S. Y. B. Tech. Chemical Engineering</b><br><b>Pattern 2022 Semester: III</b><br><b>CHE222010: Skill Development Course</b>                                                                                                                                                                                                                                                                             |                                                                                   |                            |
| <b>Teaching Scheme:</b>                                                                                                                                                                                                                                                                                                                                                                                   | <b>Credit Scheme:</b>                                                             | <b>Examination Scheme:</b> |
| <b>Practical: 02 hrs/week</b>                                                                                                                                                                                                                                                                                                                                                                             | <b>01</b>                                                                         | <b>Termwork: 25 Marks</b>  |
| <b>Prerequisite Courses, if any:</b> -Basic Knowledge of computer, Communication and English                                                                                                                                                                                                                                                                                                              |                                                                                   |                            |
| <b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To enhance ability of students to write technical reports without errors.</li> <li>To enable students to make effective power point slides in MS PowerPoint or equivalent software.</li> <li>To improve group working ability of students' group/ team work.</li> <li>To improve computational ability using Microsoft Excel.</li> </ul> |                                                                                   |                            |
| <b>Course Outcomes:</b> On completion of the course, students will be able to–                                                                                                                                                                                                                                                                                                                            |                                                                                   |                            |
|                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Course Outcomes</b>                                                            | <b>Bloom's Level</b>       |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                                                                                                | Write grammatically correct technical reports in MS Words or equivalent software. | 3-Apply                    |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                                                                                                                | Prepare effective power point slides in MS PowerPoint or equivalent software.     | 3-Apply                    |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                                                                                                                | Perform the group/ team Work/ task.                                               | 3-Apply                    |
| <b>CO4</b>                                                                                                                                                                                                                                                                                                                                                                                                | Apply MS Excel and it's features for solving problems.                            | 3-Apply                    |
| <b>CO5</b>                                                                                                                                                                                                                                                                                                                                                                                                | Present, convince and persuade to be an effective and successful professional.    | 3-Apply                    |

| <b>List of Assignments</b> |                                                                                                               |                  |
|----------------------------|---------------------------------------------------------------------------------------------------------------|------------------|
| <b>Sr. No.</b>             | <b>Particulars</b>                                                                                            | <b>CO Mapped</b> |
| 1                          | Development of communication skills in oral as well as writing.                                               | CO1, CO3         |
| 2                          | The writing skills should emphasize technical report writing, scientific paper writing, letter drafting, etc. | CO1, CO5         |

|                                                                                                                                                                     |                                                                                                                          |          |
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| 3                                                                                                                                                                   | The oral communication skills should emphasize presentation skills.                                                      | CO2, CO5 |
| 4                                                                                                                                                                   | Use of audio-visual facilities like working of LCD, powerpoint presentations required for making effective presentation. | CO2, CO5 |
| 5                                                                                                                                                                   | Group Discussion                                                                                                         | CO3, CO5 |
| 6                                                                                                                                                                   | Group Task                                                                                                               | CO3, CO5 |
| 7                                                                                                                                                                   | Introduction to Microsoft Excel                                                                                          | CO4, CO5 |
| <b>Text Books</b>                                                                                                                                                   |                                                                                                                          |          |
| 1. Kaul, Asha. Business Communication. Delhi: Prentice-Hall of India, 2006<br>2. Nitin Bhatnagar. Effective Communication and Soft Skills. Pearson Education India. |                                                                                                                          |          |
| <b>Reference Books</b>                                                                                                                                              |                                                                                                                          |          |
| 1. Eric Garner. Team Building.<br>2. Wendy Palmer and Janet Crawford. Leadership Embodiment.                                                                        |                                                                                                                          |          |

| <b>Guidelines for Assignments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
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| <ul style="list-style-type: none"> <li>• Teacher will brief the given assignment to students its procedure, observations calculation, and outcome of this assignments.</li> <li>• software required for the allotted assignments will be provided by the lab assistants using SOP.</li> <li>• Students will perform the allotted experiment in a group (two students in each group) under the supervision of faculty and lab assistant.</li> <li>• After performing the assignment students will check the same from faculty.</li> <li>• After checking they have to prepare final copy of the assignment.</li> </ul> |
| <b>Guidelines for Student's Assignments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Printed assignments should include title, aim, diagram (if any), procedure, observations, graphs, calculations, conclusion and questions, if any.                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Guidelines for Termwork Assessment</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <ul style="list-style-type: none"> <li>• Each assignment from lab journal is assessed for thirty marks based on three rubrics.</li> <li>• Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journal writing where each rubric carries ten marks.</li> </ul>                                                                                                                                                                                                                                                                                                                            |



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| S. Y. B. Tech. Chemical Engineering                                                                                                                                                                                                                                                 |                                                                                     |                                                                                             |               |
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| Pattern 2022 Semester: IV<br>CHE222011: Chemistry II                                                                                                                                                                                                                                |                                                                                     |                                                                                             |               |
| Teaching Scheme:                                                                                                                                                                                                                                                                    | Credit Scheme:                                                                      | Examination Scheme:                                                                         |               |
| Theory :03 hrs/week                                                                                                                                                                                                                                                                 | 03                                                                                  | Continuous Comprehensive Evaluation: 20Marks<br>InSem Exam: 20Marks<br>EndSem Exam: 60Marks |               |
| Prerequisite Courses, if any: Knowledge of fundamental Chemistry up to XII standard and first year Engineering Chemistry.                                                                                                                                                           |                                                                                     |                                                                                             |               |
| Course Objectives: <ul style="list-style-type: none"><li>To impart the basic concepts of organic chemistry</li><li>To develop understanding about concepts of organic reactions for analysis of unit</li><li>To study the different analytical instrumentation techniques</li></ul> |                                                                                     |                                                                                             |               |
| Course Outcomes: On completion of the course, students will be able to–                                                                                                                                                                                                             |                                                                                     |                                                                                             |               |
|                                                                                                                                                                                                                                                                                     | Course Outcomes                                                                     |                                                                                             | Bloom's Level |
| CO1                                                                                                                                                                                                                                                                                 | Apply the concept of naturally occurring polymer and synthesize the new polymers.   |                                                                                             | 2 Understand  |
| CO2                                                                                                                                                                                                                                                                                 | Apply the theory of synthesis of complex and evaluate their properties              |                                                                                             | 3 Apply       |
| CO3                                                                                                                                                                                                                                                                                 | Analyze the given chemical substance by different Instrumentation techniques.       |                                                                                             | 3 Apply       |
| CO4                                                                                                                                                                                                                                                                                 | Understand catalyst and its mechanism and apply it in the synthesis of compounds.   |                                                                                             | 3 Apply       |
| CO5                                                                                                                                                                                                                                                                                 | Understand concept of isomerism and analyze different isomers and their properties. |                                                                                             | 4 Analyze     |
| COURSE CONTENTS                                                                                                                                                                                                                                                                     |                                                                                     |                                                                                             |               |
| Unit I                                                                                                                                                                                                                                                                              | Green Chemistry                                                                     | (08hrs)                                                                                     | CO1           |
| Definition, goals of green chemistry, efficiency parameters, need of green chemistry, Major applications, traditional and green path way of adipic acid, polycarbonate, indigo dye, ibuprofen,                                                                                      |                                                                                     |                                                                                             |               |

carbaryl Carbohydrate: Cyclic structure of glucose, cellulose, starches. Ethanol based products, Cellulose acetate, nitrate, ether. catalytic site of enzyme, factors affecting enzyme activity

