

## Maharashtra State Board of Technical Education, Mumbai

### TEACHING PLAN (TP)

Academic Year: 2026-27 (ODD)

**Institute Code and Name:** 0078- K. K. Wagh Polytechnic, Nashik

**Semester:** Third

**Programme and Code:** Chemical Engineering (CH)

**Course Index:** 301

**Course and Code:** Process Calculations (PCAL) and 313336

**Name of Faculty:** Mrs. J. H. Nihalani

**CLASS:** SYCH

### INDUSTRY EXPECTED OUTCOME

Compute the mass and energy balances for a certain unit operation and chemical process reactions.

Determine the quantity and composition of the input and output streams from the operation/process.

### COURSE LEVEL LEARNING OUTCOMES (COS)

- CO301.1 - Apply the gas law for different chemical engineering operations and processes
- CO301.2 - Estimate requirement of materials for a unit operation using law of conservation of mass
- CO301.3 - Compute material balances for processes with chemical reactions
- CO301.4 - Calculate heat of reaction for a given chemical process
- CO301.5 - Calculate the calorific value of fuel to justify its quality

### TEACHING-LEARNING & ASSESSMENT SCHEME

| Course Code | Course Title         | Abbr | Course Category | Learning Scheme         |        |        |     |     |       | Credits | Paper Duration | Assessment Scheme |       |       |     |                             |     |       |     |             |             |
|-------------|----------------------|------|-----------------|-------------------------|--------|--------|-----|-----|-------|---------|----------------|-------------------|-------|-------|-----|-----------------------------|-----|-------|-----|-------------|-------------|
|             |                      |      |                 | Actual Contact Hrs/Week |        |        |     |     | Total |         |                | Theory            |       |       |     | Based on LL & TSL Practical |     |       |     | Based on SL | Total Marks |
|             |                      |      |                 | C<br>L                  | T<br>L | L<br>L | SLH | NLH |       |         |                | FA-TH             | SA-TH | Total |     | FA-PR                       |     | SA-PR |     | SLA         |             |
|             |                      |      |                 |                         |        |        |     |     |       |         |                |                   |       | Max   | Min | Max                         | Min | Max   | Min | Max         |             |
| 313336      | Process Calculations | PCAL | DSC             | 4                       | 2      | -      | -   | 6   | 3     | 03      | 30             | 70                | 100   | 40    | 50  | 20                          | --  | --    | --  | --          | 150         |

**Total IKS Hrs for Sem.:** 0 Hrs

Abbreviations: CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH- Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment Legends: @ Internal Assessment, # External Assessment, \*# On Line Examination , @\$ Internal Online Examination

### THEORY LEARNING OUTCOME (TLO)

| TLO No. | Title of TLO   |
|---------|--|
| TLO 1.1 | Apply the units of different physical quantities for the given system.           |
| TLO 1.2 | Convert units among different systems  |
| TLO 1.3 | Solve numerical based on the ideal gas law                                       |
| TLO 1.4 | Calculate vol%, mol% and pressure% for the given system                          |
| TLO 1.5 | Apply Raoult's and Henry's law to the given system                               |
| TLO 1.6 | Calculate the average molecular weight and density for the given chemical system |

|                |  |
|----------------|--|
| <b>TLO 2.1</b> | Apply the law of conservation of mass for the given system                                     |
| <b>TLO 2.2</b> | Delineate the procedure of material balance of process involving unit operation                |
| <b>TLO 2.3</b> | Write material balance equations for given unit operation.                                     |
| <b>TLO 2.4</b> | Calculate the quantity of raw materials for the given unit operation at steady state condition |
| <b>TLO 2.5</b> | Elaborate bypass, purge, and recycle operations used in chemical industry                      |
| <b>TLO 3.1</b> | Write material balance with chemical reaction  |
| <b>TLO 3.2</b> | Identify limiting and excess reactant for the given chemical reaction                          |
| <b>TLO 3.3</b> | Calculate %conversion and % yield of the given system  |
| <b>TLO 3.4</b> | Calculate %excess reactant for the given chemical reaction                                     |
| <b>TLO 4.1</b> | Apply the law of conservation of energy for the given system                                   |
| <b>TLO 4.2</b> | Calculate the heat involved during phase change for the given system                           |
| <b>TLO 4.3</b> | Apply Hess's law for the calculation of heat of formation for the given chemical system        |
| <b>TLO 4.4</b> | Calculate standard heat of reaction for the given system.                                      |
| <b>TLO 5.1</b> | Select relevant fuel for the given industrial application                                      |
| <b>TLO 5.2</b> | Explain the combustion process for the given system  |
| <b>TLO 5.3</b> | Calculate the calorific values for the given fuel  |
| <b>TLO 5.4</b> | Calculate the air required for combustion of given fuel  |

