CHEMICAL ENGINEERING

GUIDEBOOK
The guidebook provides a brief and comprehensive information about Department of Chemical Engineering, Faculty of Engineering, Diponegoro University. This book can be used as a guide for students, faculty, and administrative in carrying out the teaching learning process in order to achieve the best educational purposes. This manual will be reviewed every year in order to improve the content with the developments and progress in the Department of Chemical Engineering Faculty of Engineering, University of Diponegoro.

Finally, We hope this book is useful for stakeholders of Department of Chemical Engineering, Faculty of Engineering, University of Diponegoro.

Semarang, July 2016
Head of Chemical Engineering Department

Dr. Siswo Sumardiono, ST, MT

1 DEPARTMENT PROFILE

1.1 VISION, MISION, AND OBJECTIVES

Vision Statement of the Department

To be recognized both nationally and internationally for excellence in chemical engineering education and research.
Mission Statement of the Department

To achieve its vision, the DCE has decided to perform activities based on the *Tridharma Perguruan Tinggi* (Three Pillars of Higher Education). The mission of the CESP can be stated in three statements:

1. Carrying out high-quality education to produce graduates having fundamental chemical engineering science and expertise by considering recent competitive job market.
2. Performing high-quality researches in chemical engineering field and increasing the number of patents and publications in national and international scientific journals.
3. Performing community service by providing consultation, supervision, and professional training in chemical engineering field.

Goals of the Department

Considering its vision and mission, the DCE has set its goals as:

1. to prepare students for careers in industry or government, and for further study at the graduate level,
2. to produce innovative and applied science and technology based on local resource and culture.

To achieve the goals, the Department of Chemical Engineering always:

1. improves the quality of the management,
2. periodically updates its curriculum inline with the requirements in chemical engineer’s job markets,
3. improves the competence of its graduates, especially in English, leadership, computer, and entrepreneurship,
4. improves the quality of teaching and learning as well as laboratory facilities, textbooks, and scientific journals, improves the quality of human resources, including academic, laboratory, and administrative staffs.

Expected Learning Outcomes

Consistent with the mission of the chemical engineering program, the educational objectives for the program are to enable graduates during various phases of their careers to exhibit:

1. Ability to apply knowledge of basic sciences and chemical engineering
2. Ability to design, conduct and analyze experiments as well as analyze and interpret data
3. Ability to design of an integrated system and its various components and processes, within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability for a chemical engineering project
4. Ability to identify, evaluate and solve chemical engineering problems
5. Ability to use modern engineering tools, skills and design techniques necessary for the practice of the chemical engineering
6. Ability to perform innovation in chemical engineering
7. Understanding of the potential impacts of engineering solutions on society and the environment
8. Ability to communicate effectively
9. An ability to function on multi-disciplinary teams to analyze and solve problems
10. Understanding of the responsibility of chemical engineers to practice in a professional and ethical manner at all times
11. Knowledge of contemporary issues related to chemical engineering
12. Willingness to have long life learning

1.2 HISTORY OF THE DEPARTMENT

Department of Chemical Engineering Diponegoro University was founded in 1965 as a respond of vast increase of chemical industries in Indonesia, including Semarang as the capital of Central Java Province. The idea of establishing the department came from Ir. Basit Wachid and Ir. Nisyamhuri. In August 1965 the Department of Chemical Engineering became the third department in the Faculty of Engineering after the Department of Civil Engineering and the Department of Architecture.

In its early ages, the department was supported by ten full-time academic staffs and seventeen part-time staffs from the Gadjah Mada University and industries. After more than four decades, now the department consists of forty one academic staffs. Twenty of the staffs hold doctorate degree, while the rest hold master degree.

Over the past four decades, the department has trained and produced engineering manpower of the high quality. Up to April 2011, the department has graduated more than 4,000 graduates. Many of the graduates are now in top positions in the industry, R & D organizations, government, and academia.
1.3 DEPARTMENT PRODUCTIVITY

Academic staff of the Chemical Engineering Department is very active in research and research publications, both in national and international journals. The number of publications increased from year to year, as shown in Figure 1.

Early years 1990, the academic staff realized that research publication in the journal was not easy, so giving rise to the idea of publishing a scientific journal. Journal "REAKTOR" was first published in 1997. In 2001, the journal accredited "B" of the Directorate General of Higher Education. REAKTOR is the first accredited scientific journals in the field of chemical engineering and the only one in Indonesia. In the next accreditation period, 2003 and 2008, the journal is also accredited "B" as well.

In 2005, CREC group members began thinking about the concept of electronic journals. In 2007, the Bulletin of Chemical Reaction Engineering and Catalysis (BCREC) published first time online. This bulletin into the online scientific journal first time in the University of Diponegoro. The journal has been indexed and distributed by EBSCO PUBLISHING (ACADEMIC SEARCH COMPLETE) Volume 4 Number 1 since 2009 until now. Since 2001, the BCREC been indexed by SCOPUS, Compendex, ENCOMPASSLIT, and ENGINEERING VILLAGE. In addition, Chemical Engineering Undip also publish several international journal such as International Journal of Science and Engineering (IJSE) [ISSN: 20865023] , International Journal of Renewable Energy Development (IJRED) [ISSN : 2252-4940] ; and International Journal of Waste Resources (IJWR)[ISSN: 2252-5211].
1.4 RESEARCH PROFILE

Research activities in the Department of Chemical Engineering done by establishing groups based on academic staff interests and expertise. It is intended that each group is more focused on research in their respective fields. Until 2011, Department of Chemical Engineering has six research groups, that is Centre of Bioprocess and Renewable Energy (C-Biore), Chemical Reaction Engineering and Catalysis Group (CREC), Thermal Process Engineering Group (Temper), Separation Process Center (SPEC), Membrane Research Center (MeR-C), and Waste Treatment Center (WTC).

To support the vision of Diponegoro University, Department of Chemical Engineering have always encouraged academic staff to obtain research funds provided by the government, such as DP2M-Higher Education and IPTEKDA (from the Ministry of National Education), Ministry of Research and Technology, Research and Development (Balitbang), Central Java Province and other research funding provided by the University of Diponegoro itself.

Total research funding given to the staff of Chemical Engineering increased from year to year. Until 2010, the fund collected more than 6 billion dollars. The research activities produce scientific outcomes, that is scientific articles published in national journals (> 200 manuscripts), as well as international journals (> 50 manuscripts). Given this excellent performance, Chemical Engineering Department trying to get more funds of funds and publish more scientific articles, mainly in

![Figure 1. Number of publications](image-url)
international journals Air-peered reviewed restaurants. Figure 2 shows the total grant obtained by the Chemical Engineering Department from various sources in 2012.

Figure 2. Total funds received Department of Chemical Engineering
2.1 EDUCATION SYSTEM

Since the 2007/2008 academic session, the Department of Chemical Engineering has implemented The 2007 Curriculum. The curriculum is designed so that its graduates are familiar with the techniques used in analyzing and solving engineering problems associated with the chemical and related industries (petroleum, pharmaceutical, metallurgical, plastics, pollution control, etc.).

According to the Decree of the Rector No. 469/PER/H7/2010 about Academic Regulation in Undergraduate and Diploma Educations in Diponegoro University, the education system applied in the Department of Chemical Engineering is Semester Credit System. In this system, each academic session is divided into two academic semesters, of which each consists of 14 (fourteen) teaching weeks and (2) two examination weeks. The Semester Credit System was divided into Four Year Study System as determined by the Directorate General of Higher Education, Ministry of National Education, the Republic of Indonesia. The academic program commences in August (for Semester 1) and February (for semester 2). A total 67 courses with 147 credit units (cu) are required to complete the chemical engineering bachelor degree program.

2.2 CURRICULUM

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#### SEMESTER I

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**Objectives:** After completion of this course, the student should be able to describe the concept of physics, and apply it to analyze the simple common events and a basic understanding of chemical engineering sciences.

**Syllabus:**
1. Mechanics
2. Hydrostatics
3. Expansion
4. Heat Effect
5. Vapor and gas
6. Electrostatic potential and Electrostatic intensity
7. Capacity, condenser, and inductor
8. Electric circuit (Direct current; Alternating current)
9. Electricity (Electric force; Electric field)
10. Magnetism (Magnetic field; Electromagnetic Induction)
11. Maxwell’s equation

**References:**
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<td>After completion of this course, the student should be able to explain the concept of analytical chemistry (both quantitative and qualitative) and able to choose the proper method.</td>
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| Syllabus        | 1. Basic principle of chemical analysis  
|                 | 2. Chemical analysis terminology  
|                 | 3. Evaluation the result of chemical analysis  
|                 | 4. Calibration, standardization and blank solution  
|                 | 5. Preparation sample for analysis  
|                 | 6. Conventional analysis techniques (Gravimetry and titrations)  
|                 | 7. Instrumental analysis techniques  
|                 | 8. Important organic compounds analysis |

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<td>Competency</td>
<td>KU1, KU2, KU4</td>
</tr>
<tr>
<td>Objectives</td>
<td>After completion of this course, the student should be able to describe structure, characteristic, and basic principle of atom, chemical bond, acid base theory, acid-base reaction equilibrium, and oxidation-reduction reaction.</td>
</tr>
</tbody>
</table>
| Syllabus        | 1. Introduction of inorganic chemistry and its
consciousness for chemical engineering
2. Atomic and molecule structure
3. Condensed phase
4. Acid-base theory
5. Chemical element
6. Coordination compounds

references:

Course Title: Mathematics I
Code: TKK204
Credit Hour: 3
Pre-requisite: -
Competency: KU1, KU2, KU4
Objectives: After completion of this course, the student should be able to describe mathematics concept (differential and integral calculus), and manipulate mathematics analytical for differential and integral cases.

