



ITS  
chemical  
engineering

# MODULE HANDBOOK



DEPARTMENT OF

**CHEMICAL ENGINEERING**

FACULTY OF INDUSTRIAL TECHNOLOGY AND SYSTEM ENGINEERING

INSTITUT TEKNOLOGI SEPULUH NOPEMBER

**Program Educational Objective (PEO) of the MoChE ITS:**

| <b>PEO</b>                  | <b>DESCRIPTION</b>   |
|-----------------------------|--|
| PEO-1<br>Technical skill    | Students are able to apply chemical engineering to design a process system (change raw materials into products that have added value through physical, chemical and biological processes in a safe, environmentally friendly and economical manner), identify, formulate, and solve engineering problems, both in industry and through research activities |
| PEO-2<br>Professional skill | Students are able to develop leadership and develop a sense of professional ethics and high personal integrity   |
| PEO-3<br>Professional skill | Students are able to develop a culture of working independently and in collaboration in teams consisting of various disciplines on a national / international scale  |
| PEO-4<br>Life-Long Learning | Students always develop themselves through learning and professional activities both independently and in groups so that they are able to adapt to the latest technological developments.  |

**Program Learning Outcomes (PLO) of the MoChE ITS:**

| <b>PLO</b> | <b>DESCRIPTION</b>  |
|------------|---|
| PLO-1      | Able to master engineering science theory, design engineering, the latest methods and techniques required for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into products that have added value   |
| PLO-2      | Able to develop logical, critical, systematic, and creative thinking through scientific research, design creation or works of art in the field of science and technology that pay attention to and apply humanities values in accordance with their areas of expertise, compile scientific conceptions and study results based on rules, procedures, and scientific ethics in the form of a thesis or other equivalent, and uploaded on the college website, as well as papers that have been published in accredited scientific journals or accepted in international journals |
| PLO-3      | Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community;   |
| PLO-4      | Able to develop themselves and compete at national and international levels   |
| PLO-5      | Able to deepen or expand knowledge in the field of processes, processing systems, and equipment needed to convert raw materials into products that have added value with chemical, physical and biological processes to make original and tested contributions through independent research.  |
| PLO-6      | Able to formulate new ideas (new research questions) from the results of research carried out for the development of science and technology in the fields of processes, processing systems, and equipment needed to convert raw materials into products that have added value through chemical, physical and biological processes.  |
| PLO-7      | Show an attitude of responsibility for work in their field of expertise independently   |
| PLO-8      | Working together to be able to make the most of their potential   |

**Matrix of PLO-PEO of the MoChE ITS:**

| PLO                       | PEO 1 | PEO 2 | PEO 3 | PEO 4 |
|---------------------------|-------|-------|-------|-------|
| Knowledge 1.1 (PLO-1)     | X     |       |       |       |
| General Skill 2.1 (PLO-2) | X     |       |       |       |
| General Skill 2.2 (PLO-3) | X     |       |       |       |
| General Skill 2.3 (PLO-4) |       |       |       | X     |
| Special Skill 3.1 (PLO-5) | X     |       |       |       |
| Special Skill 3.2 (PLO-6) | X     |       |       |       |
| Attitude 4.1 (PLO-7)      |       | X     |       |       |
| Attitude 4.2 (PLO-8)      |       |       | X     |       |

**Course List of the MoChE ITS:**

| No.                 | Course Code | Course Name                                  | Credit    |
|---------------------|-------------|--|-----------|
| <b>SEMESTER I</b>   |             |  |           |
| 1                   | TK185101    | Advanced Chemical Engineering Thermodynamics | 4         |
| 2                   | TK185102    | Advanced Synthesis Process                   | 4         |
| 3                   | TK185xxx    | Elective I                                   | 3         |
| Number of Credit    |             |  | 11        |
| <b>SEMESTER II</b>  |             |  |           |
| 1                   | TK185201    | Advanced Transport Phenomena                 | 4         |
| 2                   | TK185202    | Advanced Chemical Reaction Engineering       | 4         |
| 3                   | TK185xxx    | Elective II                                  | 3         |
| 4                   |             | Thesis                                       |           |
| Number of Credit    |             |  | 11        |
| <b>SEMESTER III</b> |             |  |           |
| 1                   | TK185xxx    | Elective III                                 | 3         |
| 2                   | TK185xxx    | Elective IV                                  | 3         |
| 3                   |             | Thesis                                       |           |
| Number of Credit    |             |  | 6         |
| <b>SEMESTER IV</b>  |             |  |           |
| 1                   | TK185401    | Thesis                                       | 8         |
| Number of Credit    |             |  | 8         |
| <b>Total Credit</b> |             |  | <b>36</b> |

**Thesis TK185401:**

| No                             | Semester | Description  | Credit   |
|--------------------------------|----------|--|----------|
| 1                              | II       | Proposal   |          |
| 2                              | III      | Progress   |          |
| 3                              | IV       | Published article in a good reputable international conference |          |
| 4                              |          | Final presentation   |          |
| <b>Total credit for thesis</b> |          |  | <b>8</b> |

**List of Elective Courses:**

| No. | Course Code | Course Name                          | Credit |
|-----|-------------|--------------------------------------|--------|
| 1   | TK185103    | Advanced Separation Process          | 3      |
| 2   | TK185104    | Particle Technology                  | 3      |
| 3   | TK185105    | System Thermal Analysis              | 3      |
| 4   | TK185203    | Biochemical Reactor                  | 3      |
| 5   | TK185204    | Advanced Industrial Waste Management | 3      |
| 6   | TK185205    | Computational Fluid Dynamics         | 3      |
| 7   | TK185301    | Membrane Technology                  | 3      |
| 8   | TK185302    | Coal Processing and Utilization      | 3      |
| 9   | TK185303    | Electrochemical Reaction Engineering | 3      |
| 10  | TK185304    | Heterogeneous Catalyst               | 3      |
| 11  | TK185305    | Aerosol Technology                   | 3      |
| 12  | TK185306    | Natural Gas Processing               | 3      |
| 13  | TK185307    | Advanced Combustion Engineering      | 3      |
| 14  | TK185308    | Polymer Technology                   | 3      |
| 15  | TK185309    | Research Methodology                 | 3      |
| 16  | TK185310    | Advanced Multi Variable Control      | 3      |

**PLO achievement targets for graduated student of the MoChE ITS (the target value is adjusted based on the credits course).**

| Semester  | Course Code | Course                             | Credits (SKS) | PLO score*  |            |             |            |             |             |            |            |              |
|---|-------------|------------------------------------|---------------|-------------|------------|-------------|------------|-------------|-------------|------------|------------|--------------|
|   |             |                                    |               | 1.1         | 2.1        | 2.2         | 2.3        | 3.1         | 3.2         | 4.1        | 4.2        | overall      |
| 1   | TK185101    | Advanced Chem. Eng. Thermodynamics | 4             | 1.2         | 0          | 0.4         | 0.4        | 0.8         | 0.4         | 0.4        | 0.4        | 4            |
|   | TK185102    | Advanced Process Synthesis         | 4             | 1.2         | 0          | 0.4         | 0.4        | 0.8         | 0.4         | 0.4        | 0.4        | 4            |
|   | TK185xxx    | Elective 1                         | 3             | 0.9         | 0          | 0.3         | 0.3        | 0.6         | 0.3         | 0.3        | 0.3        | 3            |
| 2   | TK185201    | Advanced Transport Phenomena       | 4             | 1.2         | 0          | 0.4         | 0.4        | 0.8         | 0.4         | 0.4        | 0.4        | 4            |
|   | TK185202    | Advanced Chem. React. Eng.         | 4             | 1.2         | 0          | 0.4         | 0.4        | 0.8         | 0.4         | 0.4        | 0.4        | 4            |
|   | TK185xxx    | Elective 2                         | 3             | 0.9         | 0          | 0.3         | 0.3        | 0.6         | 0.3         | 0.3        | 0.3        | 3            |
| 3   | TK185xxx    | Elective 3                         | 3             | 0.9         | 0          | 0.3         | 0.3        | 0.6         | 0.3         | 0.3        | 0.3        | 3            |
|   | TK185xxx    | Elective 4                         | 3             | 0.9         | 0          | 0.3         | 0.3        | 0.6         | 0.3         | 0.3        | 0.3        | 3            |
| 4   | TK185401    | Thesis                             | 8             | 0.4         | 1.6        | 1.6         | 0.4        | 1.6         | 1.6         | 0.4        | 0.4        | 8            |
|   |             |                                    |               | <b>8.8</b>  | <b>1.6</b> | <b>4.4</b>  | <b>3.2</b> | <b>7.2</b>  | <b>4.4</b>  | <b>3.2</b> | <b>3.2</b> | <b>36</b>    |
| <b>Percentage target of PLO for graduated student (%)</b> |             |                                    |               | <b>24.4</b> | <b>4.4</b> | <b>12.2</b> | <b>8.9</b> | <b>20.0</b> | <b>12.2</b> | <b>8.9</b> | <b>8.9</b> | <b>100.0</b> |