#### SUGGESTED COS - POS MATRIX FORM

| Course Outcomes (COs) | Programme Outcomes (POs)                     |                       |                                       |                        |  |                         |                         | Programme Specific Outcomes (PSOs) |        |
|-----------------------|--|-----------------------|---------------------------------------|------------------------|--|-------------------------|-------------------------|------------------------------------|--------|
|                       | PO-1 Basic and Discipline Specific Knowledge | PO-2 Problem Analysis | PO-3 Design/ Development of Solutions | PO-4 Engineering Tools | PO-5 Engineering Practices for Society, Sustainability and Environment | PO-6 Project Management | PO-7 Life Long Learning | PSO- 1                             | PSO- 2 |
| CO1                   | 3  | 2                     | 2                                     | -                      | -  | 1                       | 1                       | 3                                  | 3      |
| CO2                   | 3  | 3                     | 2                                     | 2                      | 1  | 1                       | 2                       | 3                                  | 3      |
| CO3                   | 3  | 3                     | 2                                     | 2                      | 1  | 1                       | 2                       | 3                                  | 3      |
| CO4                   | 3  | 3                     | 2                                     | 2                      | 1  | 1                       | 2                       | 3                                  | 3      |
| CO5                   | 3  | 3                     | 1                                     | 1                      | -  | 1                       | 2                       | 3                                  | 3      |

Legends :- High:03, Medium:02,Low:01, No Mapping: -  
\*PSOs are to be formulated at institute level

Teaching Plan (TP)

Academic Year: 2025-26

Program: Chemical Engineering

Course: Process Calculations (PCAL)

Name of faculty: Mrs. J. H. Nihalani

Institute Code: 0078

Course Code: 313336

Semester: Third (CH-3K)

| Chap No. (Alloted Hrs.)                                     | CO Mention only Number | TLO Mention only Number | Unit Name and Learning Content Title/ Details  | No. of Lecture | Plan (From-To)           | Actual Execution (From-To) | Teaching method/ Media        | Remark |
|---|------------------------|-------------------------|--|----------------|--------------------------|----------------------------|-------------------------------|--------|
| <b>Unit - I Introduction to Basic Chemical Calculations</b> |                        |                         |  |                |                          |                            |                               |        |
| 1 (10)  | CO-1                   | TLO 1.1                 | 1.1 Various systems of units, conversion of units  | 2              | 01/07/2026 to 04/07/2026 |                            | Blackboard, Books, media, PPT |        |
|   |                        | TLO 1.2                 | 1.2 Numerical on unit conversion of given system. (SI,MKS, CGS and FPS)  | 2              | 04/07/2026 to 07/07/2026 |                            |                               |        |
|   |                        | TLO 1.3                 | 1.3 Partial pressure, vapor pressure & pure component volume: definition, Ideal gas law, Dalton's law, Amagat's law, Real gas equation (Van der Waal equation), reference conditions of gas: Standard Temperature & Pressure(STP),Normal Temperature & Pressure(NTP), numerical (based on ideal gas law), <b>MKCL Quiz 1</b> | 2              | 07/07/2026 to 08/07/2026 |                            |                               |        |
|   |                        | TLO 1.4                 | 1.4 Relation between vol%, mol% and pressure% for an ideal gas, numerical  | 2              | 11/07/2026 to 11/07/2026 |                            |                               |        |
|   |                        | TLO 1.5                 | 1.5 Raoult's and Henry's Law: statement, numerical.  | 2              | 14/07/2026 to 14/07/2026 |                            |                               |        |
|   |                        | TLO 1.6                 | 1.6 Average molecular weight, density of gas mixture: numerical  | 2              | 15/07/2026 to 18/07/2026 |                            |                               |        |