Syllabus:
1. Relation and function
2. Limit
3. Differential and partial differential
4. Maximum and minimum
5. Integral
6. Vector
7. Matrix

References:
<table>
<thead>
<tr>
<th>Course Title</th>
<th>Introduction of Chemical Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>TKK205</td>
</tr>
<tr>
<td>Credit Hour</td>
<td>2</td>
</tr>
<tr>
<td>Pre-requisite</td>
<td>-</td>
</tr>
<tr>
<td>Competency</td>
<td>KU1, KU3, KU6, KL1</td>
</tr>
<tr>
<td>Objectives</td>
<td>The objective of the course is to give the student an understanding of the role of the chemical engineer in chemical processing and to give the student an appreciation for the methodology and quantitative approach of the chemical engineer developing a critical thinking illustrating the role of different subjects in the analysis and design of chemical reactors and separation processes</td>
</tr>
<tr>
<td>Syllabus</td>
<td>1. Introduction to Chemical Engineering (curriculum, career, and skill)</td>
</tr>
<tr>
<td></td>
<td>2. Strategic learning</td>
</tr>
<tr>
<td></td>
<td>3. Reference</td>
</tr>
<tr>
<td></td>
<td>4. Units, dimension, and unit conversion</td>
</tr>
<tr>
<td></td>
<td>5. Graphic and table</td>
</tr>
<tr>
<td></td>
<td>6. Process flow diagram</td>
</tr>
<tr>
<td></td>
<td>7. Process variable (mass and volume debit, composition, Pressure, temperature)</td>
</tr>
<tr>
<td></td>
<td>8. Mass and energy balance concept</td>
</tr>
<tr>
<td></td>
<td>9. Introduction to unit process, process equipment, and unit operation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Chemical Engineering Fundamental Laboratory I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>TKK206P</td>
</tr>
<tr>
<td>Credit Hour</td>
<td>2</td>
</tr>
<tr>
<td>Pre-requisite</td>
<td>Taken together with organic and inorganic chemistry</td>
</tr>
<tr>
<td>Competency</td>
<td>KU1, KU2, KU4, KU5, KP1, KP3</td>
</tr>
<tr>
<td>Objectives</td>
<td>After completion of this course, the student should</td>
</tr>
</tbody>
</table>
be able to analysis the organic and inorganic compounds using quantitative and qualitative analytical methods.

**Syllabus**

1. Gravimetry
3. Fat, carbohydrate, and protein analysis.
4. Moisture content and ash analysis
5. Spectrophotometry

**References**


**SEMESTER II**

**Course Title** : Bioprocess Fundamental

**Code** : TKK207

**Credit Hour** : 2

**Pre-requisite** : -

**Competency** : KU1, KU2, KU4

**Objectives** : After completion of this course, the student should be able to describe and explain the role of microbe/enzyme in bioprocess.

**Syllabus**

1. Introduction: Biotechnology, biochemical engineer, biology process, fermentation definition.
2. Enzyme kinetics
3. Enzyme immobilization
4. Pure culture technique and kinetics
5. Bioreactor
6. Sterilization
7. Case study : bioprocess product : production concept and its application

**References**


**Course Title**: Physical Chemistry  
**Code**: TKK208  
**Credit Hour**: 3  
**Pre-requisite**: Physics  
**Competency**: KU1, KU2, KU4  
**Objectives**: After completion of this course, the student should be able to explain physical characteristics of gases, liquids, and solids, physical and chemical changes in solution and colloid, interface (liquid-liquid; liquid-gas; liquid-solid), and electrochemistry  
**Syllabus**:  
1. Physical of characteristics of gases, liquids, and solids.  
2. Kinetics theory of gas  
3. Ideal and non ideal solution  
4. Electrolyte and non electrolyte solutions  
5. Colloid and suspension  
6. Solids surface process  
**References**:  

**Course Title**: Organic Chemistry  
**Code**: TKK209  
**Credit Hour**: 2  
**Pre-requisite**: Inorganic Chemistry  
**Competency**: KU1, KU2, KU4  
**Objectives**: After completion of this course, the student should be able to describe characteristics, structures, and making of organic compounds.  
**Syllabus**:  
1. Introduction  
2. Organic bonds  
3. Theory of orbital  
4. Reactivity
5. Alkane compounds
6. Alkene and alkyne compounds
7. Alkyl halide compounds
8. Aromatic compounds
9. Aldehyde and Ketone compounds
10. Carbohydrate
11. Fat
12. Protein
13. Determination of organic structure using Infrared spectroscopy (IR) and Proton Nuclear Magnetic Resonance (H-RMN)

References:

Course Title: Environmental Conservation
Code: TKK210
Credit Hour: 2
Pre-requisite: Analytical chemistry taken together with organic chemistry
Competency: KU4, KP1, KL3
Objectives: After completion of this course, the student should be able to describe basic concept of environmental conservation.
Syllabus:
1. The basic concept of sustainable development of the chemical industry
2. Environmental management (LCA, Amdal, etc.)
3. Definition of conservation
4. Conservation techniques of surface water resources, ground water, air, and beaches, forest and agricultural resources will be given as completions.

References:


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**Course Title**: Mathematics II  
**Code**: TKK304  
**Credit Hour**: 2  
**Pre-requisite**: Mathematics I  
**Competency**: KU1, KU2, KU4  
**Objectives**: After completion of this course, the student should be able to describe basic concept of differential and integral, to solve problems in differential equation using various methods.

**Syllabus**:  
1. Complex number  
2. Ordinary differential equation  
3. Partial differential equation  
4. Simultaneous differential equation  
5. The expansion of the infinite series (Taylor, McLaurin, Fourier, etc.).

**References**:  

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**Course Title**: Thermodynamics I  
**Code**: TKK 343  
**Credit Hour**: 3  
**Pre-requisite**: Physics, Inorganic chemistry, physical chemistry  
**Competency**: KU1, KU2, KU3, KU4, KU6  
**Objectives**: After completion of this course, the student should be able to describe thermodynamics characteristic of pure fluids, application of the first law on various
processes; The second law of thermodynamics.

Syllabus

1. Introduction of thermodynamics
2. Volumetric characteristic
3. First law of thermodynamics
4. Application of the first law of thermodynamics on various process
5. Effect of heat
6. Second law of thermodynamics
7. Application of the second law of thermodynamics

References


Course Title: Chemical Engineering Fundamental Laboratory II

Code: TKK212P
Credit Hour: 2
Pre-requisite: Taken together with physical chemistry and organic chemistry
Competency: KU1, KU2, KU4, KU5, KP3
Objectives: After completion of this course, the student should be able to perform electrochemical reaction and phase equilibrium, and to determine physical properties of materials.

Syllabus

1. Determination of heat of solution
2. Determination of density, viscosity and surface tension; refraction index
3. Determination of boiling point elevation and freezing point depression
4. Phase equilibrium
5. Instrumental analysis

References

SEMESTER III

Course Title : Chemical Engineering Principles I
Code : TKK213
Credit Hour : 3
Pre-requisite : Mathematics II, Inorganic Chemistry, Physical Chemistry
Competency : KU1, KU2, KU3, KU4, KU6
Objectives : After completion of this course, the student should be able to apply mass and energy balances to determine unknown process/operation variables.

Syllabus
1. Engineering calculation
2. Process and process variable
3. Single phase system
4. Multi phase system
5. Material balance in non-reacting system and reacting system
6. Energy balance in non-reacting system (closed system, open system)
7. Energy balance in reacting system (single and multiple reactions)
8. Simultaneous mass and energy balances in process flow sheet

References
<table>
<thead>
<tr>
<th>Course Title</th>
<th>Material Engineering Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>TKK214</td>
</tr>
<tr>
<td>Credit Hour</td>
<td>3</td>
</tr>
<tr>
<td>Pre-requisite</td>
<td>Inorganic Chemistry, Organic Chemistry, Physical Chemistry</td>
</tr>
<tr>
<td>Competency</td>
<td>KU1, KU2, KU3, KU4, KU6</td>
</tr>
<tr>
<td>Objectives</td>
<td>After completion of this course, the student should be able to describe properties, structures, and the utilization of various materials for industrial equipment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Chemical Engineering Mathematics I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>TKK215</td>
</tr>
<tr>
<td>Credit Hour</td>
<td>3</td>
</tr>
<tr>
<td>Pre-requisite</td>
<td>Mathematics II</td>
</tr>
<tr>
<td>Competency</td>
<td>KU2, KU4, KU5</td>
</tr>
<tr>
<td>Objectives</td>
<td>After completion of this course, the student should be able to solve chemical engineering problems in non-linear ordinary differential equations</td>
</tr>
</tbody>
</table>
References


Course Title : Chemical Industry Process
Code : TKK216
Credit Hour : 3
Pre-requisite : Inorganic chemistry, Organic chemistry
Competency : KU1, KU2, KU3, KU4, KU6
Objectives : After completion of this course, the student should be able to describe and explain processes in organic and inorganic chemical industry (petrochemical, polymer, fertilizer, steel, and cement) based on thermodynamic, catalysis, and transport phenomena concepts.