**Module List of the MoChE ITS:**

| Course Name                       |   | Advanced Chemical Engineering Thermodynamics |       |
|-----------------------------------|---|--|-------|
| Course Code                       | TK185101  |  |       |
| Person responsible for the module | Prof. Gede Wibawa<br>Thermodynamics Lab.<br>Department of Chemical Engineering 3 <sup>rd</sup> Floor.   |  |       |
| Teaching method(s)                | Lecture; discussion; problem solving based on case study  |  |       |
| Workload                          | 1. Lectures: 4 SKS x 50 min/SKS = 200 min./week.<br>2. Exercises and Assignments: 4 SKS x 60 min/SKS = 240 min./week.<br>3. Independent learning: 4 SKS x 60 min/SKS = 240 min./week.   |  |       |
| Credit                            | 4 credit points (SKS)   |  |       |
| Intended learning outcomes        | After completing this module, a student is expected to:   |  |       |
|                                   | Understand the theory/model of the principle of the related state and the group contribution to its application in the estimation of the pure properties such as critical property, normal boiling point, vapor pressure, etc   | PLO-1  | PLO-3 |
|                                   | Understand the solution theory and its application to the equation of state in the determination of PVT for binary and multicomponent systems.  | PLO-1  | PLO-4 |
|                                   | Apply the solution theory in solving problems in phase equilibria   | PLO-5  | PLO-6 |
|                                   | Recognize the development of thermodynamic models in phase equilibrium calculations.  | PLO-5  |       |
|                                   | Understand the component constants, thermodynamic properties of the ideal gas, PVT relations: gas and liquids, mixtures   | PLO-1  | PLO-7 |
|                                   | Determine the equilibrium constants and conversions in chemical-reaction equilibria.  | PLO-8  |       |
| Content                           | 1. Method/model in estimating pure properties such as critical property, normal boiling point, vapor pressure, etc.<br>2. Relationship between thermodynamic properties.<br>3. Equations of state for the prediction and correlation of pure and mixture components.<br>4. Solution theory.<br>5. Analysis of the equations for the activity coefficients.<br>6. Calculation of the phase equilibria with the methods of activity coefficient and equation of state.<br>7. Chemical-reaction equilibria.<br>8. Applications in polymer-containing systems.  |  |       |
| Planned use/applicability         | Compulsory  |  |       |
| Prerequisites                     | -   |  |       |
| Form(s) of assessment             | Assignments, quiz, and team-based project   |  |       |
| The module mark is calculated     | The final grade is drawn from following components:<br>• Assignments: 20% of grade<br>• Quiz: 30% of grade<br>• Team-based project: 50% of grade<br>Students must have a final grade of 56% or higher to pass   |  |       |
| Recommended literature            | 1. B. E. Poling, J. M. Prausnitz, J. P. O'Connell, The Properties of Gases and Liquids, Fifth ed., McGraw-Hill International Editions, Singapore, 2001.<br>2. J. M. Smith, H. C. Van Ness, M. M. Abbott, Introduction to Chemical Engineering Thermodynamics, 6th ed., McGraw-Hill Co-Singapore, 2001.<br>3. S. M. Walas, Phase Equilibrium in Chemical Engineering, Butterworth Publisher, USA, 1985.<br>4. M. Modell and R. C. Reid, Thermodynamics and Its Applications, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1974.<br>5. S. I. Sandler, Models for Thermodynamic and Phase Equilibria Calculations, Marcel Dekker, Inc., New York, 1994 |  |       |
| Date of last amendment made       | -   |  |       |

| <b>Course Name</b>                | <b>Advanced Process Synthesis</b>   |                    |
|-----------------------------------|---|--------------------|
| Course Code                       | TK185102  |                    |
| Person responsible for the module | Prof. Renanto H<br>Process System Lab.<br>Department of Chemical Engineering 4 <sup>th</sup> Floor.   |                    |
| Teaching method(s)                | Lectures, discussions, project/problem-based learning.  |                    |
| Workload                          | 1. Lectures: 4 SKS x 50 min/SKS = 200 min./week.<br>2. Exercises and Assignments: 4 SKS x 60 min/SKS = 240 min./week.<br>3. Independent learning: 4 SKS x 60 min/SKS = 240 min./week.   |                    |
| Credit                            | 4 credit points (SKS)   |                    |
| Intended learning outcomes        | After completing this module, a student is expected to:   |                    |
|                                   | Students understand the importance of energy and natural resources.   | PLO - 1            |
|                                   | Students understand how to use energy efficiently in a heat exchanger network.  | PLO - 3            |
|                                   | Students understand the theory of heat network of chemical industrial equipment and its application.  | PLO - 5<br>PLO - 1 |
|                                   | Students understand management of steam and cogeneration.   | PLO - 8            |
|                                   | Students understand the theory of cooling system and water circulation and its application.   | PLO - 5<br>PLO - 1 |
|                                   | Students understand the source of air pollution and how to prevent it.  | PLO - 6            |
|                                   | Students understand health and safety issues.   | PLO - 7            |
|                                   | Simulate the chemical process with Aspen HYSYS.   | PLO - 4            |
| Content                           | <ol style="list-style-type: none"> <li>Theory and application of heat exchanger network</li> <li>Theory and application of network of chemical industry equipment's (reactor, distillation column, evaporator, and equipment).</li> <li>Theory and application of steam management and cogeneration.</li> <li>Theory and application of cooling and refrigeration systems</li> <li>Theory and application of water management</li> <li>Solving environmental and occupational safety issues in industry</li> <li>Simulation for chemical process</li> </ol>   |                    |
| Planned use/applicability         | Compulsory  |                    |
| Prerequisites                     | -   |                    |
| Form(s) of assessment             | Assignments, quiz, and project/problem-based project  |                    |
| The module mark is calculated     | The final grade is drawn from following components: <ul style="list-style-type: none"> <li>• Assignments: 20% of grade</li> <li>• Quiz: 30% of grade</li> <li>• Project-based project: 50% of grade</li> </ul> Students must have a final grade of 56% or higher to pass  |                    |
| Recommended literature            | <ol style="list-style-type: none"> <li>Robin Smith, "Chemical Process Design and Integration", John Wiley and Son, 2005</li> <li>James M Douglas, "Conceptual Design of Chemical Processes", New York McGraw-Hill - McGraw-Hill chemical engineering series, 1998</li> <li>Warren D. Seider, J. D. Seader, Daniel R. Lewin, Widagdo, "Process Design Principles: Synthesis, Analysis and Evaluation", 3rd edition, John Wiley &amp; Sons, 2008</li> <li>Lorenz T. Biegler, Ignacio E. Grossmann, Arthur W. Westerberg, "Systematic Methods of Chemical Process Design", Prentice Hall, 1997.</li> </ol> |                    |
| Date of last amendment made       | -   |                    |

| Course Name   | Advanced Transport Phenomena  |       |
|---|---|-------|
| Course Code   | TK185201  |       |
| Person responsible for the module   | Heru Setyawan<br>Electrochemistry Lab.<br>Department of Chemical Engineering 3 <sup>rd</sup> Floor.   |       |
| Teaching method(s)  | Lecture; discussion; exercises and problem-solving tasks.   |       |
| Workload  | 1. Lectures: 4 SKS x 50 min/SKS = 200 min./week.<br>2. Exercises and Assignments: 4 SKS x 60 min/SKS = 240 min./week.<br>3. Independent learning: 4 SKS x 60 min/SKS = 240 min./week.   |       |
| Credit  | 4 credit points (SKS)   |       |
| Intended learning outcomes  | After completing this module, a student is expected to:   |       |
|   | Student being able to derive differential balance for certain property including momentum, energy and mass of species, accounting appropriately property flux by convective and diffusive (molecular) process, along with property generation.  | PLO-1 |
|   | Student being able to write the continuity equation, Navier Stoke equation, energy equation, and species continuity equation and simplify them appropriately for specific transport problem   | PLO-3 |
|   | Student being able to determine the appropriate boundary conditions for specific transport problem  | PLO-4 |
|   | Student being able to solve steady state isothermal one dimension viscous fluid flow problem and physically interpret the solution  | PLO-1 |
|   | Student being able conduct scale or dimensional analyses of transport problems using the analysis to help simplify or enhance understanding of underlying transport process.  | PLO-1 |
|   | Student being able to solve steady state one dimension conduction and species diffusion problem in rectangular, cylinder and spherical geometry with/without first or zero order generation and physically interpreted the solution   | PLO-6 |
|   | Student being able to solve isothermal viscous fluid flow problem with two independent variables (steady state two dimensions flow, and unsteady state one dimension flow) using similarity transformation, separation variable and stream function concept (creeping flow) and interpreted the solution physically |       |
|   | Student being able to solve steady state two dimensions inviscid flow (potential flow) and interpreted the solution physically.   | PLO-5 |
|   | Student being able to solve steady state two-dimension fluid flow using boundary layer theory and interpreted the solution physically   | PLO-5 |
|   | Student being able to apply separation variable method to solve two-dimension conduction and diffusion problem and interpreted the solution physically  |       |
|   | Student being able to apply the similarity transformation method to solve unsteady state conduction and diffusion problem in unbounded region and interpreted the solution physically.  |       |
|   | Student being able to apply Finite Fourier Transform Method to solve unsteady state conduction and diffusion problem in bounded region and interpreted the solution physically.   |       |
| Student being able to solve simultaneous convection and diffusion (or conduction) problem comprising thermal or concentration boundary layer interaction by developing velocity profile or by using given velocity profile and interpreted the solution physically. |   |       |
| Student being able to solve multicomponent mass transfer problem using Stevan-Maxwell equation and interpreted the solution physically.   |   |       |
| Content   | <ol style="list-style-type: none"> <li>1. Fundamental Concepts (Shell Balance, Equation of Change)</li> <li>2. Steady state One Dimensional Isothermal Fluid Flow Problems</li> <li>3. Steady State One Dimensional Conduction and Diffusion Problems</li> </ol>  |       |