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                |                |            |
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| <b>Unit II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Transition metals and Co-ordination chemistry</b>           | <b>(08hrs)</b> | <b>CO2</b> |
| Electronic configuration of first series transition metals shapes of d- orbital characteristics (variable oxidation states, magnetic property, color of transition metal compounds). Ligands, C.N. and geometry, nomenclature of complexes, chelates. Theories of co-ordination- i) Werner ii) EAN iii) VBT for tetrahedral and octahedral complexes iv) CFT (including crystal field splitting in octahedral field and tetrahedral field, CFSE for octahedral complexes, applications of CFT)                                                                                |                                                                |                |            |
| <b>Unit III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Volumetric Analysis</b>                                     | <b>(8hrs)</b>  | <b>CO3</b> |
| Standard solutions and their preparations, Concentration terms, small scale units of concentration, types of titrations-neutralization (with titration curves), complexometric, redox and precipitation with examples. Theory of indicators in above titrations. Numericals on all above                                                                                                                                                                                                                                                                                      |                                                                |                |            |
| <b>Unit IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Surface Chemistry</b>                                       | <b>(8hrs)</b>  | <b>CO4</b> |
| <p>(a) Adsorption: Introduction to Freundlich and Langmuir theories of adsorption, adsorption from solution, B.E.T. Theory of adsorption of gases, Application of adsorption, numerical on above.</p> <p>(b) Applications characteristics, types, adsorption theory of catalysis, promoters, poisons, industrial applications of catalysts; Zeolites- structure, properties , applications as catalyst for reactions( amination of alcohol. NOX pollution control, alkylation, cracking conversion of methanol), Hydroformylation using catalyst, functionalized polymer,</p> |                                                                |                |            |
| <b>Unit V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Stereochemistry and Unit processes in organic synthesis</b> | <b>(8hrs)</b>  | <b>CO5</b> |
| Basic concepts, conformation isomerism of ethane, propane, butane, cyclohexane, monosubstituted cyclohexane, optical isomerism with 1 and 2 chiral centres, Mechanism, thermodynamics and kinetics of nitration, halogenations, sulphonation, preparation of nitrobenzene, chloral (DDT) and vinyl chloride (PVC), dodecyl benzenesulphonate, alpha-olefin sulphonate, 2-ethyl hexanol                                                                                                                                                                                        |                                                                |                |            |
| <b>Text Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                |                |            |
| 1. Inorganic chemistry - J.D. Lee<br>2. Inorganic chemistry - Cotton and Wilkinson's<br>3. Physical chemistry -P L Soni<br>4. Physical Chemistry- Atkins<br>5. Physical Chemistry – Maron Pruton<br>6. Instrumental methods of chemical analysis Chatwal –Anand                                                                                                                                                                                                                                                                                                               |                                                                |                |            |

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|                                                                                                                                                                                                                                                                         |  |
| <b>Reference Books</b>                                                                                                                                                                                                                                                  |  |
| 1. Analytical chemistry- Skooge and West<br>2. Reaction mechanism - Jerry March<br>3. Organic Chemistry - Morrison and Boyd<br>4. Instrumental Methods of Analysis, H.H.Willard, L.L. Merritt and J.A. Dean & F.A Settle, CBS Publishers, 7 <sup>th</sup> Edition, 1988 |  |

| <b>Guidelines for Continuous Assessment of Theory Course</b> |                                                           |                       |
|--------------------------------------------------------------|-----------------------------------------------------------|-----------------------|
| <b>Sr. No.</b>                                               | <b>Components for Continuous Comprehensive Evaluation</b> | <b>Marks Allotted</b> |
| 1                                                            | Assignment on 1,2,3,4,Unit                                | <b>10</b>             |
| 2                                                            | Group presentations on Unit 5                             | <b>05</b>             |
| 3                                                            | Learnico test on each unit                                | <b>05</b>             |



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| S. Y. B. Tech. Chemical Engineering                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                          |                                                                                                |                            |
| Pattern 2022 Semester: IV                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                          |                                                                                                |                            |
| CHE222012: Heat Transfer                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                          |                                                                                                |                            |
| Teaching Scheme:                                                                                                                                                                                                                                                                                                                                                                                                                                    | Credit Scheme:                                                                                           | Examination Scheme:                                                                            |                            |
| Theory :03 hrs/week                                                                                                                                                                                                                                                                                                                                                                                                                                 | 03                                                                                                       | Continuous Comprehensive Evaluation: 20 Marks<br>InSem Exam: 20 Marks<br>EndSem Exam: 60 Marks |                            |
| Prerequisite Courses, if any: -Engineering Mathematics I and II, Thermodynamics                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                          |                                                                                                |                            |
| Course Objectives: <ul style="list-style-type: none"><li>To use heat transfer principles to understand the behavior of thermal systems.</li><li>To recognize the various modes of heat transfer i.e. conduction, convection and radiation.</li><li>To provide the basic knowledge in thermal system design and to enlighten heat transfer applications.</li></ul>                                                                                   |                                                                                                          |                                                                                                |                            |
| Course Outcomes: On completion of the course, students will be able to–                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                          |                                                                                                |                            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Course Outcomes                                                                                          | Bloom’s Level                                                                                  |                            |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Demonstrate knowledge of the fundamental concepts of conduction, radiation, and convection heat transfer | 3-Apply                                                                                        |                            |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Calculate problem on conduction, convection and radiation.                                               | 3-Apply                                                                                        |                            |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Identify the type of heat transfer model that needs to be applied.                                       | 2-Understand                                                                                   |                            |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Identify, formulate and solve engineering problems based on heat exchanger.                              | 3-Apply                                                                                        |                            |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Select evaporator for industrial applications.                                                           | 2-Understand                                                                                   |                            |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                          |                                                                                                |                            |
| Unit I                                                                                                                                                                                                                                                                                                                                                                                                                                              | Introduction                                                                                             | (08hrs)                                                                                        | COs Mapped - CO1, CO2, CO3 |
| Modes of heat transfer- radiation, conduction and convection, Thermal conductivity, dimensional analysis. Steady state heat conduction through a plane slab, composite slab, hollow cylinder, composite cylinder and hollow sphere. Contact resistance, heat transfer between surfaces and surrounding, critical thickness of insulation. Heat transfer through extended surfaces (fins). Introduction to transient/unsteady state heat conduction. |                                                                                                          |                                                                                                |                            |
| Unit II                                                                                                                                                                                                                                                                                                                                                                                                                                             | Convection                                                                                               | (08hrs)                                                                                        | COs Mapped -               |



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                 |                |                                   |
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                 |                | <b>CO1, CO2, CO3</b>              |
| Natural and forced convection, Equations for convective heat transfer through annulus and over a flat plate. Condensation: Modes and features, Nusselt's equation, condensation on vertical and horizontal plate Boiling: Pool boiling and nucleate boiling                                                                                                                                                                                                                                                                                       |                 |                |                                   |
| <b>Unit III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Radiation       | <b>(08hrs)</b> | <b>COs Mapped – CO1, CO2, CO3</b> |
| Thermal radiation, black body radiation, properties of radiation, laws of radiation. Various cases of radiation between two surfaces, radiation shields                                                                                                                                                                                                                                                                                                                                                                                           |                 |                |                                   |
| <b>Unit IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Heat Exchangers | <b>(08hrs)</b> | <b>COs Mapped – CO4</b>           |
| Basic types of heat exchangers, overall heat transfer coefficient, fouling factor, Double pipe heat exchanger design by LMTD and effectiveness-NTU methods (calculations of overall heat transfer coefficient and area), Shell and tube heat exchangers, Plate type heat exchange                                                                                                                                                                                                                                                                 |                 |                |                                   |
| <b>Unit V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Evaporation     | <b>(08hrs)</b> | <b>COs Mapped – CO5</b>           |
| Introduction, types of evaporators, material and energy balance, boiling point elevation, capacity and economy, multiple effect evaporators                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                |                                   |
| <b>Text Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |                |                                   |
| 1. Fundamentals of Engineering Heat and Mass Transfer (SI Units), New Age International Publishers.<br>2. Heat and Mass Transfer by P K Nag, McGraw-Hill publications                                                                                                                                                                                                                                                                                                                                                                             |                 |                |                                   |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |                |                                   |
| 1. J P Holman, "Heat Transfer" 9 <sup>th</sup> edition, Tata McGraw Hill Publications, New Delhi (2004)<br>2. S. P. Sukhatme, "A Textbook on Heat Transfer", 4 <sup>th</sup> ed, Universities Press (India), 2005<br>3. D. Q. Kern, "Process Heat Transfer", 11 <sup>th</sup> ed., Tata McGraw Hill Publication, New Delhi<br>4. Bird R.B., Stewart W.E., Lightfoot E.N. "Transport phenomena" 2ed., Wiley Publications, 2002<br>5. Yunus A. Cengel "Heat and Mass Transfer" 3 <sup>rd</sup> ed., Tata McGraw Hill Publications, New Delhi (2007) |                 |                |                                   |

| <b>Guidelines for Continuous Comprehensive Evaluation of Theory Course</b> |                                                           |                       |
|----------------------------------------------------------------------------|-----------------------------------------------------------|-----------------------|
| <b>Sr. No.</b>                                                             | <b>Components for Continuous Comprehensive Evaluation</b> | <b>Marks Allotted</b> |
| 1                                                                          | 3 Assignments on Units 1, 2, 3 and 4                      | 10                    |
| 2                                                                          | Group Presentation on Unit 5                              | 05                    |
| 3                                                                          | LearnCo Test on Each Unit                                 | 05                    |
|                                                                            | <b>Total</b>                                              | <b>20</b>             |