| Chap No. (Alloted Hrs.)                                    | CO Mention only Number | TLO Mention only Number | Unit Name and Learning Content Title/ Details  | No. of Lecture | Plan (From-To)           | Actual Execution (From-To) | Teaching method/ Media        | Remark  |
|--|------------------------|-------------------------|--|----------------|--------------------------|----------------------------|-------------------------------|---------|
|  |                        | ----                    | Practice test 1 and MKCL Quiz 2  | 1              | 18/07/2026               |                            |                               | 1 extra |
| <b>Unit - II Material Balance of Unit Operations</b>       |                        |                         |  |                |                          |                            |                               |         |
| 2(10)  | CO-2                   | TLO 2.1                 | 2.1 Law of conservation of mass, steady & unsteady state operation   | 1              | 21/07/2026               |                            | Blackboard, Books, media, PPT |         |
|  |                        | TLO 2.2                 | 2.2 Material balance of unit operation: concept and procedure  | 2              | 21/07/2026 to 22/07/2026 |                            |                               |         |
|  |                        | TLO 2.3                 | 2.3 Material balance equation for unit operations: definition, block diagram with brief description, <b>MKCL Quiz 3</b>  | 2              | 25/07/2026 to 25/07/2026 |                            |                               |         |
|  |                        | TLO 2.4                 | 2.4 Numerical on material balance for following unit operations at steady state condition - distillation, drying, extraction, evaporation, crystallization, absorption, filtration, mixing & blending <b>MKCL Quiz 4</b> | 10             | 28/07/2026 to 08/08/2026 |                            |                               |         |
|  |                        | TLO 2.5                 | 2.5 Recycle, purge & bypass operation: definition and applications only. <b>Practice test 2</b>  | 2              | 11/08/2026 to 11/08/2026 |                            |                               | 2 extra |
| <b>Unit - III Material Balance with Chemical Reactions</b> |                        |                         |  |                |                          |                            |                               |         |
| 3(9)   | CO-3                   | TLO 3.1                 | 3.1 Chemical reaction terms: stoichiometric equation, stoichiometric coefficient, stoichiometric ratio, extent of reaction (definition)  | 1              | 12/08/2026               |                            | Blackboard, Books, media, PPT |         |
|  |                        | TLO 3.2                 | 3.2 Definition: limiting reactant and excess reactant, %excess, <b>MKCL Quiz 5</b>   | 1              | 18/08/2026               |                            |                               |         |
|  |                        | TLO 3.3                 | 3.3 Simple numerical for calculating % conversion, yield and selectivity   | 5              | 18/08/2026 to 25/08/2026 |                            |                               |         |

| Chap No. (Alloted Hrs.)             | CO Mention only Number | TLO Mention only Number | Unit Name and Learning Content Title/ Details   | No. of Lecture | Plan (From-To)           | Actual Execution (From-To) | Teaching method/ Media        | Remark |
|-------------------------------------|------------------------|-------------------------|---|----------------|--------------------------|----------------------------|-------------------------------|--------|
|                                     |                        | TLO 3.4                 | 3.4 Simple numerical for calculating % excess reactant, composition of product and reactant stream <b>MKCL Quiz 6</b>   | 6              | 25/08/2026 to 01/09/2026 |                            |                               |        |
|                                     |                        | ---                     | <b>Practice test 3</b>  | 1              | 02/09/2026               |                            |                               |        |
| <b>Unit - IV Energy Balance</b>     |                        |                         |   |                |                          |                            |                               |        |
| 4(8)                                | CO-4                   | TLO 4.1                 | 4.1 Law of conservation of energy, different forms of energy, definition and unit of heat, heat capacity, specific heat, mean heat capacity of gases  | 1              | 05/09/2026               |                            | Blackboard, Books, media, PPT |        |
|                                     |                        | TLO 4.2                 | 4.2 Heat capacity of gas mixture and liquid mixture types of heat (sensible heat & latent heat) sensible heat changes in gases, liquids, and solids, numerical on mean heat capacity <b>MKCL Quiz 7</b> | 5              | 05/09/2026 to 12/09/2026 |                            |                               |        |
|                                     |                        | TLO 4.3                 | 4.3 Heat of combustion, heat of formation and Hess's law of constant heat summation, numerical  | 4              | 12/09/2026 to 16/09/2026 |                            |                               |        |
|                                     |                        | TLO 4.4                 | 4.4 Heat of reaction definition, numerical. Heat of dilution and dissolution definition   | 1              | 19/09/2026               |                            |                               |        |
|                                     |                        | ---                     | <b>Practice test 4 and MKCL Quiz 8</b>  | 1              | 19/09/2026               |                            |                               |        |
| <b>Unit - V Fuel and Combustion</b> |                        |                         |   |                |                          |                            |                               |        |
| 5(8)                                | CO-5                   | TLO5.1                  | 5.1 Fuel: definition, types of fuel (solid, liquid, and gaseous fuel)   | 1              | 22/09/2026               |                            | Blackboard, Books, media, PPT |        |
|                                     |                        | TLO 5.2                 | 5.2 Combustion process: complete combustion and in complete combustion  | 1              | 22/09/2026               |                            |                               |        |