|                               |  |
|-------------------------------|--|
|                               | <ol style="list-style-type: none"> <li>4. Unsteady state One Dimensional Isothermal Fluid Flow Problems (Closed and Open Region)</li> <li>5. Steady State Two Dimension Fluid Flow Problem (Creeping flow, potential flow, Laminar boundary layer theory)</li> <li>6. Two Dimension Conduction and Diffusion Problems</li> <li>7. Two Dimension Conduction and Diffusion with Convection Problems (Asymptotic Approximation)</li> <li>8. Multicomponent Mass Transport Problems</li> </ol>   |
| Planned use/applicability     | Compulsory   |
| Prerequisites                 | -  |
| Form(s) of assessment         | Assignments, quiz, and team-based project  |
| The module mark is calculated | <p>The final grade is drawn from following components:</p> <ul style="list-style-type: none"> <li>• Assignments: 30% of grade</li> <li>• Quiz: 40% of grade</li> <li>• Team-based project: 30% of grade</li> </ul> <p>Students must have a final grade of 56% or higher to pass</p>  |
| Recommended literature        | <ol style="list-style-type: none"> <li>1. R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, Transport Phenomena, second edition, Wiley (2002)</li> <li>2. L. Gary Leal, Advanced Transport Phenomena, Cambridge University Press (2010)</li> <li>3. William M. Deen, Analysis of Transport Phenomena, Oxford University Press (2012).</li> <li>4. Truskey, Yuan and Katz, Transport Phenomena in Biological Systems, Pearson Prentice Hall (2009).</li> <li>5. Ali Altway, Sugeng Winardi, Heru Seyawan, <i>Proses Perpindahan</i>, ITS Press, Surabaya, 2012</li> </ol> |
| Date of last amendment made   | -  |

|                                   |  |                |
|-----------------------------------|--|----------------|
| <b>Course Name</b>                | <b>Advanced Chemical Reaction Engineering</b>  |                |
| Course Code                       | TK185202   |                |
| Person responsible for the module | Prof. Arief Widjaja<br>Biochemical Lab.<br>Department of Chemical Engineering 3 <sup>rd</sup> Floor.   |                |
| Teaching method(s)                | Lecture; discussion; presentation  |                |
| Workload                          | 1. Lectures: 4 SKS x 50 min/SKS = 200 min./week.<br>2. Exercises and Assignments: 4 SKS x 60 min/SKS = 240 min./week.<br>3. Independent learning: 4 SKS x 60 min/SKS = 240 min./week.  |                |
| Credit                            | 4 credit points (SKS)  |                |
| Intended learning outcomes        | After completing this module, a student is expected to:  |                |
|                                   | Students can find out in general: Non-isothermal Operation   | PLO-1          |
|                                   | Students can design with the principle of mixed flow reactor stability   | PLO-1          |
|                                   | Students understand the basic techniques of isothermal and non-isothermal system reactor design  | PLO-1          |
|                                   | Students understand the concept of diffusion and kinetics  | PLO-4<br>PLO-3 |
|                                   | Students are able to evaluate the kinetic/mass transfer regime in solid catalysts  | PLO-5          |
|                                   | Students can do Reactor design with heat transfer evaluation   | PLO-7<br>PLO-5 |
|                                   | Students can apply chemical engineering concepts in catalyst engineering and heterogeneous catalytic reactions   | PLO-8<br>PLO-6 |
| Content                           | The basics of heterogeneous catalytic technology and its applications:<br>1. Non-isothermal reactor<br>2. Stability of the stirred tank reactor<br>3. Selection of contact systems<br>4. Catalyst pore diffusion<br>5. Mass transfer vs kinetics<br>6. Packed bed reactors<br>7. The equilibrium of chemical reactions and applications in polymer-containing systems. |                |
| Planned use/applicability         | Compulsory   |                |
| Prerequisites                     | -  |                |
| Form(s) of assessment             | Assignments, quiz, and team-based project  |                |
| The module mark is calculated     | The final grade is drawn from following components:<br>• Assignments: 50% of grade<br>• Quiz: 30% of grade<br>• EAS: 20% of grade<br>Students must have a final grade of 56% or higher to pass   |                |
| Recommended literature            | 1. J.M.Smith, "Reaction Kinetics" 3rd ed, McGraw-Hill,1982<br>2. Octave Levenspiel, "Chemical Reaction Engineering" 3rd Ed. McGraw-Hill, 2000.<br>3. Fogler," Elements of Chemical Reaction Engineering ", 3rd Ed, Prentice-Hall, 1999.  |                |
| Date of last amendment made       | -  |                |

|                                   |  |                         |
|-----------------------------------|--|-------------------------|
| <b>Course Name</b>                | <b>Advanced Separation Process</b>   |                         |
| Course Code                       | TK185103   |                         |
| Person responsible for the module |  |                         |
| Teaching method(s)                | Lecture; discussion: assignments.  |                         |
| Workload                          | 1. Lectures: 3 SKS x 50 min/SKS = 150 min./week.<br>2. Exercises and Assignments: 3 SKS x 60 min/SKS = 180 min./week.<br>3. Independent learning: 3 SKS x 60 min/SKS = 180 min./week.  |                         |
| Credit                            | 3 credit points (SKS)  |                         |
| Intended learning outcomes        | After completing this module, a student is expected to:  |                         |
|                                   | Students understand the principles and can analyse the conventional separation process: distillation, absorption, and multicomponent extraction.   | PLO-1<br>PLO-5<br>PLO-6 |
|                                   | Students are able can analyse the absorption and distillation process with chemical reaction.  | PLO-3<br>PLO-4<br>PLO-5 |
|                                   | Students are able to analyse supercritical fluid extraction process.   | PLO-1<br>PLO-7          |
|                                   | Students are able to analyse membrane technology for process separation.   | PLO-1<br>PLO-8          |
| Content                           | 1. Conventional Separation Process: Distillation, Absorption, Extraction.<br>2. Azeotropic Distillation & Extractive Distillation.<br>3. Distillation with Chemical Reaction.<br>4. Absorption with Chemical Reaction.<br>5. Extraction with Supercritical Fluid.<br>6. Separation by Membrane Technology. |                         |
| Planned use/applicability         | Elective   |                         |
| Prerequisites                     | -  |                         |
| Form(s) of assessment             | Assignments, quiz, and team-based project  |                         |
| The module mark is calculated     | The final grade is drawn from following components:<br>• Assignments: 30% of grade<br>• Quiz: 40% of grade<br>• EAS 30% of grade<br>Students must have a final grade of 56% or higher to pass  |                         |
| Recommended literature            | 1. J. D. Seader and Ernest J. Henley, Separation Process Principles', John Wiley, New York 1998.<br>2. W.E. Treybal, Mass Transfer Operation", McGrawHill, New York.   |                         |
| Date of last amendment made       | -  |                         |