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| S. Y. B. Tech. Chemical Engineering                                                                                                                                                                                                                                                                |                                                                                                                                              |                |                                                                                             |
| Pattern 2022 Semester: IV                                                                                                                                                                                                                                                                          |                                                                                                                                              |                |                                                                                             |
| CHE222013: Mechanical Operations                                                                                                                                                                                                                                                                   |                                                                                                                                              |                |                                                                                             |
| Teaching Scheme:                                                                                                                                                                                                                                                                                   |                                                                                                                                              | Credit Scheme: | Examination Scheme:                                                                         |
| Theory :03 hrs/week                                                                                                                                                                                                                                                                                |                                                                                                                                              | 03             | Continuous Comprehensive Evaluation: 20Marks<br>InSem Exam: 20Marks<br>EndSem Exam: 60Marks |
| Prerequisite Courses, if any: -Courses of Engineering Mathematics, Engineering Mechanics, Physics and Chemistry                                                                                                                                                                                    |                                                                                                                                              |                |                                                                                             |
| Course Objectives: <ul style="list-style-type: none"><li>To study properties of solids, separation and size reduction of solids.</li><li>To understand fluid solid separation using sedimentation operation, Fluidization.</li><li>To study mixing, agitation and Filtration Operations.</li></ul> |                                                                                                                                              |                |                                                                                             |
| Course Outcomes: On completion of the course, students will be able to–                                                                                                                                                                                                                            |                                                                                                                                              |                |                                                                                             |
|                                                                                                                                                                                                                                                                                                    | Course Outcomes                                                                                                                              |                | Bloom’s Level                                                                               |
| CO1                                                                                                                                                                                                                                                                                                | Classify the type of screening and size reduction equipment for different particle sizes                                                     |                | 2- Understand                                                                               |
| CO2                                                                                                                                                                                                                                                                                                | To understand different types solid-liquid, solid-gas separation options                                                                     |                | 2-Understand                                                                                |
| CO3                                                                                                                                                                                                                                                                                                | Explain fluidization applications in Industries and able select a suitable type of conveyor for transportation of different types of solids. |                | 2-Understand                                                                                |
| CO4                                                                                                                                                                                                                                                                                                | Calculate the mixing index and select a suitable type of mixing operation for various types of solids and liquids.                           |                | 3-Apply                                                                                     |
| CO5                                                                                                                                                                                                                                                                                                | Use concepts Filtration operations select suitable type of filtration equipment.                                                             |                | 3-Apply                                                                                     |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                    |                                                                                                                                              |                |                                                                                             |
| Unit I                                                                                                                                                                                                                                                                                             | Size Reduction and Screening Operations                                                                                                      | (08hrs)        | COs Mapped - CO1, CO2                                                                       |
| Particle size and shape, specific surface area; measurement of surface area, necessity of size reduction, different size reduction equipment’s, crushing efficiency, wet grinding, open circuit and closed circuit grinding industrial screening equipment and its types, screen analysis.         |                                                                                                                                              |                |                                                                                             |
| Unit II                                                                                                                                                                                                                                                                                            | Sedimentation and Separation Methods                                                                                                         | (06hrs)        | COs Mapped -, CO2, CO3                                                                      |
| Sedimentation, kynch theory of sedimentation equipment and its types, classifiers, centrifugal equipment, forth-flotation cell, magnetic separator, cyclone separator, liquid cyclone, electrostatic separator, precipitator, mineral jig.                                                         |                                                                                                                                              |                |                                                                                             |

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| <b>Unit III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Fluidization and transportation of solids | <b>(08hrs)</b> | <b>COs Mapped - CO3</b> |
| Concept of fluidization, fluidized bed systems, determination of minimum fluidization velocity, flow through packed bed, applications of fluidized bed. Spouted bed and fixed bed. Conveyors: principle, construction and working. Advantages, disadvantages and design calculations of belt conveyors, screw conveyors, chain & flight conveyors, bucket elevators and pneumatic conveyors                                                                                                                      |                                           |                |                         |
| <b>Unit IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Mixing Operation                          | <b>(08hrs)</b> | <b>COs Mapped – CO4</b> |
| Necessity of mixing and agitation in chemical industries, axial flow and radial flow agitators and its types agitation vessel, un-baffled and baffled tanks, draft tube, power requirement in mixing calculations, performance of mixers, mixing index, types of mixing equipment's sigma mixer, static mixer, ribbon blender, bunbury mixer, pug mill.                                                                                                                                                          |                                           |                |                         |
| <b>Unit V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Filtration                                | <b>(08hrs)</b> | <b>COs Mapped - CO5</b> |
| Filtration theory: constant pressure, constant rate, and variable pressure-variable rate filtration, incompressible and compressible cake filtration, classification of filtration and filters, filtration equipment, selection, sizing filter media and filter aids, classification of filtration, pressure drop through filter cake, filter medium resistance, specific cake resistance, types of filters – plate and frame, rotary vacuum, horizontal pressure leaf filters. Centrifugal filters-basket type. |                                           |                |                         |
| <b>Text Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                           |                |                         |
| 1. R.S. Hiremath and A.P. Kulkarni, Unit operation in Chemical Engineering, Everest publication.<br>2. Kiran D. Patil, Mechanical operations: Fundamental Principles and Application, Nirali publication.                                                                                                                                                                                                                                                                                                        |                                           |                |                         |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                           |                |                         |
| 1. McCabe W. L. & Smith J.C. "Unit Operations in Chemical Engineering". McGraw Hill Publications.<br>2. Coulson J. M. and Richardson J.F. "Chemical Engineering, Vol. 2".<br>3. Badger W. L and Banchero J.T. "Introduction to Chemical Engineering", McGraw Hill Publications.                                                                                                                                                                                                                                  |                                           |                |                         |

| <b>Guidelines for Continuous Comprehensive Evaluation of Theory Course</b> |                                                           |                       |
|----------------------------------------------------------------------------|-----------------------------------------------------------|-----------------------|
| <b>Sr. No.</b>                                                             | <b>Components for Continuous Comprehensive Evaluation</b> | <b>Marks Allotted</b> |
| 1                                                                          | Three Assignments on unit-1, Unit-2, Unit-3 & 4           | 10                    |
| 2                                                                          | Group Presentation on Unit-5                              | 05                    |
| 3                                                                          | LearnCo Test on Each Unit                                 | 05                    |
|                                                                            | <b>Total</b>                                              | <b>20</b>             |