Syllabus

1. Introduction to chemical industry
2. Alcoholysis, hydrolisis, oxidation, polimerization, sulfonation, sulfatation, nitration, halogenation, esterification, calcination, Fischer-Tropsch
3. Food industry
4. Pharmacy industry
5. Basic Chemical Industry (cement, fertilizer, soda, sulfuric acids, dll)


Course Title : Thermodynamics II
Code : TKK311
Credit Hour : 3
Pre-requisite : Physical Chemistry, Thermodynamics I
Competency : KU1, KU2, KU3, KU4, KU6
Objectives : After completion of this course, the student should
be able to describe phase equilibrium (vapor-liquid), phase rule, Duhem’s theory, solution thermodynamics, equilibrium in single and multiple reaction

Syllabus: 1. Application of fluid’s thermodynamic characteristics
2. Vapor-liquid, solid-liquid, and solid-gas equilibrium
3. Chemical reaction equilibrium


Course Title: Bioprocess Laboratory
Code: TKK 217P
Credit Hour: 2
Pre-requisite: Bioprocess Fundamental
Competency: KU1, KU2, KU4, KU5, KP1, KP3
Objectives: After completion of this course, the student should be able to describe and perform microbe breeding, enzyme isolation, and fermentation process

Syllabus: 1. Cell calculation (microbes, fungi, and bacteria)
2. Bacteria identification on dairy product
3. Enzyme isolation
4. Making sugar by enzymatic reaction
5. Solid state fermentation: making of tempe
6. Making of citric acids
7. Making of yogurt
8. Making of bioethanol
9. Making of soya milk (optional)

SEMESTER IV

Course Title: **Chemical Engineering Principles II**
Code: TKK218
Credit Hour: 2
Pre-requisite: Mathematics II
Competency: KU1, KU2, KU3, KU4, KU6
Objectives: After completion of this course, the student should be able to explain dimensional analysis and apply the theoretical model for the process scale-up tool.

Syllabus:
1. Units and dimensions
2. Dimensional analysis
3. Similarity
4. Regime concept
5. Theoretical model

References:

Course Title: **Transport Phenomena**
Code: TKK219
Credit Hour: 3
Pre-requisite: Chemical Engineering Mathematics I, Chemical Engineering Principles I
Competency: KU1, KU2, KU3, KU4, KU5, KU6
Objectives: After completion of this course, the student should be able to describe and explain the concepts of mass, energy, and momentum transfer and to apply the concepts in chemical engineering problems.

Syllabus:
1. Basic law of momentum transport,
2. Microscopic analysis of momentum transport
3. Basic law of mass transport
4. Microscopic analysis of mass transport
5. Basic law of heat transport
6. Simultaneous mass, energy, and momentum transport

References

Course Title: Chemical Engineering Mathematics II
Code: TKK315
Credit Hour: 3
Pre-requisite: Chemical Engineering Principles I, Chemical Engineering Principles II, Chemical Engineering Mathematics I
Competency: KU2, KU4, KU5
Objectives: After completion of this course, the student should be able to develop mathematical model for various phenomena related to chemical engineering problems and to solve it both analytically and numerically
Syllabus
1. Finding roots of non-linear equations (Newton-Raphson, etc.),
2. Completion of single and simultaneous linear equations
3. Completion of single and simultaneous non-linear equations
4. Numerical Method for Differential and Integral Equation
5. Completion of ordinary and partial differential equations using numerical methods (initial value problems and boundary value problems)
6. Chemical Engineering Process Modeling
References
Course Title: Heat Transfer

Code: TKK220

Credit Hour: 2

Pre-requisite: Thermodynamics I, Chemical Engineering I, Material Engineering Science

Competency: KU1, KU2, KU3, KU4, KU6

Objectives: After completion of this course, the students are expected to understand the modes, laws and rules, types and heat transfer equipment design consideration

Syllabus:
1. Review on conductive; Convective and convective heat transfers; Simultaneous conduction and convection; Heat transfer system in heat (double pipe, shell and tube, plate); Extended surface heat transfer systems (air-cooled HE); Unsteady state heat transfer. Basic law of heat transfer
2. Basic concept of heat transfer (radiation, convection, conduction)
3. Heat transfer equipment
4. Analysis of heat transfer equipment
5. STHE (Shell & Tube Heat Exchanger)
6. PHE (Plate Heat Exchanger)

References:
Course Title : Chemical Reaction Engineering
Code : TKK221
Credit Hour : 3
Pre-requisite : Thermodynamics II, Chemical Engineering Principles I, taken together with transport phenomena
Competency : KU1, KU2, KU3, KU4, KU5, KU6
Objectives : After completion of this course, the student should be able to describe classification, rate, and mechanism of reaction, and to analyze data of homogeneous and heterogeneous reaction. After completion of this course, the student should be able to describe and explain mechanism of reaction and catalytic and non-catalytic reaction kinetics.
Syllabus : 1. Stoichiometric
2. The basic concept of chemical kinetics-the determination of the rate of a chemical reaction, the reaction mechanism
3. Interpretation of experimental data on batch reactor
4. Multiple reaction
5. Kinetics of non elementary reaction
6. Definition of heterogeneous catalyst
7. Kinetics of heterogeneous catalytic reaction
8. Kinetics of Heterogeneous multi phase and non-catalytic reaction

<table>
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<tr>
<th><strong>Course Title</strong></th>
<th>Waste Treatment Technology</th>
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<tbody>
<tr>
<td><strong>Code</strong></td>
<td>TKK222</td>
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<tr>
<td><strong>Credit Hour</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Pre-requisite</strong></td>
<td>Environmental conservation, Bioprocess Fundamental</td>
</tr>
<tr>
<td><strong>Competency</strong></td>
<td>KU3, KU4, KU6, KP1</td>
</tr>
<tr>
<td><strong>Objectives</strong></td>
<td>After completion of this course, the student should be able to describe and explain the concepts of liquid, solid, and gas waste treatment.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Course Title</strong></th>
<th>Unit Operation I: Mechanical Process</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Code</strong></td>
<td>TKK223</td>
</tr>
<tr>
<td><strong>Credit Hour</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Pre-requisite</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Competency</strong></td>
<td>KU1, KU2, KU3, KU4, KU5, KU6</td>
</tr>
<tr>
<td><strong>Objectives</strong></td>
<td>After completion of this course, the student should be able to describe and explain process and equipment for transporting fluid and solid</td>
</tr>
</tbody>
</table>
### Course Title
- **Chemical Process Laboratory**

### Code
- TKK224P

### Credit Hour
- 2

### Pre-requisite
- Chemical Engineering Fundamental Laboratory I & II, bioprocess laboratory

### Competency
- KU1, KU2, KU4, KU5, KP3

### Objectives
- After completion of this course, the student should be able to develop skill to design and perform experiments

### Syllabus
1. Hydrodynamics of airlift reactor (sodium thiosulfite oxidation)
2. Continuous-flow ideal reactor for saponification reaction
3. Kinetics of hydrolysis of starch and oil
4. Gas-liquid reaction (carbon dioxide absorption using caustic soda)
5. Esterification (Ethyl acetate or methyl ester)
6. Preparation of catalysts by impregnation and coprecipitation
7. Modification and activation zeolite

### References

### SEMESTER V

### Course Title
- Process Modeling and Computations

### Code
- TKK225

### Credit Hour
- 3

### Pre-requisite
- Chemical Engineering Principles I & II, Chemical Engineering Mathematic II

### Competency
- KU2, KU3, KU4, KU5

### Objectives
- After completion of this course, the students are expected to be able to identify and develop a model of chemical engineering problems, and solve it using
computation models

**Syllabus**

1. Mathematical model of the process
2. Introduction to Computer Programming Language (Scilab, Matlab) and Simulator (Chemcad, HYSYS, atau Aspen Plus)
3. Computational Estimation of the model parameters
4. Completion of the model numerically computing programming language.

**References**


**Course Title** : Research Methodology

**Code** : TKK226

**Credit Hour** : 3

**Pre-requisite** : -

**Competency** : KU2, KU3, KU4, KU5, KU6, KP1

**Objectives** : After completion of this course, students are expected to possess basic principles, procedures and analyses as well as to accomplish a research project comprehensively.