| Course Name                       | Particle Technology  |  |
|-----------------------------------|--|--|
| Course Code                       | TK185104   |  |
| Person responsible for the module | Prof. Heru Setyawan<br>Electrochemical Lab.<br>Department of Chemical Engineering 3 <sup>rd</sup> Floor.   |  |
| Teaching method(s)                | Lecture; discussion; problem solving based on case study   |  |
| Workload                          | 1. Lectures: 3 SKS x 50 min/SKS = 150 min./week.<br>2. Exercises and Assignments: 3 SKS x 60 min/SKS = 180 min./week.<br>3. Independent learning: 3 SKS x 60 min/SKS = 180 min./week.  |  |
| Credit                            | 3 credit points (SKS)  |  |
| Intended learning outcomes        | After completing this module, a student is expected to:  |  |
|                                   | Students are able to use particle characterization concepts.   |  |
|                                   | Students are able to use particle processing procedures.   |  |
|                                   | Students can use the concept of particle formation.  |  |
|                                   | Students are able to show the transport mechanism of particles.  |  |
|                                   | Students are able to distinguish various kinds of particle-particle separation.  |  |
| Content                           | Students are able to connect the concepts of particle technology to security.  |  |
|                                   | <ol style="list-style-type: none"> <li>1. Particle characterization</li> <li>2. Particle processing (mixing and segregation, granulation, deposition)</li> <li>3. Particle formation (size reduction and enlargement, granulation)</li> <li>4. Particle transportation (multiphase flow, pneumatic transportation, fluidization)</li> <li>5. Fluid-particle separation (filtration, precipitation, cyclone)</li> <li>6. Security (fire and explosion hazard of fine particle)</li> </ol> |  |
| Planned use/applicability         | Elective   |  |
| Prerequisites                     | -  |  |
| Form(s) of assessment             | Assignments, quiz, and team-based project  |  |
| The module mark is calculated     | <p>The final grade is drawn from following components:</p> <ul style="list-style-type: none"> <li>• Assignments: 30% of grade</li> <li>• Quiz: 40% of grade</li> <li>• Team-based project: 30% of grade</li> </ul> <p>Students must have a final grade of 56% or higher to pass</p>  |  |
| Recommended literature            | <ol style="list-style-type: none"> <li>1. Bard, A. J. and Faulkner, L. R., "Electrochemical Methods, Fundamentals and Applications", 2<sup>nd</sup> edition, John Wiley &amp; Sons, Inc., 2001</li> <li>2. Perez, N., "Electrochemistry and Corrosion Science", Kluwer Academic Publishers, 2004</li> <li>3. Goodridge, F. and Scott, K., "Electrochemical Process Engineering", Plenum Press, New York, 1995</li> </ol>   |  |
| Date of last amendment made       | -  |  |

| Course Name  | System Thermal Analysis   |                |
|--|---|----------------|
| Course Code  | TK185105  |                |
| Person responsible for the module  | Juwari<br>Perdalpro Lab.<br>Department of Chemical Engineering 4 <sup>th</sup> Floor.   |                |
| Teaching method(s)   | Lecture; discussion; problem solving based on case study  |                |
| Workload   | 1. Lectures: 3 SKS x 50 min/SKS = 150 min./week.<br>2. Exercises and Assignments: 3 SKS x 60 min/SKS = 180 min./week.<br>3. Independent learning: 3 SKS x 60 min/SKS = 180 min./week.   |                |
| Credit   | 3 credit points (SKS)   |                |
| Intended learning outcomes   | After completing this module, a student is expected to:   |                |
|  | Students are able to define exergy.   | PLO-1          |
|  | Students are able to make an exergy balance on open and closed system.  | PLO-1          |
|  | Students are able to calculate exergy of a process.   | PLO-5          |
|  | Students are able to make an exergy rate balance on control volumes.  | PLO-5          |
|  | Students are able to design a process using exergy.   | PLO-6<br>PLO-7 |
| Content  | Students understand the second law of thermodynamics and the concepts of entropy production “irreversible” along with the ability to analyse and to design system related to energy using exergy method.  |                |
|  | 1. Definition, concepts and formula for energy and exergy and its correlation.  |                |
|  | 2. Background development of exergy method as a tool for analyzing exergy from systems related to energy.   |                |
|  | 3. Example of profit obtained by using exergy method to determine exergy loss and its cause in a power plant.   |                |
|  | 4. Example of application exergy method on analyzing individual chemical engineering system (simple system), that is heat exchange system, combustion system, and process reactions and many others.  |                |
|  | 5. Block method from exergy analyzes  |                |
| 6. Application of exergy analyzes for complex system consist of loops of individual systems. |   |                |
| Planned use/applicability  | Elective  |                |
| Prerequisites  | -   |                |
| Form(s) of assessment  | Assignments, quiz, and team-based project   |                |
| The module mark is calculated  | The final grade is drawn from following components:<br>• Assignments: 30% of grade<br>• Quiz: 40% of grade<br>• Team-based project: 30% of grade<br>Students must have a final grade of 56% or higher to pass   |                |
| Recommended literature   | 1. Michael J. Moran, Howard N. Sapiro, “Fundamentals of Engineering Thermodynamics “, 5 <sup>th</sup> edition, John Wiley & Sons, New York, 2006<br>2. T.J. Kotas, “The Exergy Method of Thermal Plant Analysis, 2 <sup>nd</sup> edition, Krieger Publishing Company, New York, 1995. |                |
| Date of last amendment made  | -   |                |

| <b>Course Name</b>   | <b>Biochemical Reactor</b>  |  |  |   |
|--|---|--|--|---|
| Course Code  | TK185203  |  |  |   |
| Person responsible for the module  | Prof. Arief Widjaja<br>Biochemical Lab.<br>Department of Chemical Engineering 3 <sup>rd</sup> Floor.  |  |  |   |
| Teaching method(s)   | Lecture; discussion; problem solving based on case study  |  |  |   |
| Workload   | 1. Lectures: 3 SKS x 50 min/SKS = 150 min./week.<br>2. Exercises and Assignments: 3 SKS x 60 min/SKS = 180 min./week.<br>3. Independent learning: 3 SKS x 60 min/SKS = 180 min./week.   |  |  |   |
| Credit   | 3 credit points (SKS)   |  |  |   |
| Intended learning outcomes   | <p>After completing this module, a student is expected to:</p> <table border="1"> <tr> <td>Students must be able to design basic biochemical reactor using enzyme or living cells as catalyst, must be able to design various type of ideal reactor, i.e., batch, mixed flow and plug flow reactor.</td> <td>PLO-1<br/>PLO-3<br/>PLO-4<br/>PLO-5<br/>PLO-6<br/>PLO-7<br/>PLO-8</td> </tr> </table>  |  | Students must be able to design basic biochemical reactor using enzyme or living cells as catalyst, must be able to design various type of ideal reactor, i.e., batch, mixed flow and plug flow reactor. | PLO-1<br>PLO-3<br>PLO-4<br>PLO-5<br>PLO-6<br>PLO-7<br>PLO-8 |
| Students must be able to design basic biochemical reactor using enzyme or living cells as catalyst, must be able to design various type of ideal reactor, i.e., batch, mixed flow and plug flow reactor. | PLO-1<br>PLO-3<br>PLO-4<br>PLO-5<br>PLO-6<br>PLO-7<br>PLO-8   |  |  |   |
| Content  | <ol style="list-style-type: none"> <li>1. Basic bioreactor design using enzyme or living cells as biocatalyst</li> <li>2. Kinetics of enzymatic reaction and reaction employing living microorganism</li> <li>3. Immobilization of enzyme and whole cells.</li> <li>4. Design of batch, mixed flow and plug flow bioreactor</li> </ol>  |  |  |   |
| Planned use/applicability  | Elective  |  |  |   |
| Prerequisites  | -   |  |  |   |
| Form(s) of assessment  | Assignments, quiz, and team-based project   |  |  |   |
| The module mark is calculated  | <p>The final grade is drawn from following components:</p> <ul style="list-style-type: none"> <li>• Assignments: 30% of grade</li> <li>• Quiz: 40% of grade</li> <li>• Team-based project: 30% of grade</li> </ul> <p>Students must have a final grade of 56% or higher to pass</p>   |  |  |   |
| Recommended literature   | <ol style="list-style-type: none"> <li>1. B. E. Poling, J. M. Prausnitz, J. P. O'Connell, The Properties of Gases and Liquids, Fifth ed., McGraw-Hill International Editions, Singapore, 2001.</li> <li>2. J. M. Smith, H. C. Van Ness, M. M. Abbott, Introduction to Chemical Engineering Thermodynamics, 6th ed., McGraw-Hill Co-Singapore, 2001.</li> <li>3. S. M. Walas, Phase Equilibrium in Chemical Engineering, Butterworth Publisher, USA, 1985.</li> <li>4. M. Modell and R. C. Reid, Thermodynamics and Its Applications, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1974.</li> <li>5. S. I. Sandler, Models for Thermodynamic and Phase Equilibria Calculations, Marcel Dekker, Inc., New York, 1994</li> </ol> |  |  |   |
| Date of last amendment made  | -   |  |  |   |