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| <b>S. Y. B. Tech. Chemical Engineering</b>                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                   |                                                                                                                  |                         |
| <b>Pattern 2022 Semester: IV</b>                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                   |                                                                                                                  |                         |
| <b>CHE222014: Thermodynamics</b>                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                   |                                                                                                                  |                         |
| <b>Teaching Scheme:</b>                                                                                                                                                                                                                                                                                                                                                                                   | <b>Credit Scheme:</b>                                                                                                                                                             | <b>Examination Scheme:</b>                                                                                       |                         |
| <b>Theory :03 hrs/week</b>                                                                                                                                                                                                                                                                                                                                                                                | <b>03</b>                                                                                                                                                                         | <b>Continuous Comprehensive Evaluation: 20Marks</b><br><b>InSem Exam: 20Marks</b><br><b>EndSem Exam: 60Marks</b> |                         |
| <b>Prerequisite Courses, if any:</b> - Courses in Engineering Mathematics, Physics and Chemistry.                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                   |                                                                                                                  |                         |
| <b>Course Objectives:</b> <ul style="list-style-type: none"><li>• To introduce basic concepts of thermodynamics, and their applications.</li><li>• To formulate and apply the laws of thermodynamics in order to solve a given problem using a particular thermodynamic process.</li><li>• To understand different methods for performing phase and chemical reaction equilibrium calculations.</li></ul> |                                                                                                                                                                                   |                                                                                                                  |                         |
| <b>Course Outcomes:</b> On completion of the course, students will be able to–                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                   |                                                                                                                  |                         |
|                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Course Outcomes</b>                                                                                                                                                            | <b>Bloom’s Level</b>                                                                                             |                         |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                                                                                                | Understand basic concepts of thermodynamics, as well as their applications and limitations in Chemical Engineering                                                                | 2-Understand                                                                                                     |                         |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                                                                                                                | Formulate the relationship between different thermodynamic parameters for different processes and apply the thermodynamic laws to the given process in order to solve the problem | 3-Apply                                                                                                          |                         |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                                                                                                                | Compare ideal gas/solution models to reflect behavior of real mixtures based on the concepts of chemical potential, fugacity, and excess free energy                              | 3-Apply                                                                                                          |                         |
| <b>CO4</b>                                                                                                                                                                                                                                                                                                                                                                                                | Evaluate the various methods and assumptions for performing phase equilibrium calculations                                                                                        | 3-Apply                                                                                                          |                         |
| <b>CO5</b>                                                                                                                                                                                                                                                                                                                                                                                                | Determine the equilibrium products and their concentration in equilibrium when dealing with systems involving chemical reactions                                                  | 2-Understand                                                                                                     |                         |
| <b>COURSE CONTENTS</b>                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                   |                                                                                                                  |                         |
| <b>Unit I</b>                                                                                                                                                                                                                                                                                                                                                                                             | Introduction and Basic Concept                                                                                                                                                    | <b>(08hrs)</b>                                                                                                   | <b>COs Mapped - CO1</b> |
| Introduction and Fundamentals of Thermodynamics, Systems and variables, state and path function,                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                   |                                                                                                                  |                         |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                          |                |                         |
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| work, heat, reversible and irreversible processes, internal energy, Zeroth law of thermodynamics, First law of thermodynamics for non-flow process and flow process, equilibrium state, phase rule, heat capacity.                                                                                                                                                                                                                                                      |                                          |                |                         |
| <b>Unit II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                          | P-V-T Behavior and law of thermodynamics | <b>(08hrs)</b> | <b>COs Mapped - CO2</b> |
| P.V.T. behavior of pure fluids, Equation of state and concept of ideal gas, Processes involving ideal gas: constant volume process, constant pressure process, constant temperature process, adiabatic process and polytropic process; Equation of state for real gases, second law of thermodynamics: Spontaneous process, heat reservoir, heat pump, heat engine, Kelvin Plank statement, Clausius statement, entropy, Carnot principle, third law of thermodynamics. |                                          |                |                         |
| <b>Unit III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Thermodynamic Properties of Fluids       | <b>(08hrs)</b> | <b>COs Mapped – CO3</b> |
| Fundamental property relations for closed systems, Maxwell relationships, Clausius- Clapeyron equation, Partial molar properties, chemical potential, Ideal and non-ideal mixtures/Solutions, fugacity and fugacity coefficient for pure components and for mixture of gases and liquids. Lewis Randall rule, Henry's law, activity co-efficient, Gibbs-Duhem equation, Excess properties of mixtures.                                                                  |                                          |                |                         |
| <b>Unit IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Phase equilibrium                        | <b>(08hrs)</b> | <b>COs Mapped – CO4</b> |
| Criteria of equilibrium, phase equilibrium criteria, the phase rule, Duhem's theorem, vapor-liquid equilibrium of ideal and non-ideal solution at low to moderate pressures, Raoult's Law and Modified Raoult's Law, dew point and bubble point calculations, thermodynamic consistency test.                                                                                                                                                                           |                                          |                |                         |
| <b>Unit V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Chemical reaction equilibrium            | <b>(08hrs)</b> | <b>COs Mapped – CO5</b> |
| The reaction coordinates, Application of the criteria for equilibrium to chemical reactions, the standard Gibbs free energy change and the equilibrium constant, effect of temperature on equilibrium constant, evaluation of the equilibrium constant, relation of equilibrium constant to composition, calculation of equilibrium conversion for single reactions, the phase rule and Duhem's theorem for reacting systems                                            |                                          |                |                         |
| <b>Text Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                          |                |                         |
| 1. S.Sandler, Chemical, Biochemical and Engineering Thermodynamics, 4th edition, John Wiley, 2006.<br>2. Rao Y.V.C., Chemical Engineering Thermo Dynamics, University press (INDIA) Ltd.<br>3. Hill, T.L., An Introduction to Statistical Thermodynamics, Dover Publications, 1960.                                                                                                                                                                                     |                                          |                |                         |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                          |                |                         |
| 1. J. M. Smith, H. C. Vanness, M. M. Abott, 2005, Introduction to Chemical Engineering Thermodynamics, McGraw Hill, 7 <sup>th</sup> edition<br>2. K. V. Narayanan, 2011, Chemical Engineering Thermodynamics, Prentice Hall Of India, New Delhi.                                                                                                                                                                                                                        |                                          |                |                         |

| <b>Guidelines for Continuous Comprehensive Evaluation of Theory Course</b> |                                                           |                       |
|----------------------------------------------------------------------------|-----------------------------------------------------------|-----------------------|
| <b>Sr. No.</b>                                                             | <b>Components for Continuous Comprehensive Evaluation</b> | <b>Marks Allotted</b> |
| 1                                                                          | Three Assignments on unit-1, Unit-2, Unit-3 & 4           | 10                    |
| 2                                                                          | Group Presentation on Unit-5                              | 05                    |
| 3                                                                          | LearnCo Test on Each Unit                                 | 05                    |
|                                                                            | <b>Total</b>                                              | <b>20</b>             |



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| S. Y. B. Tech. Chemical Engineering                                                                                                                                                                                                                                                                                                                              |                                                                                   |                |                                                                                                |
| Pattern 2022 Semester: IV                                                                                                                                                                                                                                                                                                                                        |                                                                                   |                |                                                                                                |
| CHE222015: Soft Skills                                                                                                                                                                                                                                                                                                                                           |                                                                                   |                |                                                                                                |
| Teaching Scheme:                                                                                                                                                                                                                                                                                                                                                 |                                                                                   | Credit Scheme: | Examination Scheme:                                                                            |
| Theory :03 hrs/week                                                                                                                                                                                                                                                                                                                                              |                                                                                   | 03             | Continuous Comprehensive Evaluation: 20 Marks<br>InSem Exam: 20 Marks<br>EndSem Exam: 60 Marks |
| Prerequisite Courses, if any: - English                                                                                                                                                                                                                                                                                                                          |                                                                                   |                |                                                                                                |
| Course Objectives: <ul style="list-style-type: none"><li>To encourage the students for the development of soft skills and communication skills through creative thinking.</li><li>To make the students aware of critical thinking and problem-solving skills.</li><li>To develop leadership skills and organizational skills through group activities.</li></ul> |                                                                                   |                |                                                                                                |
| Course Outcomes: On completion of the course, students will be able to–                                                                                                                                                                                                                                                                                          |                                                                                   |                |                                                                                                |
|                                                                                                                                                                                                                                                                                                                                                                  | Course Outcomes                                                                   |                | Bloom’s Level                                                                                  |
| CO1                                                                                                                                                                                                                                                                                                                                                              | Memorize various elements of effective communicative skills.                      |                | 2-Understand                                                                                   |
| CO2                                                                                                                                                                                                                                                                                                                                                              | Apply critical thinking skills in problem solving.                                |                | 3-Apply                                                                                        |
| CO3                                                                                                                                                                                                                                                                                                                                                              | Improve social and work-life skills as well as personal and emotional well-being. |                | 2-Understand                                                                                   |
| CO4                                                                                                                                                                                                                                                                                                                                                              | Interpret people at the emotional level through emotional intelligence.           |                | 3-Apply                                                                                        |
| CO5                                                                                                                                                                                                                                                                                                                                                              | Identify the situation and take necessary decisions as a leader.                  |                | 2-Understand                                                                                   |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                  |                                                                                   |                |                                                                                                |
| Unit I                                                                                                                                                                                                                                                                                                                                                           | Soft Skills & Communication Skills                                                | (08hrs)        | COs Mapped - CO1                                                                               |
| Introduction, meaning, significance of soft skills: definition, significance; types of communication skills: Intrapersonal & Inter-personal skills:Verbal and Non-verbal Communication.                                                                                                                                                                          |                                                                                   |                |                                                                                                |
| Unit II                                                                                                                                                                                                                                                                                                                                                          | Critical Thinking                                                                 | (08hrs)        | COs Mapped - CO2                                                                               |
| Active Listening, Observation, Curiosity, Introspection, Analytical Thinking, Open-mindedness, Creative Thinking.                                                                                                                                                                                                                                                |                                                                                   |                |                                                                                                |
| Unit III                                                                                                                                                                                                                                                                                                                                                         | Problem Solving & Decision Making                                                 | (08hrs)        | COs Mapped – CO3                                                                               |