**Syllabus**

1. Definition of scientific and technical research,
2. Research design,
3. Measuring (basic concept, accuracy, and precision)
4. Data processing (statistic analysis; Random variables and probability; continue probability;
Assessment; Testing hypotheses; Variance, Regression, and ANOVA)
5. Research report,
6. Writing procedures and preparation of scientific papers.

References:

Course Title: Reactor
Code: TKK227
Credit Hour: 3
Pre-requisite: Chemical Engineering Principles I, Modeling and Process Computations, Chemical Reaction Engineering, Applied Mathematics for Chemical Engineers II
Competency: KU1, KU2, KU3, KU4, KU5, KU6
Objectives: After completion of this course, the students are expected to be able to design catalytic and non-catalytic homogeneous and heterogeneous reactors
Syllabus:
1. Introduction
2. Concept of ideal reactor: mixed flow and plug flow
3. Design of Constant-Stirred Tank Reactor (CSTR)
4. Design of Plug Flow Reactor (PFR)
5. Design of Packed Bed Reactor (PBR)
6. Design of Fluidized Bed Reactor (FBR)
### References

### Course Title: Unit Operation II: Fluid Mechanics
- **Code**: TKK228
- **Credit Hour**: 3
- **Pre-requisite**: Thermodynamics I
- **Competency**: KU1, KU2, KU3, KU4, KU5, KU6
- **Objectives**: After completion of this course, the student should be able to explain the mechanism and the concept of handling equipment for handling fluids and solids mixture.

### Syllabus
1. The concept of fluid mechanics
2. Piping system
3. Gas transportation
4. Fluid transport
5. Fluid flow rate measuring devices
6. Sedimentation
7. Filtration
8. Agitation
9. Fluidization
10. Centrifugation

### References

### Course Title: Unit Operation III: Heat Separation
- **Code**: TKK229
- **Credit Hour**: 3
- **Pre-requisite**: Inorganic Chemistry, Thermodynamics I, Thermodynamics II
- **Competency**: KU1, KU2, KU3, KU4, KU5, KU6
- **Objectives**: After completion of this course, the student should be able to explain the mechanism and the concept
of separation processes based on heat transfer is applied to the operation of evaporation, condensation, crystallization, drying and humidification.

Syllabus

1. Evaporation
2. Crystallization
3. Drying
4. Humidification


Course Title: Research proposal
Code: TKK230
Credit Hour: 1
Pre-requisite: Taken together Research Methodology
Competency: KU1, KU2, KU3, KU4, KU5, KU6, KP1, KP2, KP3
Objectives: After completion of this course, the student should be able to prepare a research proposal

Course Title: Unit Operation Laboratory
Code: TKK231P
Credit Hour: 2
Pre-requisite: Thermodynamics II, Unit Operation I, Unit Operation II, Unit Operation III
Competency: KU1, KU2, KU4, KU5, KP1, KP3
Objectives: After completion of this course, the student should be able to develop a procedure of the experiment, select and assemble experimental apparatus, measurement and analysis and discussion of the data in the operations of chemical engineering as well as reporting
Syllabus:

1. Batch Distillation,
2. Filtration (Plate and Frame Filter Press; Cross-flow filtration),
3. Heat transfer (Shell and Tube HE),
4. Size Reduction (Hammer Mill),
5. Drying (Tray drier),
6. Fluid Flow,
7. Fluidization (solid-gas),
8. Liquid-Liquid Extraction,
9. Solid-Liquid Extraction,
10. Mixing and agitation,
11. Continuous crystallization,
12. Wetted Wall Column,

SEMESTER VI

Course Title: Process Control
Code: TKK232
Credit Hour: 3
Pre-requisite: Chemical Reaction Engineering, Thermodynamics II, Transfer Phenomena
Competency: KU1, KU2, KU3, KU4, KU5, KU6
Objectives: After completion of this course, the student should be able to explain the process control systems, stability analysis and conditioning controllers, as well as the design of control systems in chemical engineering.

Syllabus:

1. Introduction to Process Control: Benefits of control in the chemical industry, the introduction of variables type: manipulated, control, disturbance
2. The basics of modeling in process control: Static and Dynamics, Linear and non-linear, Linearization Model
3. Laplace Transforms: Fundamentals of transformation, the method of partial fractions
4. Transfer Functions: The Basics transfer function, block diagram
5. Model for first order and second order process:
level tank model, interaction and without interaction two tank models
6. Dynamic Respond: Respond model of order 1 and order 2, the determination of the time constant and the gain constant, over damping, system delay, overshoot, frequency response and Bode analysis
7. Signals and instrumentation
8. Feedback and feed forward control: Introduction to feedback control configurations, respond with a feedback control
9. Stability: stability analysis, Routh-Hurwitz method, Nyquist plots, calculation of phase margin and gain margin
10. PID control design: system tuning, performance of Proportional, Integral and Dynamic Control
11. Process Control Design: Applications in the flow sheet system control, ratio control

References:

Course Title: Chemical Product and Process Design
Code: TKK233
Credit Hour: 3
Pre-requisite: PIK
Competency: KU1, KU2, KU3, KU4, KU5, KU6, KP1, KL1, KL3
Objectives: After attending this course, students are expected to develop an innovative chemical product design as the integration between the ability of chemical engineering knowledge with managerial skills.
Syllabus:
1. The basic concept of chemical product design
2. The concept of technology push and market pull
3. Chemical products design and life cycle analysis
4. Quality function deployment
5. Interaction of product and process design
6. The basic principle and design stages of a chemical process;
7. Structure and synthesis of process flow diagrams;
8. Heuristic / rule of thumb synthesis process;
9. Selection of separator system;
10. The selection of the reactor system;
11. Simulator / software for synthesis and simulation process;
12. Fundamentals of heater network synthesis;
13. Reactor-separator network design;
14. The concept of the integration process

References

Course Title : Unit Operation IV: Multistage Separations
Code : TKK234
Credit Hour : 3
Pre-requisite : Physical Chemistry; Chemical Engineering Principles I; Thermodynamics II
Competency : KU1, KU2, KU3, KU4, KU5, KU6
Objectives : After completion of this course, the student should be able to explain the mechanism and the concept of separation based on mass transfer processes that apply to the operation of adsorption, absorption, distillation, and extraction.
Syllabus :
1. Distillation
   a. The basic concept
   b. Distillation 2 components
   c. Multi-component distillation
   d. Plate tower design
   e. Packed tower design
2. Absorption
   a. The basic concept
   b. Plate tower design for absorption
   c. Packed tower design for gas absorption
3. Extraction
   a. The basic concept
   b. The calculation of the theoretical stage
4. Adsorption
   a. Adsorbent
   b. The basic concept
   c. Fixed bed column design for adsorption
   d. Adsorbent regeneration

Course Title : Utility
Code : TKK235
Credit Hour : 3
Pre-requisite : -
### Competency
- KU3, KU4, KU5

### Objectives
After completion of this course, the student should be able to explain the heating medium supply system, cooling media, and electricity to support the plant production process.

### Syllabus
1. Water supply (drinking water, cooling water, boiler feed, process);
2. Steam generation; fuel supply;
3. Electricity supply;
4. Cooling supply (air conditioner and refrigerator);
5. Compressed air and inert gas supply

### References

### Course Title: Research
- **Code**: TKK236
- **Credit Hour**: 3
- **Pre-requisite**: Research Proposal
- **Competency**: KU1, KU2, KU3, KU4, KU5, KU6, KP1, KP2, KP3
- **Objectives**: After completion of this course, the student should be able to carry out the steps of the scientific research in accordance with the proposals that have been presented at a seminar.

### SESEMER VII

### Course Title: Chemical Engineering Economics
- **Code**: TKK238
- **Credit Hour**: 2
- **Pre-requisite**: Taken together with Design of Chemical Plant
Competency: KU3, KU5, KU6, KL3
Objectives: After completion of this course, the student should be able to explain and calculate the economic aspects of a system or a process of chemical plant equipment.