| <b>Course Name</b>                | <b>Advanced Industrial Waste Management</b>  |   |
|-----------------------------------|--|---|
| Course Code                       | TK185204   |   |
| Person responsible for the module | Tri Widjaja<br>Biochemical Lab.<br>Department of Chemical Engineering 3 <sup>rd</sup> Floor.   |   |
| Teaching method(s)                | Lecture; discussion; problem solving based on case study   |   |
| Workload                          | 1. Lectures: 3 SKS x 50 min/SKS = 150 min./week.<br>2. Exercises and Assignments: 3 SKS x 60 min/SKS = 180 min./week.<br>3. Independent learning: 3 SKS x 60 min/SKS = 180 min./week.  |   |
| Credit                            | 3 credit points (SKS)  |   |
| Intended learning outcomes        | After completing this module, a student is expected to:  |   |
|                                   | Students are aware of the impacts of industrial activities on the environment such as environmental damage and pollution, water quality, air and soil, key parameters, and their health effects.   | PLO-1<br>PLO-5                            |
|                                   | Students are able to apply the basics of industrial waste treatment, water and air sampling techniques   | PLO-1<br>PLO-6<br>PLO-3                   |
|                                   | Students understand about industrial waste management which includes main factors in the form of planning (legislation), environmental quality standard, net program, blue sky program, reduced net production (reduced, recovery, reused, recycle and case study) environmental management, identification systems to industrial activities, environmental impact assessments, environmental audits. Approach system in the form of approach of technology, social and institutional. | PLO-1<br>PLO-5<br>PLO-4<br>PLO-7<br>PLO-8 |
| Content                           | 1. Industry and the environment<br>2. Industrial waste management: (i) Planning: Environmental Management System; (ii) Industrial impacts impact identification system; (iii) Environmental Impact Assessment Environmental Audit; Supervision; Technology: Waste processing, hazardous and toxic industrial waste management, Technology, social and institutional approach systems.  |   |
| Planned use/applicability         | Elective   |   |
| Prerequisites                     | -  |   |
| Form(s) of assessment             | Assignments, quiz, and team-based project  |   |
| The module mark is calculated     | The final grade is drawn from following components:<br>• Assignments: 30% of grade<br>• Quiz: 40% of grade<br>• Team-based project: 30% of grade<br>Students must have a final grade of 56% or higher to pass  |   |
| Recommended literature            | 1. Connell : “ Chemistry an ecotoxicology of pollution”, John Wiley & sons, Singapore<br><br>2. W.W. Eckenfelder,”Water Pollution Control”, Jenkins Publishing Company,1970<br><br>3. Michael R.Overcash,”Techniques for Industrial Pollution Prevention”, Lewis Publishers Inc.   |   |
| Date of last amendment made       | -  |   |

| Course Name                       | Computational Fluid Dynamics   |                |
|-----------------------------------|--|----------------|
| Course Code                       | TK185205   |                |
| Person responsible for the module | Tantular Nurtono<br>Fluid Mixing Lab.<br>Department of Chemical Engineering 4 <sup>th</sup> Floor.   |                |
| Teaching method(s)                | Lecture; discussion; problem solving based on case study   |                |
| Workload                          | 1. Lectures: 3 SKS x 50 min/SKS = 150 min./week.<br>2. Exercises and Assignments: 3 SKS x 60 min/SKS = 180 min./week.<br>3. Independent learning: 3 SKS x 60 min/SKS = 180 min./week.  |                |
| Credit                            | 3 credit points (SKS)  |                |
| Intended learning outcomes        | After completing this module, a student is expected to:  |                |
|                                   | Able to re-explain the definition of CFD.  | PLO-1          |
|                                   | Able to analyze phenomena and correlate with relevant equations  | PLO-6          |
|                                   | Able to explain again three CFD stages (pre-processor, solver, and post-processor)   | PLO-1<br>PLO-4 |
|                                   | Able to demonstrate expertise in process simulation on fluid flow in pipes   | PLO-3          |
|                                   | able to demonstrate expertise in simulating the process of separation on cyclone   | PLO-5          |
|                                   | Able to demonstrate expertise in simulating homogeneous combustion process   | PLO-1<br>PLO-7 |
|                                   | Able to demonstrate expertise in conducting simulations of heterogeneous combustion processes  | PLO-5<br>PLO-8 |
| Content                           | 1. Definition of CFD.<br>2. Governing equations on CFD methods.<br>3. Three stages of CFD (pre-processor, solver, and post-processor).<br>4. Simulation of fluid flow.<br>5. Simulation of separation process.<br>6. Simulation of homogeneous combustion process.<br>7. Simulation of heterogeneous combustion process. |                |
| Planned use/applicability         | Elective   |                |
| Prerequisites                     | -  |                |
| Form(s) of assessment             | Assignments, quiz, and team-based project  |                |
| The module mark is calculated     | The final grade is drawn from following components:<br>• Assignments: 30% of grade<br>• Quiz: 40% of grade<br>• Team-based project: 30% of grade<br>Students must have a final grade of 56% or higher to pass  |                |
| Recommended literature            | 1. Versteeg, H.K., Malalasekera, W. (2007). <i>An Introduction to Computational Fluid Dynamics</i> (2 ed.). Pearson, Prentice Hall.<br>2. Fluent User's Guide.   |                |
| Date of last amendment made       | -  |                |

| Course Name                       | Membrane Technology   |   |
|-----------------------------------|---|---|
| Course Code                       | TK185310  |   |
| Person responsible for the module | Susianto<br>Mass and Heat Transfer Lab.<br>Department of Chemical Engineering 3 <sup>rd</sup> Floor.  |   |
| Teaching method(s)                | Lecture; discussion; problem solving based on case study  |   |
| Workload                          | 1. Lectures: 3 SKS x 50 min/SKS = 150 min./week.<br>2. Exercises and Assignments: 3 SKS x 60 min/SKS = 180 min./week.<br>3. Independent learning: 3 SKS x 60 min/SKS = 180 min./week.   |   |
| Credit                            | 3 credit points (SKS)   |   |
| Intended learning outcomes        | After completing this module, a student is expected to:   |   |
|                                   | Students are aware of the impacts of industrial activities on the environment such as environmental damage and pollution, water quality, air and soil, key parameters, and their health effects.  | PLO-1<br>PLO-3<br>PLO-5                   |
|                                   | Students are able to apply the basics of industrial waste treatment, water and air sampling techniques  | PLO-1<br>PLO-5                            |
|                                   | Students understand about industrial waste management which includes main factors in the form of planning (legislation), environmental quality standard, net program, blue sky program, reduced net production (reduced, recovery, reused, recycle and case study) environmental management, identification systems to industrial activities, environmental impact assessments, environmental audits. Approach system in the form of approach of technology, social and institutional   | PLO-1<br>PLO-6<br>PLO-4<br>PLO-7<br>PLO-8 |
| Content                           | <ul style="list-style-type: none"> <li>• Introduction and selection of membrane material properties</li> <li>• Membrane manufacturing process</li> <li>• Membrane characterization</li> <li>• The phenomenon of displacement in the membrane</li> <li>• Membrane applications</li> </ul>  |   |
| Planned use/applicability         | Elective  |   |
| Prerequisites                     | -   |   |
| Form(s) of assessment             | Assignments, quiz, and team-based project   |   |
| The module mark is calculated     | <p>The final grade is drawn from following components:</p> <ul style="list-style-type: none"> <li>• Assignments: 30% of grade</li> <li>• Quiz: 40% of grade</li> <li>• Team-based project: 30% of grade</li> </ul> <p>Students must have a final grade of 56% or higher to pass</p>   |   |
| Recommended literature            | <ol style="list-style-type: none"> <li>1. B. E. Poling, J. M. Prausnitz, J. P. O'Connell, The Properties of Gases and Liquids, Fifth ed., McGraw-Hill International Editions, Singapore, 2001.</li> <li>2. J. M. Smith, H. C. Van Ness, M. M. Abbott, Introduction to Chemical Engineering Thermodynamics, 6th ed., McGraw-Hill Co-Singapore, 2001.</li> <li>3. S. M. Walas, Phase Equilibrium in Chemical Engineering, Butterworth Publisher, USA, 1985.</li> <li>4. M. Modell and R. C. Reid, Thermodynamics and Its Applications, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1974.</li> <li>5. S. I. Sandler, Models for Thermodynamic and Phase Equilibria Calculations, Marcel Dekker, Inc., New York, 1994</li> </ol> |   |
| Date of last amendment made       | -   |   |