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| Meaning & features of Problem Solving, Managing Conflict, Conflict resolution, Methods of decision making, Effective decision making in teams, Methods & Styles                                                                                                                                                                                                                                                                                                                                                                                                                       |                                            |                |                         |
| <b>Unit IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Emotional Intelligence & Stress Management | <b>(08hrs)</b> | <b>COs Mapped – CO4</b> |
| Managing Emotions, Thinking before Reacting, Empathy for Others, Self-awareness, Self-Regulation, Stress factors, Controlling Stress –Tips and Buckingham’s method                                                                                                                                                                                                                                                                                                                                                                                                                    |                                            |                |                         |
| <b>Unit V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Leadership Skills                          | <b>(08hrs)</b> | <b>COs Mapped – CO5</b> |
| Team-Building, Decision-Making, Accountability, Planning, Public Speaking, Motivation, Risk-Taking, -Team Building, Time Management                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                            |                |                         |
| <b>Text Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                            |                |                         |
| 1. Personality Development and Soft Skills Publisher: Oxford University Press; Pap/Cdr edition (July 22, 2012)<br>2. Personality Development and Soft Skills: Preparing for Tomorrow, Dr Shikha Kapoor Publisher : I K International Publishing House; (February 28, 2018)                                                                                                                                                                                                                                                                                                            |                                            |                |                         |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                            |                |                         |
| 1. Soft skills: personality development for life success by Prashant Sharma, BPB publications 2018.<br>2. Soft Skills by Alex K. Published by S.Chand<br>3. Soft Skills: An Integrated Approach to Maximise Personality Gajendra Singh Chauhan, Sangeetha Sharma Published by Wiley.<br>4. Communication Skills and Soft Skills (Hardcover, A. Sharma) Publisher: Yking books<br>5. Soft Skills for a Big Impact (English, Paperback, RenuShorey) Publisher: Notion Press<br>6. Life Skills Paperback English Dr. Rajiv Kumar Jain, Dr. Usha Jain Publisher: Vayu Education of India. |                                            |                |                         |

| <b>Guidelines for Continuous Comprehensive Evaluation of Theory Course</b> |                                                           |                       |
|----------------------------------------------------------------------------|-----------------------------------------------------------|-----------------------|
| <b>Sr. No.</b>                                                             | <b>Components for Continuous Comprehensive Evaluation</b> | <b>Marks Allotted</b> |
| 1                                                                          | Assignments on Each Unit                                  | 05                    |
| 2                                                                          | Group Presentation/Discussion on Each Unit                | 10                    |
| 3                                                                          | LearnCo Test on Each Unit                                 | 05                    |
|                                                                            | <b>Total</b>                                              | <b>20</b>             |





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| <b>S. Y. B. Tech. Chemical Engineering</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                         |                                    |                              |
| <b>Pattern 2022 Semester: IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                         |                                    |                              |
| <b>CHE222016:Process Simulation using DWSIM</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                         |                                    |                              |
| <b>Teaching Scheme:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Credit Scheme:</b>                                                   | <b>Examination Scheme:</b>         |                              |
| <b>Theory :01 hrs/week</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Spoken Tutorial Certification</b>                                    | <b>Spoken Tutorial Online Exam</b> |                              |
| <b>Prerequisite Courses, if any:</b> - Basics of unit operations, unit processes, reactors and Heat Exchangers                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                         |                                    |                              |
| <b>Course Objectives:</b> <ul style="list-style-type: none"><li>• To introduce different process simulation software</li><li>• To study unit operations via simulation approach</li><li>• To learn unit processes via simulation approach</li></ul>                                                                                                                                                                                                                                                                                                    |                                                                         |                                    |                              |
| <b>Course Outcomes:</b> On completion of the course, students will be able to–                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                         |                                    |                              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Course Outcomes</b>                                                  | <b>Bloom’s Level</b>               |                              |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Understand basic concepts of process simulation.                        | 2-Understand                       |                              |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Simulate unit operation problems by DWSIM software.                     | 3-Apply                            |                              |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Solve different reactors and heat exchanger problems by DWSIM software. | 3-Apply                            |                              |
| <b>COURSE CONTENTS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                         |                                    |                              |
| <b>Module 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Basics of Chemical Process Simulation Software</b>                   | <b>(03hrs)</b>                     | <b>COs Mapped - CO1</b>      |
| Defining Simulation Configuration Wizard window Selecting chemical compounds, Selecting property packages, Choosing the units, Adding a stream to the flowsheet, Defining mole fractions of a stream, Defining stream condition of a stream, Introduction to Property Editor Window, adding mixer to the flowsheet, Defining single phase and two phase streams Carrying out material balance calculations, Adding a flash vessel to the flowsheet, Repeating all of the above with flash vessel, Verifying the results of calculations, mixer problem |                                                                         |                                    |                              |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Simulation of Unit operations</b>                                    | <b>(04hrs)</b>                     | <b>COs Mapped - CO1, CO2</b> |
| Defining default units for variables using System of Units, Adding shortcut distillation column to the flowsheet, Connecting feed, output, energy streams to the column, Specifying condenser type Specifying condenser and reboiler pressure, Specifying desired product composition through key                                                                                                                                                                                                                                                      |                                                                         |                                    |                              |