Syllabus:
1. Chemical plant anatomy
2. Chemical plant equipment price calculation method
3. Fixed capital investment
4. Working capital
5. Manufacturing cost
6. General expense
7. Depreciation
8. Profitability analysis (ROI, DCF, ROR, POT)
9. Sensitivity and break even analysis
10. Alternative investments selection

References:

Course Title: Process Safety
Code: TKK239
Credit Hour: 2
Pre-requisite: Waste Management, Process Equipment Design, Process Control
Competency: KU3, KP1, KL1, KL3
Objectives: After completion of this course, the student should be able to explain the philosophy of safety process and related regulations, safety process support aspects particularly associated with the use of high pressure equipment and high temperature, the concept of danger and risk, and hazards control system due to exposure to B3, equipment operation and emergency control

Syllabus:
1. Process safety philosophy
2. Regulations and institution of national and international safety
3. Safety process support aspects
4. Inspection standard, observation and safety supervision
5. Safety use of pressurized tank, pressurized steel bottles at filling, transportation, storage and offloading
6. Hazard and risk analysis
7. Major hazard control techniques
8. Emergency response planning
9. Hazardous waste and toxic materials and hazardous materials management

References:
4. ______ Government Regulation no. 85, 1999 About: Amendment to Government Regulation No. 18 Year 1999 on the Handling of Hazardous and Toxic Materials
5. ______ Indonesian Government Regulation No. 74 of 2001 on Management of Hazardous and Toxic

Course Title: Industrial and Project Management
Code: TKK240
Credit Hour: 2
Pre-requisite: Waste Management, Process Equipment Design, Process Control
Competency: KU2, KU5, KP3, KL3
Objectives: After completion of this course, the student should be able to explain the principles of project management and industry as well as how to obtain economic efficiency in the production process
Syllabus: 1. Identification of project activities
2. The concept of project management
3. Project funding
4. Strategic and operational project planning
5. Techniques and methods of time planning and preparing work schedules
6. Inventory management
7. Production management
8. The organizational structure and human resource management

References:

Course Title: Process Equipment Design
Code: TKK241
Credit Hour: 3
Pre-requisite: Unit Operation III, Unit Operation IV, Materials Science Engineering, Reactor, Heat Transfer
Competency: KU2, KU3, KU4, KU5, KU6, KL1, KL3
Objectives: After completion of this course, the student should be able to specify the basic design information, pressure vessels design, liquid storage tanks design, heat exchangers design, and assessing the feasibility of the equipment design.

Syllabus:
1. Pressure vessels design;
2. Liquid storage tanks design;
3. Heat exchanger design.

References:
fusion welded pressure vessels.
4. BS EN 13445, Unfired pressure vessels.

Course Title : Chemical Plant Design
Code : TKK242
Credit Hour : 3
Pre-requisite : Unit Operation I, Unit Operation II, Unit Operation III, Unit Operation IV, Chemical Industry Process, Reactor, Utility, Process Computations
Competency : KU2, KU3, KU4, KU5, KU6, KP1, KL1, KL3
Objectives : 1. The student should be able to design a pre-designed chemical plant by considering technical, environmental, social, ethical, health and safety, and sustainability.
2. The student should be able to use the techniques, skills, and modern infrastructure in the chemical engineering applications.
Syllabus : 1. The basic concept of chemical plant design
2. Design strategies
3. Unit process and unit operation integration
4. The Selection and integration of utility and
5. The use of Chemical Engineering software as a tool of plant design and Flowsheeting
6. Equipment lay-out dan plant lay-out determination
7. HAZOP (Hazard and Operability )

References:

Course Title : Entrepreneurship
Code : MWU209
Credit Hour : 3
Pre-requisite : -
Competency : KU6, KP3, KL1, KL2, KL3
Objectives : After completion of this course, the student should be able to explain the concepts of entrepreneurship and business in the field of chemical engineering in small and large scale industries.
Syllabus : 1. Definition and entrepreneurial profile
2. Professionalism in chemical engineering
3. The concept of self-employment and entrepreneurship
4. Business circles
5. Market analysis
6. The basics of business plan
7. Type of business plan
8. Business network
9. Business organizations
10. Risk management and Technopreneurship

References:

ELECTIVE COURSES 1

**Course Title**: Functional Food Technology
**Code**: TKK245
**Credit Hour**: 2
**Pre-requisite**: -
**Competency**: KU1, KU3, KU4, KU6
**Objectives**: After completion of this course, the student are able to describe the source, benefits, and how to manufacture various kinds of functional food ingredients

**Syllabus**: 1. The introduction of functional foods and food nutriceutical
2. Determination of human nutritional needs
3. Antioxidants
4. Dietary fiber
5. Isoflavones
6. lipid
7. Prebiotics and probiotics
8. Sport drink
9. Soy products
References


Course Title: Petroleum Technology
Code: TKK246
Credit Hour: 2
Pre-requisite: -
Competency: KU1, KU3, KU4, KU6
Objectives: After completion of this course, the students are able to explain the history, classification, composition, analysis, products, and petroleum refining processes, and treating processes to improve the quality of petroleum products

Syllabus

1. Introduction
2. The composition of hydrocarbons and non-hydrocarbon contents, classification and types of petroleum
3. Petroleum and its products testing
4. The products can be produced from petroleum for fuel, petrochemicals and other materials
5. Petroleum Properties
6. Preliminary refining processes: atmospheric distillation, vacuum distillation
7. Advanced refining process: thermal, catalytic and hydro cracking; catalytic and hydro reforming
8. Hydrogenation, Isomerization, alkylation, polymerization
9. Lubricating oil technology
10. Treating technology

References


**Course Title**: Catalyst Technology  
**Code**: TKK247  
**Credit Hour**: 2  
**Pre-requisite**: -  
**Competency**: KU1, KU3, KU4, KU6  
**Objectives**: After completion of this course, the student should be able to explain the synthesis, characterization, and catalysts testing principles.  

**Syllabus**:  
1. The catalyst function  
2. Homogeneous catalysts  
3. Heterogeneous Catalysts;  
4. The basic principle of the catalyst selection  
5. Catalyst properties (catalyst structure, catalyst morphology, properties of acids and bases)  
6. Catalyst characterization (XRD and FTIR, NA and AAS, TPD and NMR)  
7. Catalysts production  
8. Catalyst testing  
9. Catalyst deactivation  
10. Catalyst regeneration  
11. Bio-and Nano-catalysts  

**References**:  

**Course Title**: Clean Technology  
**Code**: TKK248
Credit Hour : 2
Pre-requisite : -
Competency : KU1, KU3, KU4, KU6
Objectives : After completion of this course, the student should be able to explain the definitions, basic concepts of clean production technologies, and be able to assess the implementation of cleaner production technology in the chemical industry.

Syllabus : 1. Definition and basic concepts of clean production technologies (Good House Keeping, Raw material Substitution, Technology Changes, Product changes, Onsite reuse)
2. Waste minimization (Source Reduction, Reuse-Recycle-Recovery, Waste Treatment, Disposal),
3. Pollution prevention (end of pipe treatment: hard recycle, waste treatment, disposal),
4. The concept of industrial ecology (Reject Concept of wastes),
5. Application of clean production technologies in the chemical industry


ELECTIVE COURSES 2

Course Title : Food Processing and Preservation Technology
Code : TKK249
Credit Hour : 2
Pre-requisite : -
Competency : KU1, KU3, KU4, KU6
Objectives : After completion of this course, the student should be able to explain the various ways of processing, the causes and mechanisms of damage, and various
ways to preserve food.

Syllabus:
1. Food processing (heating, cooling, freezing, drying);
2. Damage to food (damage due to microbes, enzymes, the influence of environmental conditions);
3. Food preservation (principles and technologies using heat, low temperature, drying, irradiation).
4. Food safety

References:

Course Title: Coal Technology
Code: TKK250
Credit Hour: 2
Pre-requisite: -
Competency: KU1, KU3, KU4, KU6
Objectives: After completion of this course, students are able to explain and apply the principles of coal conversion into energy

Syllabus:
1. Coal reserves in Indonesia
2. The nature and characteristics of coal
3. Preparation and cleaning of coal
4. Coal carbonization
5. Coal briquettes
6. Coal gasification process
7. Coal liquefaction process
8. Coal combustion process
9. Air emissions from coal conversion
10. Particulate control
11. Flue gas desulfurization


Course Title : Polymer Technology
Code : TKK251
Credit Hour : 2
Pre-requisite : Organic Chemistry, Material Science Engineering, Chemical Plant Process
Competency : KU1, KU3, KU4, KU6
Objectives : After completion of this course, the student should be able to explain the types of polymer reactions, methods of polymerization process and polymer processing

Syllabus : 1. Introduction
2. The polymerization reaction mechanism (Polymerization condensation ; Polymerization adduct)
3. Polymerization process (mass polymerization, solution polymerization, emulsion polymerization and suspension polymerization)
4. Polymer processing into finished products (injection molding, blow molding, calendaring, blow forming and thermo forming films) and polymer additives material (colorants, antioxidants, anti electrostatics, lubricating and anticaking).
5. The nature and application of polymer

Course Title : Pinch technology
Code : TKK252
Credit Hour : 2
Pre-requisite : Thermodynamics I, Heat Transfer
Competency : KU1, KU3, KU4, KU6
Objectives : After completion of this course, the student should be able to design feasible heat exchanger networks (HEN) in an effort to improve the efficiency of heat recovery in a pinch with the principles of the system based on the first and second laws of thermodynamics.