| Course Name                       | Coal Processing and Utilization  |                         |
|-----------------------------------|--|-------------------------|
| Course Code                       | TK185302   |                         |
| Person responsible for the module | Siti Zullaikah<br>Chemical Reaction Process and Biomass Conversion Lab.<br>Department of Chemical Engineering 2 <sup>nd</sup> Floor.   |                         |
| Teaching method(s)                | Lecture; discussion; team work project.  |                         |
| Workload                          | 1. Lectures: 3 SKS x 50 min/SKS = 150 min./week.<br>2. Exercises and Assignments: 3 SKS x 60 min/SKS = 180 min./week.<br>3. Independent learning: 3 SKS x 60 min/SKS = 180 min./week.  |                         |
| Credit                            | 3 credit points (SKS)  |                         |
| Intended learning outcomes        | After completing this module, a student is expected to:  |                         |
|                                   | Understand the process of coal formation   | PLO-1                   |
|                                   | Understand the coal preparation process that will be used further  | PLO-1                   |
|                                   | Application to know the quality of coal  | PLO-5<br>PLO-4          |
|                                   | Analyse the various benefits of coal and its processing  | PLO-3<br>PLO-7<br>PLO-8 |
|                                   | Coal synthesis for electricity   | PLO-1                   |
|                                   | Coal synthesis for liquid fuels  | PLO-5                   |
|                                   | Synthesis of by-products of coal processing  | PLO-6                   |
| Content                           | <ol style="list-style-type: none"> <li>1. The process of coal formation</li> <li>2. Coal preparation process</li> <li>3. Analysis of coal quality</li> <li>4. Benefits and process of coal mocking</li> <li>5. Coal for electricity</li> <li>6. Coal for liquid fuel</li> <li>7. Coal processing byproducts</li> </ol>   |                         |
| Planned use/applicability         | Elective   |                         |
| Prerequisites                     | -  |                         |
| Form(s) of assessment             | Assignments, quiz, and team-based project  |                         |
| The module mark is calculated     | The final grade is drawn from following components: <ul style="list-style-type: none"> <li>• EAS: 20% of grade</li> <li>• Quiz: 30% of grade</li> <li>• Team-based project: 50% of grade</li> </ul> Students must have a final grade of 56% or higher to pass  |                         |
| Recommended literature            | <ol style="list-style-type: none"> <li>1. Matthias W. Haenel, Book Review: Chemistry of Coal Utilization, Second Supplementary Volume. Edited by M. A. Elliot, Angewandte Chemie International Edition in English, 1982.</li> <li>2. Shirley Cheng Tsai, Fundamentals of coal beneficiation and utilization, Amsterdam, the Netherlands; New York: Elsevier Scientific Pub. Co., 1982.</li> <li>3. James G. Speight, Handbook of coal analysis, John Wiley and Sons, Inc., Publication, 2005.</li> <li>4. Alpha Coal Handbook, ed 2012.</li> </ol> |                         |
| Date of last amendment made       | -  |                         |

|                                   |   |                                  |
|-----------------------------------|---|----------------------------------|
| <b>Course Name</b>                | <b>Electrochemical Reaction Engineering</b>   |                                  |
| Course Code                       | TK185303  |                                  |
| Person responsible for the module | Prof. Heru Setyawan<br>Electrochemical Lab.<br>Department of Chemical Engineering 3 <sup>rd</sup> Floor.  |                                  |
| Teaching method(s)                | Lecture; discussion; problem solving based on case study  |                                  |
| Workload                          | 1. Lectures: 3 SKS x 50 min/SKS = 150 min./week.<br>2. Exercises and Assignments: 3 SKS x 60 min/SKS = 180 min./week.<br>3. Independent learning: 3 SKS x 60 min/SKS = 180 min./week.   |                                  |
| Credit                            | 3 credit points (SKS)   |                                  |
| Intended learning outcomes        | After completing this module, a student is expected to:   |                                  |
|                                   | able to apply the characteristics and behaviour of electrochemical processes in certain electrochemical process applications  | PLO-1<br>PLO-5                   |
|                                   | able to develop engineering science of electrochemical reaction for practical application such as material synthesis (electrolysis), battery, electrochemical based instrumentation, corrosion, etc.  | PLO-1<br>PLO-5<br>PLO-3          |
|                                   | able to apply the electrochemical principles in the specific application such as nanomaterial (electrolysis), battery, instrumentation-based electrochemistry, and corrosion  | PLO-1<br>PLO-6<br>PLO-7<br>PLO-8 |
| Content                           | 1. Reactor performance criteria, electrochemical and catalytic reactions<br>2. Kinetic reaction electrode<br>3. Design of electrochemical reactor<br>4. Electrochemical reaction in electrolysis/battery/corrosion process  |                                  |
| Planned use/applicability         | Elective  |                                  |
| Prerequisites                     | -   |                                  |
| Form(s) of assessment             | Assignments, quiz, and team-based project   |                                  |
| The module mark is calculated     | The final grade is drawn from following components:<br>• Assignments: 30% of grade<br>• Quiz: 40% of grade<br>• Team-based project: 30% of grade<br>Students must have a final grade of 56% or higher to pass   |                                  |
| Recommended literature            | 1. Bard, A. J. and Faulkner, L. R., "Electrochemical Methods, Fundamentals and Applications", 2 <sup>nd</sup> edition, John Wiley & Sons, Inc., 2001<br>2. Perez, N., "Electrochemistry and Corrosion Science", Kluwer Academic Publishers, 2004<br>3. Goodridge, F. and Scott, K., "Electrochemical Process Engineering", Plenum Press, New York, 1995 |                                  |
| Date of last amendment made       | -   |                                  |

|                                   |  |                         |
|-----------------------------------|--|-------------------------|
| <b>Course Name</b>                | <b>Aerosol Technology</b>  |                         |
| Course Code                       | TK185305   |                         |
| Person responsible for the module | Widiyastuti<br>Electrochemical Lab.<br>Department of Chemical Engineering 3 <sup>rd</sup> Floor.   |                         |
| Teaching method(s)                | Lecture; discussion; problem solving based on case study   |                         |
| Workload                          | 1. Lectures: 3 SKS x 50 min/SKS = 150 min./week.<br>2. Exercises and Assignments: 3 SKS x 60 min/SKS = 180 min./week.<br>3. Independent learning: 3 SKS x 60 min/SKS = 180 min./week.  |                         |
| Credit                            | 3 credit points (SKS)  |                         |
| Intended learning outcomes        | After completing this module, a student is expected to:  |                         |
|                                   | Students are able to understand definition of aerosol and their examples   | PLO-1                   |
|                                   | Students are able to understand the characteristic of aerosols and instrumentations used for measuring the aerosol properties  | PLO-1                   |
|                                   | Students are able to understand the spreading of aerosol in atmosphere   | PLO-1                   |
|                                   | Students are able to understand and analyse the fabrication processes of aerosol including their mechanisms and forces exerted during deposition   | PLO-3<br>PLO-7          |
|                                   | Students are able to understand and analyse the applications of aerosol in various industries  | PLO-5<br>PLO-8          |
|                                   | Students are able to review the latest articles (journals) and present their work in the class   | PLO-5<br>PLO-6<br>PLO-4 |
| Content                           | 1. Definition and characteristic of aerosol<br>2. Instrumentation devices for measuring of aerosol<br>3. Spreading of aerosol in atmosphere<br>4. Fabrication methods of aerosol<br>5. Applications of aerosol in industries |                         |
| Planned use/applicability         | Elective   |                         |
| Prerequisites                     | -  |                         |
| Form(s) of assessment             | Assignments, quiz, and team-based project  |                         |
| The module mark is calculated     | The final grade is drawn from following components:<br>• Assignments: 30% of grade<br>• Quiz: 40% of grade<br>• Team-based project: 30% of grade<br>Students must have a final grade of 56% or higher to pass                |                         |
| Recommended literature            | 1. Hinds, W. C., Aerosol Technology: Properties, Behaviour, and Measurement of Airborne Particles, John Wiley & Sons, 2nd ed. (1999).<br>2. The latest relevance articles (journals) published in good reputable journals    |                         |
| Date of last amendment made       | -  |                         |

|                                   |  |                         |
|-----------------------------------|--|-------------------------|
| <b>Course Name</b>                | <b>Natural Gas Processing</b>  |                         |
| Course Code                       | TK185306   |                         |
| Person responsible for the module | Fadlilatul Taufany<br>Transport phenomena Lab.<br>Department of Chemical Engineering 3 <sup>rd</sup> Floor.  |                         |
| Teaching method(s)                | Lecture; discussion; problem solving based on case study   |                         |
| Workload                          | 1. Lectures: 3 SKS x 50 min/SKS = 150 min./week.<br>2. Exercises and Assignments: 3 SKS x 60 min/SKS = 180 min./week.<br>3. Independent learning: 3 SKS x 60 min/SKS = 180 min./week.  |                         |
| Credit                            | 3 credit points (SKS)  |                         |
| Intended learning outcomes        | After completing this module, a student is expected to:  |                         |
|                                   | The students must able to understand the important role of phase behavior in natural gas processing.   | PLO-1<br>PLO-3          |
|                                   | The students must able to understand the important properties used to characterize natural gas and condensate.   | PLO-1<br>PLO-5          |
|                                   | The students must able to develop some important applications of phase behavior in production operations.  | PLO-1<br>PLO-5<br>PLO-7 |
|                                   | The students must able to make basic design of main equipment in natural gas processing  | PLO-4<br>PLO-6<br>PLO-8 |
| Content                           | <ol style="list-style-type: none"> <li>1. Reserve and utilization of natural gas</li> <li>2. Properties of thermodynamics of natural gas</li> <li>3. Natural gas products and specifications</li> <li>4. Natural gas processing technology</li> <li>5. Natural gas transmission system</li> </ol>  |                         |
| Planned use/applicability         | Elective   |                         |
| Prerequisites                     | -  |                         |
| Form(s) of assessment             | Assignments, quiz, and team-based project  |                         |
| The module mark is calculated     | <p>The final grade is drawn from following components:</p> <ul style="list-style-type: none"> <li>• Assignments: 30% of grade</li> <li>• Quiz: 40% of grade</li> <li>• Team-based project: 30% of grade</li> </ul> <p>Students must have a final grade of 56% or higher to pass</p>  |                         |
| Recommended literature            | <ol style="list-style-type: none"> <li>1. Gas Processors Suppliers Association, Engineering Data Book, 12<sup>th</sup> Ed., 2004.</li> <li>2. Kidnay, Athur J. and Parrish, William R., Fundamental of Natural Gas processing, CRC Press, 2006.</li> <li>3. Campbell, John Morgan, Gas conditioning and processing (Campbell Petroleum Series), 3<sup>rd</sup> Ed., Campbell Petroleum; 1974.</li> <li>4. Mokhatab, Saeid; Poe, William; Mak, John, Handbook of Natural Gas Transmission and Processing, 3<sup>rd</sup> Ed., Gulf Professional Publishing, 2015.</li> <li>5. Poling, Bruce E.; Prausnitz, John M.; O'Connell, John, The Properties of Gases and liquids, 5<sup>th</sup> Ed., McGraw-Hill Education, 2001.</li> </ol> |                         |
| Date of last amendment made       | -  |                         |