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| values, Specifying a guess value of reflux ratio, Simulate a shortcut distillation column, Minimum and actual number of stages, Minimum reflux ratio, Optimal Feed stage location, Absorption column                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                  |                |                                    |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Simulation of different types of reactors, Heat Exchanger</b>                 | <b>(04hrs)</b> | <b>COs Mapped - CO1, CO2, CO3,</b> |
| <ul style="list-style-type: none"> <li>Selecting chemical components and thermodynamics, Adding material streams to the flowsheet, Defining the properties of the streams, adding reactors, specifying reactors, Verifying the results of calculations,</li> <li>Simulating heat exchanger- Adding heat exchanger to the flowsheet Connecting inlet and outlet streams to the exchanger, Defining calculation type and flow direction, Defining cold and hot fluid pressure drop, Changing the shell side configurations, Changing the tube side configurations, Using master property table, Defining object and heat exchanger properties</li> </ul>                                                                                                                               |                                                                                  |                |                                    |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Simulation of heat exchanges, custom unit operations using Scilab, python</b> | <b>(03hrs)</b> | <b>COs Mapped - CO1, CO2, CO3</b>  |
| <ul style="list-style-type: none"> <li>Introducing Scilab CAPE-OPEN Unit Operation, Defining molar flow rates of the compounds, Defining molar enthalpy of the compounds Defining pressures of the compounds Calculating outlet pressure of the product stream, Calculating molar flow rates of product stream, Calculating molar enthalpy of product stream</li> <li>Introducing Python script in the flowsheet Introducing GetProp and SetProp function Defining mass flow and mole flow of the compounds, Defining out, Property Package.DWCalc Equilibrium function, Defining Property Packages.FlashSpec function Calculating outlet pressure of the product stream, Calculating mass and molar flow rates of product stream, Calculating enthalpy of product stream</li> </ul> |                                                                                  |                |                                    |
| <b>Text Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                  |                |                                    |
| 1. A. K. Jana, “Process Simulation and Control Using ASPEN”, PHI Learning Pvt. Ltd. Publications.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                  |                |                                    |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                  |                |                                    |
| 3. McCabe,W. L, J. Smith, and P. Harriot, Unit Operations of Chemical Engineering, McGraw-Hill International Edition, Seventh edition.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                  |                |                                    |
| 4. M. Coulson, J.F. Richardson, with J.R. Backhurst and J.H. Harker, Coulson, Richardson Chemical Engineering, Volume-1”, 6 <sup>th</sup> ed., Butterworth-Heinemann.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                  |                |                                    |
| 5. Ralph Schefflan, Teach Yourself the Basics of Aspen Plus, A John Wiley & Sons, inc., publication                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                  |                |                                    |

## Guidelines for online test

### Step 1:

- Login to the Student Dashboard (<http://spoken-tutorial.org/participant/login/>),

Go to 'Ongoing Test' and click 'Enroll', The invigilator will mark the Attendance for you.

### Step 2:

- Please refresh your browser screen after the invigilator marks your attendance, click 'Enter into Test' in the Ongoing test tab. It will take you to a new window (Spoken Tutorial Online Test Center).

### Step 3:

- After you enter your Username and Password, you will see the Homepage where you will get the list of Tests available for various FOSS / Courses. Click on the Test which you want to give. (Note: Read the instructions which appear on the screen.)

### Step 4:

- Click on “Attempt Quiz Now”. Then click on “Start Attempt”.

### Step 5:

- At the end of the test, click on “Finish attempt” in the Quiz Navigation Panel. You will get to see “Summary of Attempts”. • It will also show if you missed any questions. You can click on “Return to attempts” or you can go back and attempt by clicking on the particular question number.

### Step 6:

- Confirm by clicking on “Submit All and Finish” once you have completed the test. • You will get your test score on the spot.



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| <b>S. Y. B. Tech. Chemical Engineering</b>                                                                                                                                                                                                                                                                                                          |                                                                                       |                                             |
| <b>Pattern 2022 Semester: IV</b>                                                                                                                                                                                                                                                                                                                    |                                                                                       |                                             |
| <b>CHE222017: Chemistry II Lab</b>                                                                                                                                                                                                                                                                                                                  |                                                                                       |                                             |
| <b>Teaching Scheme:</b>                                                                                                                                                                                                                                                                                                                             | <b>Credit Scheme:</b>                                                                 | <b>Examination Scheme:</b>                  |
| <b>Practical: 04 hrs/week</b>                                                                                                                                                                                                                                                                                                                       | <b>02</b>                                                                             | <b>Practical: 50 Marks<br/>TW: 25 Marks</b> |
| <b>Prerequisite Courses, if any:</b> - Knowledge of fundamental Chemistry up to XII standard and first year Engineering Chemistry.                                                                                                                                                                                                                  |                                                                                       |                                             |
| <b>Course Objectives:</b> <ul style="list-style-type: none"><li>To impart the basic concepts of organic, inorganic and physical chemistry</li><li>To develop understanding about concepts of organic reactions for analysis of unit Processes</li><li>To study the different analytical instrumentation techniques and their applications</li></ul> |                                                                                       |                                             |
| <b>Course Outcomes:</b> On completion of the course, students will be able to–                                                                                                                                                                                                                                                                      |                                                                                       |                                             |
|                                                                                                                                                                                                                                                                                                                                                     | <b>Course Outcomes</b>                                                                | <b>Bloom's Level</b>                        |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                                          | Estimate the purity and quantity of substance present by traditional methods          | 3-Apply                                     |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                                                          | Apply the theory of synthesis of complex and evaluate their properties                | 2-Understand                                |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                                                          | Understand catalyst and its mechanism and apply it in adsorption of organic compound. | 2-Understand                                |
| <b>CO4</b>                                                                                                                                                                                                                                                                                                                                          | Analyze the compounds purity and apply the purification techniques for it.            | 3-Apply                                     |
| <b>CO5</b>                                                                                                                                                                                                                                                                                                                                          | Apply principles of ion exchange resin for treatment of hard water.                   | 3-Apply                                     |

| <b>List of Laboratory Experiments</b> |                                                                     |                  |
|---------------------------------------|---------------------------------------------------------------------|------------------|
| <b>Sr. No.</b>                        | <b>Laboratory Experiments</b>                                       | <b>CO Mapped</b> |
| 1                                     | Adsorption of acetic acid on charcoal to verify Freundlich isotherm | CO3              |
| 2                                     | Determination of purity of sod. Carbonate by titration method       | CO1              |
| 3                                     | Preparation of tris ethylene diammine nickel (II ) thiosulphate     | CO2              |
| 4                                     | Preparation of tetramine copper (II) sulphate                       | CO2              |

|                                                                                                                                                                                               |                                                                   |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|-----|
| 5                                                                                                                                                                                             | Preparation of osazone derivative of glucose                      | CO2 |
| 6                                                                                                                                                                                             | Estimation of glucose/acetone insoluble                           | CO1 |
| 7                                                                                                                                                                                             | Purification of organic compounds by crystallization              | CO4 |
| 8                                                                                                                                                                                             | Purification of organic compounds by sublimation                  | CO4 |
| 9                                                                                                                                                                                             | Determination of chloride content by Mohr's method                | CO4 |
| 10                                                                                                                                                                                            | To determine integral and differential heat of solution of a salt | CO1 |
| 11                                                                                                                                                                                            | Demineralization of hard water using ion exchange resin.          | CO5 |
| <b>Text Books</b>                                                                                                                                                                             |                                                                   |     |
| 1. Laboratory manual on general and applied chemistry by Dr.S. K.Bhasin, Dhanpatrai publication.<br>2. Laboratory manual on engineering chemistry by Dr. S. K.Bhasin, Dhanpatrai publication. |                                                                   |     |
| <b>Reference Books</b>                                                                                                                                                                        |                                                                   |     |
| 1. Instrumental Methods of Analysis, H.H.Willard, L.L. Merritt and J.A. Dean & F.A Settle, CBS Publishers, 7th Edition, 1988<br>2. Synthesis of organic compound-Vogel                        |                                                                   |     |

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| <b>Guidelines for Laboratory Conduction</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <ul style="list-style-type: none"> <li>Teacher will brief the given experiment to students its procedure, observations calculation, and outcome of this experiment.</li> <li>Apparatus and equipments required for the allotted experiment will be provided by the lab assistants using SOP.</li> <li>Students will perform the allotted experiment in a group (two students in each group) under the supervision of faculty and lab assistant.</li> <li>After performing the experiment students will check their readings, calculations from the teacher.</li> <li>After checking they have to write the conclusion of the final result.</li> </ul> |
| <b>Guidelines for Student's Lab Journal</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Write-up should include title, aim, and diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Guidelines for Termwork Assessment</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <ul style="list-style-type: none"> <li>Each experiment from lab journal is assessed for thirty marks based on three rubrics.</li> <li>Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journal writing where each rubric carries ten marks.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                |