Syllabus :
1. Law of thermodynamics in the design process
2. Heat exchanger network and grid diagrams
3. Composite curve
4. Flow pairing
5. Hot and cold flow identification
6. The design of heat exchanger networks
7. Heat and power integration
8. Economic Evaluation
9. Applications in plant / case studies

References :

ELECTIVE COURSES 3
Course Title : Enzyme and Fermentation Technology
Code : TKK253
Credit Hour : 2
<table>
<thead>
<tr>
<th>Pre-requisite</th>
<th>Bioprocess Basics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competency</td>
<td>KU1, KU3, KU4, KU6</td>
</tr>
<tr>
<td>Objectives</td>
<td>After completion of this course, the student should be able to explain the functions and how to make the enzyme, the basics of fermentation operations and fermenters design calculations.</td>
</tr>
</tbody>
</table>
| Syllabus             | 1. Enzymes as catalysts  
                       | 2. The kinetics of enzymatic reactions  
                       | 3. The sources of enzyme  
                       | 4. Process of enzymes for food  
                       | 5. Cell division method  
                       | 6. Enzyme recovery process  
                       | 7. Fermentation operation model  
                       | 8. Microbial growth kinetics  
                       | 9. Substrate utilization kinetics  
                       | 10. Product formation kinetics  
                       | 11. The sterilizer design  
                       | 12. Inoculum development  
                       | 13. Fermentor design |

References:

Course Title: Gas Processing Technology  
Code: TKK254  
Credit Hour: 2  
Competency: KU1, KU3, KU4, KU6  
Objectives: After completion of this course, the students are able to explain the principles of the Fischer-Tropsch process and the conversion processes of natural gas.
into liquid fuels, gas, water and other chemicals.

**Syllabus**
1. LNG production process
2. LPG production process
3. Fischer-Tropsch process
4. Steam reforming process
5. Oxidative coupling process
6. Partial oxidation process
7. Reform processes
8. Gas into liquid fuel conversion process
9. Gas into liquid gas conversion process
10. Gas into chemicals conversion process

**References**

**Course Title**
: New Material Technology

**Code**
: TKK255

**Credit Hour**
: 2

**Pre-requisite**
: Material Science and Engineering

**Competency**
: KU1, KU3, KU4, KU6

**Objectives**
: After completion of this course, the students are able to explain a wide range of new materials, including manufacturing technology, benefits, and its economic aspects.

**Syllabus**
1. Semiconductors
2. Superconductors
3. Polymers and Elastomers;
4. Composites
5. Nanomaterial

**References**
New York.


**Course Title**: Emulsions and Surfactants Technology  
**Code**: TKK256  
**Credit Hour**: 2  
**Pre-requisite**: Physical Chemistry  
**Competency**: KU1, KU3, KU4, KU6  
**Objectives**: After completion of this course, the students are able to explain the ways of stabilizing the system and solving the homogeneous mixture of immiscible liquid-liquid and its application in the food industry, cosmetics, and petroleum.

**Syllabus**:  
1. Emulsion definition;  
2. Emulsification process;  
3. Overview of emulsion system thermodynamics;  
4. Factors that affect the stability of the emulsion;  
5. Destabilization of the emulsion;  
6. Emulsifiers for food;  
7. The mechanism of stabilization and destabilization;  
8. Surfactant definition;  
9. The types and properties of surfactants (anionic, cationic, nonionic, and amphoterik surfactant);  
10. Hydrophilic lipophilic balance (HLB);  
11. Critical Micelle Concentration;  
12. Micelle and reverse micelle;  
13. Cloud Point.

**References**:  


**ELECTIVE COURSES 4**

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Food Packaging and Safety Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>TKK257</td>
</tr>
<tr>
<td>Credit Hour</td>
<td>2</td>
</tr>
<tr>
<td>Pre-requisite</td>
<td>-</td>
</tr>
<tr>
<td>Competency</td>
<td>KU1, KU3, KU4, KU6</td>
</tr>
<tr>
<td>Objectives</td>
<td>After completion of this course, the students are able to explain the type and process of packaging materials, packaging requirements, food packaging techniques, and recycling of packaging</td>
</tr>
<tr>
<td>Syllabus</td>
<td>1. Introduction</td>
</tr>
<tr>
<td></td>
<td>2. Food safety</td>
</tr>
<tr>
<td></td>
<td>3. Food safety criteria</td>
</tr>
<tr>
<td></td>
<td>4. Types of packaging materials</td>
</tr>
<tr>
<td></td>
<td>5. The process of packaging manufacture</td>
</tr>
<tr>
<td></td>
<td>6. Packaging requirements</td>
</tr>
<tr>
<td></td>
<td>7. Food packaging techniques</td>
</tr>
<tr>
<td></td>
<td>8. Food packaging materials recycling</td>
</tr>
<tr>
<td><strong>Course title</strong></td>
<td><strong>Renewable Energy Technology</strong></td>
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<tr>
<td><strong>Code</strong></td>
<td>TKK258</td>
</tr>
<tr>
<td><strong>Credit Hour</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Pre-requisite</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Competency</strong></td>
<td>KU1, KU3, KU4, KU6</td>
</tr>
<tr>
<td><strong>Objectives</strong></td>
<td>Students are able to explain the resources and renewable energy technologies</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Course Title</strong></th>
<th><strong>Membrane Technology</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Code</strong></td>
<td>TKK259</td>
</tr>
<tr>
<td><strong>Credit Hour</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Pre-requisite</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Competency</strong></td>
<td>KU1, KU3, KU4, KU6</td>
</tr>
<tr>
<td><strong>Objectives</strong></td>
<td>After completion of this course, the student should be able to explain and design processes in membrane-based separation applications for various industries.</td>
</tr>
<tr>
<td><strong>Syllabus</strong></td>
<td>1. Membrane material&lt;br&gt;2. Membrane preparation&lt;br&gt;3. Membrane characterization&lt;br&gt;4. Fouling and concentration polarization in the membrane&lt;br&gt;5. The design process and the membrane module</td>
</tr>
</tbody>
</table>
6. Regeneration membrane technique
7. Membranes in industrial applications (water treatment, wastewater treatment, chemical industry, Pharmaceutical / Medical, Agricultural and food)
8. Case studies

References

Course Title: Energy Management and Conservation
Code: TKK260
Credit Hour: 2
Pre-requisite: -
Competency: KU1, KU3, KU4, KU6
Objectives: After completion of this course, the student should be able to explain and analysis the energy audit system and socio-economy aspect of energy management.

Syllabus
1. Energy audits management systems
2. The concept of energy audits
3. Energy audit procedures and techniques
4. Energy supply management system
5. Socio-economic aspects of the energy supply system


3.1 ACADEMIC STAFFS

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3.2 FACILITIES

3.2.1 Campus Buildings

a. **Building A**: with **total area of 1,579 m²** this building is used for 3 educational laboratories (Unit Operation Laboratory, Unit Process Laboratory, Microbiology Laboratory), 5 specialized laboratories (Instrumentation Laboratory, Energy and Process Engineering Laboratory, Bioprocess Laboratory, Separation Technology Laboratory, and Food Process Engineering Laboratory), 2 class rooms having capacities of 50 and 100 students, respectively, and 14 rooms for faculty members.

b. **Building B**: with **total area of 741 m²** this building is used for Process Computation Laboratory, Meeting Room, Administration Room, 12 rooms for faculty members, and Library.

c. **Building C**: with **total area of 758 m²** this building is used for 5 class rooms having capacities of 60 students each, and a room for Student Union.

d. **Building D**: with **total area of 360 m²** this building is used for Workshop and Waste Treatment Laboratory.

e. **Building E**: with **total area of 225 m²** this building is used for Chemical Engineering Fundamental Laboratory I and II.

3.2.2 Laboratories
a. Educational Laboratories:
- Chemical Engineering Fundamental Laboratory I
- Chemical Engineering Fundamental Laboratory II
- Microbiology Laboratory
- Process Computation Laboratory
- Chemical Process Laboratory
- Unit Operation Laboratory

b. Research Laboratories:
- Waste Treatment Laboratory
- Energy and Process Engineering Laboratory
- Instrumentation Laboratory
- Bioprocess Laboratory
- Separation Technology Laboratory
- Food Process Engineering Laboratory

3.2.3 Libraries
The students of the Chemical Engineering Department are able to access Diponegoro University Central Library, Engineering Faculty Library, and Departmental Library. The Departmental Library is provided with more than five hundreds textbooks, journals to support all students and faculty members’ activities. The libraries are linked to Sciencedirect and Springerlink.

3.2.4 LAN/Internet
The Engineering Faculty provides LAN/internet facilities to support the transfer of information, science, and technology, as well as academic information system. The Department provides hotspot facility for students and faculty members to access LAN/internet. The facility is available 24 hours per day, 7 days per week for free.

4. Workshop
Workshop is used to fabricate equipment needed in laboratories, researches, and community service.
All the academic regulations applied in the Department of Chemical Engineering is based on Rector Decree No. 469/PER/H7/2010. Several points that are important in the academic activities in the department are as follow.