| <b>Chap No. (Alloted Hrs.)</b> | <b>CO Mention only Number</b> | <b>TLO Mention only Number</b> | <b>Unit Name and Learning Content Title/ Details</b>  | <b>No. of Lecture</b> | <b>Plan (From-To)</b>          | <b>Actual Execution (From-To)</b> | <b>Teaching method/ Media</b> | <b>Remark</b>  |
|--------------------------------|-------------------------------|--------------------------------|---|-----------------------|--------------------------------|-----------------------------------|-------------------------------|----------------|
|                                |                               | <b>TLO 5.3</b>                 | 5.3 Net Calorific Value (NCV) and Gross Calorific Value (GCV): definition and numerical. Constituent elements of proximate and ultimate analysis of coal <b>MKCL Quiz 9</b> | 3                     | 23/09/2026<br>to<br>26/09/2026 |                                   |                               |                |
|                                |                               | <b>TLO 5.4</b>                 | 5.4 Composition of flue gases, requirement of air, numerical  | 4                     | 29/09/2026<br>to<br>03/10/2026 |                                   |                               |                |
|                                |                               |                                | <b>Practice test 5 and MKCL Quiz 10</b>   | 1                     | 03/10/2026                     |                                   |                               | <b>2 extra</b> |

## ASSESSMENT METHODOLOGIES/TOOLS

### A. Formative assessment (Assessment for Learning) (FA-TH)

- Continuous assessment based on process and product related performance indicators. Each practical will be assessed considering
  - 60% weightage is to process
  - 40% weightage to product

### B. Summative Assessment (Assessment of Learning) (SA-TH)

- Continuous Assessment based on Process and Product related performance indicators. Each practical will be assessed considering
  - 60% weightage to Process
  - 40% weightage to Product

## SUGGESTED LEARNING MATERIALS / BOOKS

| Sr. No. | Author                                 | Title of Book  | Publication  |
|---------|--|--|--|
| 1       | B. I. Bhatt,<br>Shuchen B. Thakore     | Stoichiometry  | McGraw Hill, 2010, ISBN:<br>9780070681149, 0070681147                          |
| 2       | Himmelblau David<br>M. and Riggs       | Basic Principle and<br>Calculations in Chemical<br>Engineering | Prentice Hall, 2012, ISBN:<br>9780132346603, 0132346605                        |
| 3       | Hougen and Watson                      | Chemical Process<br>Principles                                 | Wiley Eastern Ltd., New Delhi, 2004,<br>ISBN 13: 9798123909539                 |
| 4       | S.K. Ghoshal,<br>S.K. Sanyal, S. Datta | Introduction to Chemical<br>Engineering                        | Tata McGraw Hill Education Private Limited, ISBN:<br>9780074601402, 0074601407 |
| 5       | Felder R. M.<br>and Rousseau R. W.     | Elementary Principles of<br>Chemical Processes                 | Wiley, 2020, ISBN: 9781119498636, 1119498635                                   |

## LEARNING WEBSITES & PORTALS

| Sr. No | Link / Portal   | Description                                |
|--------|---|--|
| 1      | <a href="https://www.msubbu.in/sp/pc/">https://www.msubbu.in/sp/pc/</a>   | Solved Numerical in Process<br>Calculation |
| 2      | <a href="https://unacademy.com/goal/gate-ese/QGFRK/free-platform/chem">https://unacademy.com/goal/gate-ese/QGFRK/free-platform/chem</a> | Video Lectures                             |
| 3      | <a href="https://archive.nptel.ac.in/courses/103/105/103105209/">https://archive.nptel.ac.in/courses/103/105/103105209/</a>             | Video Lectures, Transcripts                |
| 4      | <a href="https://dwsim.org/">https://dwsim.org/</a>   | DWSIM Open Source Software                 |

**Note :** Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

**Mrs. J. H. Nihalani**  
(Name & Signature of Staff)

**Dr. P. S. Bhandari**  
(Name & Signature of HOD)