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| <b>S. Y. B. Tech. Chemical Engineering</b>                                                                                                                                                                                                                     |                                                           |                                              |
| <b>Pattern 2022 Semester: IV</b>                                                                                                                                                                                                                               |                                                           |                                              |
| <b>CHE222018: Heat Transfer Lab</b>                                                                                                                                                                                                                            |                                                           |                                              |
| <b>Teaching Scheme:</b>                                                                                                                                                                                                                                        | <b>Credit Scheme:</b>                                     | <b>Examination Scheme:</b>                   |
| <b>Practical: 02 hrs/week</b>                                                                                                                                                                                                                                  | <b>01</b>                                                 | <b>Oral: 25 Marks<br/>Termwork: 25 Marks</b> |
| <b>Prerequisite Courses, if any:</b> - Engineering Mathematics, Thermodynamics                                                                                                                                                                                 |                                                           |                                              |
| <b>Course Objectives:</b> <ul style="list-style-type: none"><li>To understand the various modes of heat transfer i.e. conduction, convection and radiation.</li><li>To get a knowledge of heat exchanger.</li><li>To get a knowledge of evaporators.</li></ul> |                                                           |                                              |
| <b>Course Outcomes:</b> On completion of the course, students will be able to–                                                                                                                                                                                 |                                                           |                                              |
|                                                                                                                                                                                                                                                                | <b>Course Outcomes</b>                                    | <b>Bloom's Level</b>                         |
| <b>CO1</b>                                                                                                                                                                                                                                                     | Determine the thermal conductivity.                       | 2-Understand                                 |
| <b>CO2</b>                                                                                                                                                                                                                                                     | Calculate the heat transfer coefficient using convection. | 2-Understand                                 |
| <b>CO3</b>                                                                                                                                                                                                                                                     | Determine the emissivity using radiation.                 | 2-Understand                                 |
| <b>CO4</b>                                                                                                                                                                                                                                                     | Determine the heat transfer coefficient of heat exchanger | 2-Understand                                 |
| <b>CO5</b>                                                                                                                                                                                                                                                     | Understand evaporators characteristics.                   | 2-Understand                                 |

| <b>List of Laboratory Experiments</b> |                                                                          |                  |
|---------------------------------------|--------------------------------------------------------------------------|------------------|
| <b>Sr. No.</b>                        | <b>Laboratory Experiments</b>                                            | <b>CO Mapped</b> |
| 1.                                    | Determination of thermal conductivity of composite wall                  | CO1              |
| 2.                                    | Determination of thermal conductivity of insulation powder               | CO1              |
| 3.                                    | Calculation of heat transfer coefficient using natural convection        | CO2              |
| 4.                                    | Calculation of heat transfer coefficient using forced convection         | CO2              |
| 5.                                    | Determination of Stephan Boltzmann constant                              | CO3              |
| 6.                                    | Determination of emissivity using thermal radiation                      | CO3              |
| 7.                                    | Determination of heat transfer coefficient of Double pipe heat exchanger | CO4              |
| 8.                                    | Determination of heat transfer coefficient of shell and tube heat        | CO4              |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | exchanger                                                       |     |
| 9.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Heat Transfer in agitated vessels                               | CO4 |
| 10.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Material balance and energy balance of Single effect evaporator | CO5 |
| <b>Text Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                 |     |
| 1. Fundamentals of Engineering Heat and Mass Transfer (SI Units), New Age International Publishers.<br>2. Heat and Mass Transfer by P K Nag, McGraw-Hill publications                                                                                                                                                                                                                                                                                                                                                                             |                                                                 |     |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                 |     |
| 1. J P Holman, “Heat Transfer” 9 <sup>th</sup> edition, Tata McGraw Hill Publications, New Delhi (2004)<br>2. S. P. Sukhatme, “A Textbook on Heat Transfer”, 4 <sup>th</sup> ed, Universities Press (India), 2005<br>3. D. Q. Kern, “Process Heat Transfer”, 11 <sup>th</sup> ed., Tata McGraw Hill Publication, New Delhi<br>4. Bird R.B., Stewart W.E., Lightfoot E.N. “Transport phenomena” 2ed., Wiley Publications, 2002<br>5. Yunus A. Cengel “Heat and Mass Transfer” 3 <sup>rd</sup> ed., Tata McGraw Hill Publications, New Delhi (2007) |                                                                 |     |

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| <b>Guidelines for Laboratory Conduction</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <ul style="list-style-type: none"> <li>Teacher will brief the given experiment to students its procedure, observations calculation, and outcome of this experiment.</li> <li>Apparatus and equipments required for the allotted experiment will be provided by the lab assistants using SOP.</li> <li>Students will perform the allotted experiment in a group (two students in each group) under the supervision of faculty and lab assistant.</li> <li>After performing the experiment students will check their readings, calculations from the teacher.</li> <li>After checking they have to write the conclusion of the final result.</li> </ul> |
| <b>Guidelines for Student's Lab Journal</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Write-up should include title, aim, diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Guidelines for Termwork Assessment</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <ul style="list-style-type: none"> <li>Each experiment from lab journal is assessed for thirty marks based on three rubrics.</li> <li>Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journal writing where each rubric carries ten marks.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                |



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| <b>S. Y. B. Tech. Chemical Engineering</b>                                                                                                                                                                                                                                                                      |                                                                                                       |                                                  |
| <b>Pattern 2022 Semester: IV</b>                                                                                                                                                                                                                                                                                |                                                                                                       |                                                  |
| <b>CHE222019: Mechanical Operations Lab</b>                                                                                                                                                                                                                                                                     |                                                                                                       |                                                  |
| <b>Teaching Scheme:</b>                                                                                                                                                                                                                                                                                         | <b>Credit Scheme:</b>                                                                                 | <b>Examination Scheme:</b>                       |
| <b>Practical: 02 hrs/week</b>                                                                                                                                                                                                                                                                                   | <b>01</b>                                                                                             | <b>Teamwork: 25Marks<br/>Practical: 25 Marks</b> |
| <b>Prerequisite Courses, if any:</b> -Courses of Engineering Mathematics, Engineering Mechanics, Physics and Chemistry                                                                                                                                                                                          |                                                                                                       |                                                  |
| <b>Course Objectives:</b> <ul style="list-style-type: none"><li>• To study properties of solids, separation and size reduction of solids.</li><li>• To understand fluid solid separation using sedimentation operation, Fluidization.</li><li>• To study mixing, agitation and filtration operations.</li></ul> |                                                                                                       |                                                  |
| <b>Course Outcomes:</b> On completion of the course, students will be able to–                                                                                                                                                                                                                                  |                                                                                                       |                                                  |
|                                                                                                                                                                                                                                                                                                                 | <b>Course Outcomes</b>                                                                                | <b>Bloom's Level</b>                             |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                      | Evaluate the separation methods for solid & fluids.                                                   | 3-Apply                                          |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                      | Apply the principles of size reduction equipments for solids.                                         | 3-Apply                                          |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                      | Gain the knowledge on mixing principles for solid-solid / solid-liquid mixing.                        | 2-Understand                                     |
| <b>CO4</b>                                                                                                                                                                                                                                                                                                      | Evaluate the filter medium & specific cake resistance.                                                | 3-Apply                                          |
| <b>CO5</b>                                                                                                                                                                                                                                                                                                      | Understand the various solid transportation techniques.                                               | 2- Understand                                    |
| <b>List of Laboratory Experiments</b>                                                                                                                                                                                                                                                                           |                                                                                                       |                                                  |
| <b>Sr. No.</b>                                                                                                                                                                                                                                                                                                  | <b>Laboratory Experiments</b>                                                                         | <b>CO Mapped</b>                                 |
| 1                                                                                                                                                                                                                                                                                                               | To determine effectiveness of given set of standard screen                                            | <b>CO1</b>                                       |
| 2                                                                                                                                                                                                                                                                                                               | To determine energy consumption and crushing law constants for jaw crusher                            | <b>CO1, CO2</b>                                  |
| 3                                                                                                                                                                                                                                                                                                               | To determine Critical speed of Ball mill & Average particle size of the product obtained in ball mill | <b>CO1, CO2</b>                                  |
| 4                                                                                                                                                                                                                                                                                                               | To determine mixing Index in Sigma Mixer                                                              | <b>CO3</b>                                       |
| 5                                                                                                                                                                                                                                                                                                               | To find efficiency of cyclone separator.                                                              | <b>CO1</b>                                       |