**Study load and Course Plan**

1. Study load per semester
   a. In the first semester, the freshmen are allowed to take courses with maximum of 22 credit hours.
   b. In the following semesters, the maximum load is determined by the GPA achieved in the previous semester:
      1) $\text{GPA} \geq 3.00$ : maximum study load = 24 credit hours;
      2) $2.50 \leq \text{GPA} \leq 2.99$ : maximum study load = 22 credit hours;
      3) $2.00 \leq \text{GPA} \leq 2.49$ : maximum study load = 20 credit hours;
      4) $\text{GPA} < 2.00$ : maximum study load = 18 credit hours.

2. Course plan:
   a. Prior to every semester, the students should plan the courses to be taken both online and in Course Plan Card (CPC) approved by the academic counselor.
   b. The courses that have been planned are allowed to be replaced or canceled.
   c. The replacement of any course is done by the student with the approval of the academic counselor by the end of the second week after the course begins.
   d. The cancelation of any course is done by the student with the approval of the academic counselor by the end of the sixth week after the course begins.

**Maximum Study Period**

The maximum study period for the undergraduate program is 14 (fourteen) semesters.
**Student Assessment**

1. To assess the progress of the study of the students the following forms of examination can be conducted:
   a. Written examination:
      - Quiz/test
      - Mid examination of a semester
      - Final examination of a semester
   b. Practical examination;
   c. Oral examination, such as for comprehensive examination and thesis defense;
   d. Based on reasonable arguments, other forms of examination can be conducted.

2. Examination prerequisite:
   a. Mid/Final examination:
      - The student should be registered in the List of Course Attendant (LCA)
      - The student should have attended at least 75% of every course.
   b. Final examination of the program:
      The student should have passed all the courses.

3. Assessment System
   a. Type of assessment and how to do it adjusted to the characteristics of courses.
   b. The grades are designated by alphabets with the following scores:
      \[ \begin{align*}
      A &= 4 & D &= 1 \\
      B &= 3 & E &= 2 \\
      C &= 2
      \end{align*} \]
   c. The students obtaining the grade of D for any course have to improve their grade and it is allowed for them to only attend the examination.
   d. The students obtaining the grade of E for any course have to improve their grade by attending the course and the examination.
   e. The students obtaining the grade of B and C are allowed to improve their grades. At the end of the program, the best grades are used as the final grades.
f. The grades of the examination are announced.
g. The students are allowed to improve their grades in other semesters.
h. For any reason that the grades are not defined at the end of a semester, they should be graded as IC (incomplete) with the score of zero (0).
i. Achievement
   - The achievement of the students is designated by GPA.
   - In the calculation of final GPA, every course is used once with its best grade.
   - The GPA calculation is done by using the following formula:
     \[ P = \frac{\sum KN}{\sum K} \]
     with K and N are the credit hour and the score for each course, respectively.
4. The prerequisite, the validation of the attendant, and the regulation of the examination are defined by the Faculty.

**Evaluation of Study Progress of the Student**
Evaluation performed to determine the progress of students in the study period.
1. Criteria for evaluations in stages:
   a. First three semester
      - The students must have accumulated at least 35 credit hours with the GPA ≥ 2.25.
      - Should the students have passed < 35 credit hours with the GPA < 2.25, the calculation of the GPA is done for the best 35 credit hours.
   b. Second three semester (seventh semester)
      - The students have to have passed at least 85 credit hours with the GPA ≥ 2.25.
      - Should the students have passed < 85 credit hours with the GPA< 2.25, the calculation of the GPA is done for the best 85 credit hours.
   c. End of the program
By the end of the fourteenth semester, the student should have passed all the courses with the GPA \( \geq 2.00 \).

2. Should the students not able to fulfill the above criteria, they are categorized as unable to attend the academic process. To these students, the Rector will issue a letter to terminate the academic process for the students.

3. Successful completion of undergraduate study
   The students are declared to have finished the undergraduate program whenever:
   a. They have passed all the courses,
   b. They have hold TOEFL certificate with the minimum score of 400 of which is obtained during the study.
   c. The GPA is\( \geq 2.00 \)

4. In the final transcript, the grade D is not allowed.

5. The transcript of the undergraduate originated from the DIII program includes all the converted courses and all the courses taken in the undergraduate program.

6. The date of the graduation is the date of the defining the final GPA.

**Yudicium**

1. The predicate of the undergraduates are:

<table>
<thead>
<tr>
<th>GPA</th>
<th>PREDICATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00 – 2.75</td>
<td>satisfactorily</td>
</tr>
<tr>
<td>2.76 – 3.50</td>
<td>very satisfactorily</td>
</tr>
<tr>
<td>3.51 – 4.00</td>
<td>cumlaude</td>
</tr>
</tbody>
</table>

2. The cumlaude predicate is determined by considering the length of the study as well, i.e. five years.

3. The cumlaude predicate is not awarded to the undergraduate originated from the DIII program.

**Student Sabbatical**

1. The Rector may grant a sabbatical provided:
   a. The students have received 45 credit units with the GPA \( \geq 2.25 \),
   b. The students must submit a petition letter to the Rector.

2. The Rector may also grant a leave for:
a. Medical reasons provided the petition is recommended by a hospital or other responsible institutions.

b. Students as members of delegations representing the Diponegoro University in events extend for one month or more.

3. During the study period, the students are admitted to get sabbatical for maximum of twice or two semesters.

4. Sabbatical is not allowed for previous semester.

5. The sabbatical is not included in the calculation of the study period.
5.1 TKK 382 : PRELIMINARY DESIGN (6 CREDIT HOURS)

GENERAL INSTRUCTIONAL OBJECTIVES
The students are able to comprehensively apply all the theory and skill of chemical engineering in the form of preliminary design of a chemical plant and write an executive summary.

SPECIAL INSTRUCTIONAL OBJECTIVES
After completion of this course, the students are able to:
1. write and describe the background of the plant,
2. calculate and define the capacity of the plant based on the demand of the product, the availability of the raw material, and minimum capacity,
3. explain the reason of the determination of the location of the plant,
4. write and describe the outlines of various processes that are possible to be used,
5. compare the possible processes, select the process, and explain the reason of the selection,
6. write the physical and chemical properties of the raw material and the product,
7. explain the function of the product,
8. define the specification of the raw material and the product,
9. design and draw a process flow sheet with the right equipment symbols and simple instrument,
10. write and explain the concept and the steps of the process corresponds to the flow sheet,
11. explain the background of the selection of the unit operation equipment, such as pump, absorber, distillation tower, etc.,
12. explain the reason of the utilization of controllers and indicators,
13. perform material and energy balance calculations,
14. compose/draw a material balance flow sheet,
15. write and explain the concept of the process in terms of the reaction, kinetic and thermodynamic aspects, phases of the system, and the operating conditions,
16. determine, explain, and design the reactor,
17. design the equipment for fluid and/or solid transportations,
18. design heat exchanger(s),
19. design various separating equipment, such as distillation column, absorber, dryer, and evaporator,
20. select material of constructions for process equipment,
21. predict physical and/or chemical properties ($C_p$, $E$, $H$, $S$, etc.) of which the experimental values are not available,
22. determine the condition for the storage of the raw material and the product (temperature, pressure, and phase),
23. calculate the requirement of water, steam, electricity, and fuel for every ton of product,
24. Perform economical analysis by calculating capital investment, manufacturing cost, production cost, return on investment, pay out time, shut down point, and break even point.

**PREREQUISITE**
1. The students has obtained at least 137 credit hours
2. The students should have taken all the courses except the humanity courses and elective subjects.
3. The course has to be included in the KRS.

**PROCEDURE**
1. The students register to the Coordinator of Chemical Plant Design Project by showing the KRS approved by the academic counselor.
2. The Coordinator explains the mechanism of the execution of the project to the students.
3. The Coordinator determines the groups (2 students per group), the titles of the projects, and the supervisors (2 supervisors per group). The Coordinator fills the **TA-1** form.
4. The project should be done within 16 weeks since approved by the Supervisors.
5. At the end of the semester, the supervisors have to give scores by filling the **TA-2** form and hand the form to the Coordinator.
6. The supervisors are responsible to the Coordinator.
7. The Coordinator is responsible to the Head of the Department.

**SUPERVISING GUIDELINE**
1. The content of the report is defined in the **TA-3** form.
2. At the beginning of the project, the students with the supervisors have to determine the capacity of the plant.
3. The supervisors have to supervise the students in every stage of the project and consider the time schedule.