|                                   |  |                |
|-----------------------------------|--|----------------|
| <b>Course Name</b>                | <b>Advance Combustion Technology</b>   |                |
| Course Code                       | TK185307   |                |
| Person responsible for the module | Lailatul Qadariyah<br>Chemical Reaction Process and Biomass Conversion Lab.<br>Department of Chemical Engineering 1 <sup>st</sup> Floor.   |                |
| Teaching method(s)                | Lecture; discussion; problem solving based on case study   |                |
| Workload                          | 1. Lectures: 3 SKS x 50 min/SKS = 150 min./week.<br>2. Exercises and Assignments: 3 SKS x 60 min/SKS = 180 min./week.<br>3. Independent learning: 3 SKS x 60 min/SKS = 180 min./week.  |                |
| Credit                            | 3 credit points (SKS)  |                |
| Intended learning outcomes        | After completing this module, a student is expected to:  |                |
|                                   | Able to re-explain the spectrum of various fuels and their general properties  | PLO-1          |
|                                   | Able to perform calculations on the stoichiometric combustion process  | PLO-7<br>PLO-8 |
|                                   | Able to apply thermodynamic principles in calculating the nature of the combustion process   | PLO-3          |
|                                   | Able to analyse the chemical kinetics of the hydrocarbon combustion process.   | PLO-5          |
|                                   | Able to diagnose the structure and propagation of fire based on the character of the combustion process  | PLO-6<br>PLO-4 |
|                                   | Able to analyze the role of turbulent mixing in the combustion process   | PLO-5          |
|                                   | Able to analyze the properties of liquid fuel combustion processes   | PLO-1          |
|                                   | Able to analyze the properties of solid fuel combustion processes  | PLO-1          |
| Content                           | <ol style="list-style-type: none"> <li>1. Fuel and its properties</li> <li>2. Stoichiometry of combustion.</li> <li>3. Thermodynamics in combustion</li> <li>4. Combustion Kinetics</li> <li>5. Flame structure and propagation</li> <li>6. Turbulent mixing</li> <li>7. Liquid fuel combustion process.</li> <li>8. Solid fuel combustion process.</li> </ol> |                |
| Planned use/applicability         | Elective   |                |
| Prerequisites                     | -  |                |
| Form(s) of assessment             | Assignments, quiz, and team-based project  |                |
| The module mark is calculated     | The final grade is drawn from following components: <ul style="list-style-type: none"> <li>• Assignments: 30% of grade</li> <li>• Quiz: 40% of grade</li> <li>• Team-based project: 30% of grade</li> </ul> Students must have a final grade of 56% or higher to pass  |                |
| Recommended literature            | <ol style="list-style-type: none"> <li>1. El-Mahallawy, F., El-din Habik, S.(2002). <i>Fundamentals and Technology of Combustion</i>. Elsevier.</li> <li>2. Glassman, I., Yetter, R.,A.(2008). <i>Combustion</i>. Elsevier.</li> </ol>   |                |
| Date of last amendment made       | -  |                |

| Course Name                       | Polymer Technology   |                                  |
|-----------------------------------|--|----------------------------------|
| Course Code                       | TK185308   |                                  |
| Person responsible for the module | Sumarno<br>Material Technology Lab<br>Department of Chemical Engineering 1 <sup>st</sup> Floor.  |                                  |
| Teaching method(s)                | Lecture; discussion; problem solving based on case study   |                                  |
| Workload                          | 1. Lectures: 3 SKS x 50 min/SKS = 150 min./week.<br>2. Exercises and Assignments: 3 SKS x 60 min/SKS = 180 min./week.<br>3. Independent learning: 3 SKS x 60 min/SKS = 180 min./week.  |                                  |
| Credit                            | 3 credit points (SKS)  |                                  |
| Intended learning outcomes        | After completing this module, a student is expected to:  |                                  |
|                                   | Students understand the basics of polymer, the relationship between the nature with the structure and behaviour of the process.  | PLO-1<br>PLO-3<br>PLO-5<br>PLO-7 |
|                                   | Students are able to develop polymer applications.   | PLO-1<br>PLO-4<br>PLO-6<br>PLO-8 |
| Content                           | 1. Classification of polymers, and polymer properties.<br>2. Basics of polymerization kinetics and polymerization techniques.<br>3. Predict some of the properties of the polymer and its solution.<br>4. Polymer processing.                          |                                  |
| Planned use/applicability         | Elective   |                                  |
| Prerequisites                     | -  |                                  |
| Form(s) of assessment             | Assignments, quiz, and team-based project  |                                  |
| The module mark is calculated     | The final grade is drawn from following components:<br>• Assignments: 30% of grade<br>• Quiz: 40% of grade<br>• Team-based project: 30% of grade<br>Students must have a final grade of 56% or higher to pass  |                                  |
| Recommended literature            | 1. Billmeyer. F.W. Jr., "Textbook of Polymer Science". Wilcy, New York, 1971.<br>2. Giskey, R.G. "Polymer Process Engineering ", Chapman & Hall, New York, 1995.<br>3. Fried, J.R., "Polymer Science and Technology", Prentice Hall, New Jersey, 1995. |                                  |
| Date of last amendment made       | -  |                                  |

| <b>Course Name</b>                | <b>Research Methodology</b>   |  |  |  |  |  |  |  |  |  |  |  |  |
|-----------------------------------|---|--|--|--|--|--|--|--|--|--|--|--|--|
| Course Code                       | TK185309  |  |  |  |  |  |  |  |  |  |  |  |  |
| Person responsible for the module | Hakun W<br>Biochemical Lab.<br>Department of Chemical Engineering 3 <sup>rd</sup> Floor.  |  |  |  |  |  |  |  |  |  |  |  |  |
| Teaching method(s)                | Lecture; discussion; problem solving based on case study  |  |  |  |  |  |  |  |  |  |  |  |  |
| Workload                          | 1. Lectures: 3 SKS x 50 min/SKS = 150 min./week.<br>2. Exercises and Assignments: 3 SKS x 60 min/SKS = 180 min./week.<br>3. Independent learning: 3 SKS x 60 min/SKS = 180 min./week.   |  |  |  |  |  |  |  |  |  |  |  |  |
| Credit                            | 3 credit points (SKS)   |  |  |  |  |  |  |  |  |  |  |  |  |
| Intended learning outcomes        | After completing this module, a student is expected to:<br><table border="1" data-bbox="540 499 1357 682"> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </table>   |  |  |  |  |  |  |  |  |  |  |  |  |
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|                                   |   |  |  |  |  |  |  |  |  |  |  |  |  |
| Content                           | <ol style="list-style-type: none"> <li>1. Introduction: Knowledge and Research (definition, ethics, type, etc.)</li> <li>2. Research design and preparation</li> <li>3. Literature review (Literature review)</li> <li>4. Data analysis</li> <li>5. Report and presentation of proposals and final reports of research</li> </ol>   |  |  |  |  |  |  |  |  |  |  |  |  |
| Planned use/applicability         | Elective  |  |  |  |  |  |  |  |  |  |  |  |  |
| Prerequisites                     | -   |  |  |  |  |  |  |  |  |  |  |  |  |
| Form(s) of assessment             | Assignments, quiz, and team-based project   |  |  |  |  |  |  |  |  |  |  |  |  |
| The module mark is calculated     | The final grade is drawn from following components:<br><ul style="list-style-type: none"> <li>• Assignments: 30% of grade</li> <li>• Quiz: 40% of grade</li> <li>• Team-based project: 30% of grade</li> </ul> Students must have a final grade of 56% or higher to pass  |  |  |  |  |  |  |  |  |  |  |  |  |
| Recommended literature            | <ol style="list-style-type: none"> <li>1. Pedoman Penulisan Tesis Pascasarjana ITS</li> <li>2. Catherine Dawson, 2006, A Practical Guide to Research Methods: A User-Friendly Manual for Mastering Research Techniques and Projects, How To Books Ltd., UK.</li> <li>3. Uwe Flick, 2013, Introduction Research Methodology: A Beginner's Guide to Doing a Research Project, SAGE Publication</li> <li>4. John W. Creswell, 2014, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, fourth ed., Sage Publication Inc., USA.</li> </ol> |  |  |  |  |  |  |  |  |  |  |  |  |
| Date of last amendment made       | -   |  |  |  |  |  |  |  |  |  |  |  |  |