|                                                                                                                                                                                                                                                                                   |                                                                                                        |                 |
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| 6                                                                                                                                                                                                                                                                                 | To determine filter medium resistance and specific cake resistance by using Plate & frame filter Press | <b>CO4</b>      |
| 7                                                                                                                                                                                                                                                                                 | To determine area of batch thickener by conducting batch sedimentation test.                           | <b>CO2</b>      |
| 8                                                                                                                                                                                                                                                                                 | To determine separation efficiency by using magnetic separator.                                        | <b>CO1, CO4</b> |
| 9                                                                                                                                                                                                                                                                                 | To study various conveyor systems.                                                                     | <b>CO5</b>      |
| <b>Text Books</b>                                                                                                                                                                                                                                                                 |                                                                                                        |                 |
| 1. R.S. Hiremath and A.P. Kulkarni, Unit operation in Chemical Engineering, Everest publication.<br>2. Kiran D. Patil, Mechanical operations: Fundamental Principles and Application, Nirali publication.                                                                         |                                                                                                        |                 |
| <b>Reference Books</b>                                                                                                                                                                                                                                                            |                                                                                                        |                 |
| 1. McCabe W. L. & Smith J. C. "Unit Operations in Chemical Engineering". McGraw Hill Publications.<br>2. Coulson J. M. and Richardson J. F. "Chemical Engineering, Vol. 2".<br>3. Badger W. L and Banchero J.T. "Introduction to Chemical Engineering", McGraw Hill Publications. |                                                                                                        |                 |

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| <b>Guidelines for Laboratory Conduction</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <ul style="list-style-type: none"> <li>Teacher will brief the given experiment to students its procedure, observations calculation, and outcome of this experiment.</li> <li>Apparatus and equipments required for the allotted experiment will be provided by the lab assistants using SOP.</li> <li>Students will perform the allotted experiment in a group (two students in each group) under the supervision of faculty and lab assistant.</li> <li>After performing the experiment students will check their readings, calculations from the teacher.</li> <li>After checking they have to write the conclusion of the final result.</li> </ul> |
| <b>Guidelines for Student's Lab Journal</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Write-up should include title, aim, diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Guidelines for Termwork Assessment</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <ul style="list-style-type: none"> <li>Each experiment from lab journal is assessed for thirty marks based on three rubrics.</li> <li>Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journal writing where each rubric carries ten marks.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                |



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Nashik**

**(Autonomous from Academic Year 2022-23)**

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| S. Y. B. Tech. Chemical Engineering                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                           |                |                                          |
| Pattern 2022 Semester: IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                           |                |                                          |
| CHE222020: Project Based Learning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                           |                |                                          |
| Teaching Scheme:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                           | Credit Scheme: | Examination Scheme:                      |
| Theory :02 hrs/week                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                           | 01             | Continuous Comprehensive<br>TW: 25 Marks |
| Prerequisite Courses, if any: - Physics, Chemistry, Mathematics, Material balance, and Energy balance.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                           |                |                                          |
| Course Objectives: <ul style="list-style-type: none"><li>• To emphasize long-term autonomous learning and work: unstructured multidisciplinary problems that need research.</li><li>• To integrate knowledge and skills from various areas through more complex problem solving.</li><li>• To integrate knowledge and skills from various areas through more complex problem solving.</li><li>• To improve teamwork, prepare students for a social environment through self-evaluation and self-criticism, guard against self-complacency, and try to see beyond their own ideas and knowledge.</li></ul> |                                                                                           |                |                                          |
| Course Outcomes: On completion of the course, students will be able to–                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                           |                |                                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Course Outcomes                                                                           |                | Bloom’s Level                            |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Increase their capacity for learning through shared cognition.                            |                | 2-Understand                             |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Draw on lessons from several disciplines and apply them in a practical way.               |                | 3-Apply                                  |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Learn by performing, and PBL will promote long-term retention of material.                |                | 2-Understand                             |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Replicate a skill, as well as improve teachers' and students' attitudes towards learning. |                | 2-Understand                             |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Identify the situation and take necessary decisions as a leader.                          |                | 2-Understand                             |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                           |                |                                          |
| Unit I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Selection of the relevant problem                                                         | (08hrs)        | CO1                                      |
| A problem can be theoretical, practical, social, technical, symbolic, cultural and/or scientific and grows out of students’ wondering within different disciplines and professional environments.                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                           |                |                                          |
| Unit II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Literature Review                                                                         | (08hrs)        | CO2                                      |

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| Based on the selected problem need to know the basic information about previous works knowledge. Therefore, detailed literature study should be conducted using scientific articles.                                                                                                                                                                                                  |                                 |                |            |
| <b>Unit III</b>                                                                                                                                                                                                                                                                                                                                                                       | Experimentation and Methodology | <b>(08hrs)</b> | <b>CO3</b> |
| Projects vary greatly in the depth of the questions explored, the clarity of the learning goals, the content and structure of the experiment activities like selection of raw materials and methodology etc.                                                                                                                                                                          |                                 |                |            |
| <b>Unit IV</b>                                                                                                                                                                                                                                                                                                                                                                        | Results and Discussion          | <b>(08hrs)</b> | <b>CO4</b> |
| Use of technology in meaningful ways to help them investigate, collaborate, analyze, synthesize and present their learning information and experimental data.                                                                                                                                                                                                                         |                                 |                |            |
| <b>Unit V</b>                                                                                                                                                                                                                                                                                                                                                                         | Project Completion              | <b>(08hrs)</b> | <b>CO5</b> |
| Activities may include- solving real life problem, investigation /study and writing reports of in depth study, field work, presentation etc.                                                                                                                                                                                                                                          |                                 |                |            |
| <b>Text Books</b>                                                                                                                                                                                                                                                                                                                                                                     |                                 |                |            |
| 1. Research Methodology: Methods and Techniques, New Age International Publications, C.R. Kothari and Gaurav Garg<br>2. Perry's Chemical Engineers' Handbook, by Don W. Green, Marylee Z. Southard,                                                                                                                                                                                   |                                 |                |            |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                |                                 |                |            |
| 1. M. Coulson, J.F. Richardson, with J.R. Backhurst and J.H. Harker, Coulson, Richardson Chemical Engineering, Volume-1", 6th ed., Butterworth-Heinemann.<br>2. Coulson J. M. and Richardson J.F. "Chemical Engineering Vol. 2", Pergamon Press.<br>3. Coulson J. M. and Richardson J.F. "Chemical Engineering Vol. 6", Pergamon Press.<br>4. Outlines of Chemical Technology, Dryden |                                 |                |            |

| <b>Recommended parameters for assessment, evaluation and weightage of the course</b> |                                                           |                       |
|--------------------------------------------------------------------------------------|-----------------------------------------------------------|-----------------------|
| <b>Sr. No.</b>                                                                       | <b>Components for Continuous Comprehensive Evaluation</b> | <b>Marks Allotted</b> |
| 1                                                                                    | Selection of the relevant problem                         | 05                    |
| 2                                                                                    | Literature Review                                         | 05                    |
| 3                                                                                    | Experimentation and Methodology                           | 05                    |
| 4                                                                                    | Results and Discussion                                    | 05                    |
| 5                                                                                    | Project Completion                                        | 05                    |
|                                                                                      | <b>Total</b>                                              | <b>25</b>             |

| <b>Guidelines for Laboratory Conduction</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
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| <ul style="list-style-type: none"> <li>• Teacher will brief the given experiment to students its procedure, observations calculation, and outcome of this experiment.</li> <li>• Apparatus and equipment's required for the allotted experiment will be provided by the lab assistants using SOP.</li> <li>• Students will perform the allotted experiment in a group (two students in each group) under the supervision of faculty and lab assistant.</li> <li>• After performing the experiment students will check their readings, calculations from the teacher.</li> <li>• After checking they have to write the conclusion of the final result.</li> </ul> |
| <b>Guidelines for Student's Lab Journal</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Write-up should include title, aim, and diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Guidelines for Teamwork Assessment</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <ul style="list-style-type: none"> <li>• Each experiment from lab journal is assessed for thirty marks based on three rubrics.</li> <li>• Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journal writing where each rubric carries ten marks.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                       |