|  |   |       |
|--|---|-------|
| <b>Course Name</b>                       | <b>Advanced Multi Variable Control</b>  |       |
| Course Code                              | TK185310  |       |
| Person responsible for the module        | Department of Chemical Engineering 3 <sup>rd</sup> Floor.   |       |
| Teaching method(s)                       | Lecture; discussion; problem solving based on case study  |       |
| Workload                                 | 1. Lectures: 3 SKS x 50 min/SKS = 150 min./week.<br>2. Exercises and Assignments: 3 SKS x 60 min/SKS = 180 min./week.<br>3. Independent learning: 3 SKS x 60 min/SKS = 180 min./week.   |       |
| Credit                                   | 3 credit points (SKS)   |       |
| Intended learning outcomes               | After completing this module, a student is expected to:   |       |
|  | Students are able to make a MIMO control system   | PLO-1 |
|  | Students understand deeply the limitation on performance of SISO and MIMO system.   | PLO-3 |
|  | Students understand deeply limitations due to time delay, RHP-poles and zeroes.   | PLO-1 |
|  | Students understand deeply robust stability and performance of control system.  | PLO-1 |
|  | Students are able to design control system and control structure.   | PLO-5 |
|  | Students are able to build matrix transfer function of MIMO system.   | PLO-5 |
|  | Students are able to control MIMO process   | PLO-6 |
|  | Students understand deeply the robust and its stability MIMO process  | PLO-4 |
|  | Students are able to do analysis on controllability   | PLO-4 |
|  | Students are able to do performance analysis on robust and its stability  |       |
|  | Students are able to design MIMO control system and MIMO control structure  |       |
| Students are able to do reduction model. |   |       |
| Content                                  | <ol style="list-style-type: none"> <li>1. Review on Conventional Feedback Control System</li> <li>2. Introduction to Multi variable control</li> <li>3. Element of linear system theory</li> <li>4. Limitations of performance on SISO system</li> <li>5. Limitations of performance on MIMO system</li> <li>6. SISO and MIMO stability and robust performance</li> <li>7. Design Control System and Control Structure</li> <li>8. Model reduction....</li> </ol> |       |
| Planned use/applicability                | Elective  |       |
| Prerequisites                            | -   |       |
| Form(s) of assessment                    | Assignments, quiz, and team-based project   |       |
| The module mark is calculated            | The final grade is drawn from following components: <ul style="list-style-type: none"> <li>• Assignments: 30% of grade</li> <li>• Quiz: 40% of grade</li> <li>• Team-based project: 30% of grade</li> </ul> Students must have a final grade of 56% or higher to pass   |       |
| Recommended literature                   | <ol style="list-style-type: none"> <li>1. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp, Francis J. Doyle III, "Process Dynamics and Control", 4<sup>th</sup> ed., John Wiley &amp; Sons, New. York., 2016.</li> <li>2. Sigurd Skogestad, Ian Postlethwaite, "Multivariable Feedback Control", 2<sup>nd</sup> edition, John Wiley &amp; Sons, New York, 2005.</li> </ol>  |       |
| Date of last amendment made              | -   |       |

|                                   |   |                         |
|-----------------------------------|---|-------------------------|
| <b>Course Name</b>                | <b>Advanced Chemical Engineering Mathematics</b>  |                         |
| Course Code                       | TK185311  |                         |
| Person responsible for the module | Department of Chemical Engineering 3 <sup>rd</sup> Floor.   |                         |
| Teaching method(s)                | Lecture; discussion; problem solving based on case study  |                         |
| Workload                          | 1. Lectures: 3 SKS x 50 min/SKS = 150 min./week.<br>2. Exercises and Assignments: 3 SKS x 60 min/SKS = 180 min./week.<br>3. Independent learning: 3 SKS x 60 min/SKS = 180 min./week.   |                         |
| Credit                            | 3 credit points (SKS)   |                         |
| Intended learning outcomes        | After completing this module, a student is expected to:   |                         |
|                                   | Students are able to translate chemical engineering problems into mathematical models.  | PLO-1<br>PLO-3          |
|                                   | Students are able to use mathematical models to solve chemical engineering problems and interpret the results.  | PLO-1<br>PLO-5          |
|                                   | Students are able to use mathematical tools to solve chemical engineering problems.   | PLO-1<br>PLO-6<br>PLO-7 |
|                                   | Students are able to use modern software to solve chemical engineering problems.  | PLO-5<br>PLO-8<br>PLO-4 |
| Content                           | <ol style="list-style-type: none"> <li>1. Basic concepts of modeling.</li> <li>2. Matrices, transformations, series, complex variable methods, curve fitting, numerical methods in linear algebra, nonlinear algebraic equations, ordinary and partial differential equations.</li> <li>3. Optimization.</li> <li>4. Special emphasis on problems that arise in chemical engineering applications.</li> </ol> |                         |
| Planned use/applicability         | Elective  |                         |
| Prerequisites                     | -   |                         |
| Form(s) of assessment             | Assignments, quiz, and team-based project   |                         |
| The module mark is calculated     | <p>The final grade is drawn from following components:</p> <ul style="list-style-type: none"> <li>• Assignments: 30% of grade</li> <li>• Quiz: 40% of grade</li> <li>• Team-based project: 30% of grade</li> </ul> <p>Students must have a final grade of 56% or higher to pass</p>   |                         |
| Recommended literature            | <ol style="list-style-type: none"> <li>1. R.G. Rice, D.D. Do, Applied Mathematics and Modeling for Chemical Engineers, John Wiley &amp; Sons (1995).</li> <li>2. M.E. Davis, Numerical Methods and Modeling for Chemical Engineers, John Wiley &amp; Sons, New York (1984).</li> <li>3. T.F. Edgar, D.M. Himmelblau, Optimization of Chemical Process, 2nd ed, Mc Graw Hill, New York (2001).</li> </ol>      |                         |
| Date of last amendment made       | -   |                         |

| Course Name   | Thesis   |  |   |  |
|---|--|--|---|--|
| Course Code   | TK185401   |  |   |  |
| Person responsible for the module   | . Department of Chemical Engineering 3 <sup>rd</sup> Floor.  |  |   |  |
| Teaching method(s)  | Lecture; discussion; problem solving based on case study   |  |   |  |
| Workload  | 1. Lectures: 4 SKS x 50 min/SKS = 200 min./week.<br>2. Exercises and Assignments: 4 SKS x 60 min/SKS = 240 min./week.<br>3. Independent learning: 4 SKS x 60 min/SKS = 240 min./week.  |  |   |  |
| Credit  | 4 credit points (SKS)  |  |   |  |
| Intended learning outcomes  | <p>After completing this module, a student is expected to:</p> <table border="1"> <tr> <td>The learning outcome of this course is students can carry out research and write research results in national journals accredited or good reputable international conference.</td> <td> PLO-1<br/> PLO-2<br/> PLO-3<br/> PLO-4<br/> PLO-5<br/> PLO-6<br/> PLO-7<br/> PLO-8 </td> </tr> </table> |  | The learning outcome of this course is students can carry out research and write research results in national journals accredited or good reputable international conference. | PLO-1<br>PLO-2<br>PLO-3<br>PLO-4<br>PLO-5<br>PLO-6<br>PLO-7<br>PLO-8 |
| The learning outcome of this course is students can carry out research and write research results in national journals accredited or good reputable international conference. | PLO-1<br>PLO-2<br>PLO-3<br>PLO-4<br>PLO-5<br>PLO-6<br>PLO-7<br>PLO-8   |  |   |  |
| Content   | 1. Introduction<br>2. Purposes<br>3. Literature review<br>4. Methodology<br>5. Results and Discussion<br>6. Conclusion   |  |   |  |
| Planned use/applicability   | Compulsory   |  |   |  |
| Prerequisites   | -  |  |   |  |
| Form(s) of assessment   | Assignments, quiz, and team-based project  |  |   |  |
| The module mark is calculated   | The final grade is drawn from following components:<br>• Assignments: 30% of grade<br>• Quiz: 40% of grade<br>• Team-based project: 30% of grade<br>Students must have a final grade of 56% or higher to pass  |  |   |  |
| Recommended literature  | 1. Journals or books related with their thesis work<br>2. Guidance Book from Graduate Program ITS<br>3. Thesis Writing Instructional from Graduate Program ITS   |  |   |  |
| Date of last amendment made   | -  |  |   |  |