**ASSESSMENT GUIDELINE**

<table>
<thead>
<tr>
<th>Week</th>
<th>Assessment Components</th>
<th>Max. score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 2</td>
<td>Design strategy</td>
<td>10</td>
</tr>
<tr>
<td>3 – 8</td>
<td>Process design</td>
<td>35</td>
</tr>
<tr>
<td>9 – 13</td>
<td>Equipment and utility design</td>
<td>35</td>
</tr>
<tr>
<td>14 – 15</td>
<td>Economic calculation</td>
<td>10</td>
</tr>
<tr>
<td>16</td>
<td>Report/executive summary writing</td>
<td>10</td>
</tr>
<tr>
<td>TOTAL SCORE (in number)</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

**DESCRIPTION OF THE CONTENT**

**I. DESIGN STRATEGY**

- **Background:**
  In this section, a brief explanation about the importance of the project is given.
- **Production capacity:**
  This section explains about the determination of the production capacity based on in-country demand, raw material availability, and minimum capacity of the existing plants.
- **Raw material and product:**
  - Raw material: type, specification, requirement, origin, and price.
  - Product: specification, marketing, and price.
Location:
This section consists of explanation about the reasons of the determination of the location:
- The raw materials are heavier than the products (weight loosing) → the location should be close to the origin of the raw material.
- The raw materials are lighter than the products (weight gaining) → the location should be close to the market.
- The raw materials are classified as dangerous materials (explosive, burn, fragile, etc.) → the location should be close to the origin of the raw material.
- The products are classified as dangerous materials (explosive, burn, fragile, etc.) → the location should be close to the market.
- The raw materials are imported or the products are exported → the location should be close to shipping facilities.

Process selection:
This section consists of a brief description of available processes along with the advantages and disadvantages. The selection of the process used with the reasons must also be explained in this section.

II. PROCESS DESIGN

- Flow sheeting:
The process flow sheet is constructed with correct equipment symbols and dimensions along with the operating conditions and instruments.

- Material and energy balances
  - Material balance is used to calculate all process variables, i.e. flow rates and compositions of all flows in the process.
  - Energy balance is used to calculate all process variables, i.e. temperatures and pressures of all flows in the process. In many cases, both material and energy balances must be solved simultaneously.

- Process description
Description of the treatment of raw materials, raw materials into reaction products in the reactor, the product separation process
after leaving the reactor, to the handling of products produced (according to the process flow diagram).

- Scalability
  Labeling flow rate and composition of the materials on the inflow and outflow of each equipment (according to the flow sheet).

III. MAIN EQUIPMENT DESIGN AND UTILITIES

- Major equipment design:
  - Raw material storage tank (until the mechanical design): types, construction materials, and dimensions.
  - Reactor: type, residence time, dimension, jacket design or stirrer.
  - Heat exchanger (until the mechanical design).
  - Pumps: types, construction materials, piping systems, and power requirements.
  - Separator (one of the following equipment: Distiller, Absorber, Evaporator, extractor, Dryer)

- Utility design
  - Water: process water, cooling/heater water; boiler feed; miscellaneous water (drinking, parks, clinics, fire, etc..); Needs of each and total (m$^3$/day); sources of water; short description of the process procurement of each water type above; outline water treatment plant.
  - Steam: the type and quality of the steam needed; each quantity; types of boilers used (water pipes, pipe fire); needs of fuel.
  - Electricity: total number of power plants needed; power source (generator, PLN).
  - Fuel: type of fuel used; types of usage, the number of needs (liters / day)
  - Air instruments: the quality and quantity requirements.

IV. THE ECONOMIC CALCULATION

- Estimated price of equipment, raw materials and products, including the estimation method and data sources.
\begin{itemize}
\item Calculation of Physical Plant Cost, Fixed Capital Investment, Working Capital, and the economic feasibility including Pay Out Time, ROI, Discounted Cash Flow, BEP, and SDP.
\item Determination of BEP and SDP graphically.
\end{itemize}

V. EXECUTIVE SUMMARY
Contains a summary of I - IV that can be used by (executives) decision makers in order to conclude proper of project design of the plant followed.

EXAMINATION GUIDELINE
1. Examinations held in the specific period and was adjusted to the academic calendar.
2. Students, who have completed the preliminary design assignment, eligible to take the exam.
3. Before the exam, students must fulfill the administrative requirements, such as:
   a. reports that have been signed by supervisor (4 exp)
   b. college transcript
4. After completing the administrative requirements, Coordinator establish the examiner.
5. The exam led by Chief Examiners
6. Examination performed independently
7. Examiners right to postpone the exam, if the student is not considered feasible to take the exam.
8. Basically, there is no revision after the exam. However, report deficiency should be noted in the blank pages, which is provided on the front page after approval sheet.
9. Basically, the exam is conducted openly, if the place allows
10. The examination take place for 2,5 hours (maximum)
11. Student must prepare a process flow chart with an easily readable size and supporting literature.
12. Students required to wear a white long sleeve shirt, tie, and black skirt/pants.
13. Minutes and scores of examination submitted to the Coordinator
14. Students can be declared to have passed when the average scores of supervisors and the examiners greater than or equal to 60.
15. At the end of the exam period, Chemical Engineering Department will hold a meeting to determine the graduation.
PRELIMINARY DESIGN

No : ........................................
Subject : Preliminary Design

To

__________________________________________
Preliminary Design Supervisor
The Department of Chemical Engineering
Faculty of Engineering
Diponegoro University
in
S E M A R A N G

We kindly ask willingness to provide guidance of chemical plant design project to students:

1. Name / ID : .............................................................................................................
2. Name / ID : .............................................................................................................
   Title : ....................................................................................................................
   Start date guidance : ..............................................................................................

Thank you for your attention

Semarang,
Coordinator of
Preliminary Design

__________________________
ID.
ASSESSMENT SHEET OF CHEMICAL PLAN DESIGN PROJECT

Name : ...........................................................
ID : ............................................................
Title : ..................................................................

<table>
<thead>
<tr>
<th>Assessment Components</th>
<th>Max. score</th>
<th>Score</th>
<th>Advisor sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design strategy</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process design</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment and utility design</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic calculation</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Report/executive summary writing</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL SCORE (in number)</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FINAL GRADE (in alphabet)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Semarang, ........................................
Coordinator of Preliminary Design

_______________________
NIP
EXECUTIVE SUMMARY

PRELIMINARY DESIGN PROJECT

PRELIMINARY DESIGN OF SULFURIC ACID PLANT USING CONTACT PROCESS

By:

(Name) ID. .................
(Name) ID. .................

THE DEPARTMENT OF CHEMICAL ENGINEERING
FACULTY OF ENGINEERING
DIPONEGORO UNIVERSITY
SEMARANG
2013
EXECUTIVE SUMMARY

<table>
<thead>
<tr>
<th>TITLE</th>
<th>PRODUCTION CAPACITY</th>
<th>Ton/year</th>
</tr>
</thead>
</table>

I. DESIGN STRATEGY

<table>
<thead>
<tr>
<th>Background</th>
<th>Basis for determining production capacity</th>
<th>Basis for determining the location of the factory</th>
<th>Process selection</th>
<th>Raw material</th>
<th>Name</th>
<th>Specification</th>
<th>Requirement</th>
<th>Ton/day</th>
<th>Origin</th>
<th>Product</th>
<th>Name</th>
<th>Specification</th>
<th>Production</th>
<th>Ton/day</th>
<th>Marketing area</th>
</tr>
</thead>
</table>

II. PROCESS FLOWSHEET

In this section, the engineering flow sheet provided with the instrumentations, operating conditions (temperature and pressure), and material balance is presented.

III. PROCESS EQUIPMENTS AND UTILITY

1. Specification of main equipment
2. Utility

<table>
<thead>
<tr>
<th>WATER</th>
<th>m³/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service water</td>
<td>m³/day</td>
</tr>
<tr>
<td>Cooling water</td>
<td>m³/day</td>
</tr>
<tr>
<td>Process water</td>
<td>m³/day</td>
</tr>
<tr>
<td>Boiler feed water</td>
<td>m³/day</td>
</tr>
<tr>
<td>Total</td>
<td>m³/day</td>
</tr>
<tr>
<td>Source</td>
<td>m³/ton of product</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STEAM</th>
<th>Ton/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam requirement</td>
<td>Mega Watt</td>
</tr>
<tr>
<td>Type of boiler</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ELECTRICITY</th>
<th>Mega Watt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity requirement</td>
<td>Own Generator : Mega Watt</td>
</tr>
<tr>
<td>Source</td>
<td>Own Generator : Mega Watt</td>
</tr>
<tr>
<td>PLN</td>
<td>Mega Watt</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FUEL</th>
<th>Ton/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>Requirement</td>
<td>Ton/day</td>
</tr>
<tr>
<td>Source</td>
<td></td>
</tr>
</tbody>
</table>

IV. ECONOMIC CALCULATION

<table>
<thead>
<tr>
<th>Physical Plant Cost</th>
<th>Ton/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed Capital</td>
<td></td>
</tr>
<tr>
<td>Working Capital</td>
<td></td>
</tr>
<tr>
<td>Total Capital Investment</td>
<td></td>
</tr>
</tbody>
</table>

FEASIBILITY ANALYSIS

<table>
<thead>
<tr>
<th>Return on Investment (ROI)</th>
<th>Before tax :</th>
<th>after tax :</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pay Out Time (POT)</td>
<td>Before tax :</td>
<td>after tax :</td>
</tr>
<tr>
<td>Break Even Point (BEP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shut Down Point (SDP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discounted Cash Flow (DCF)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# CONSULTATION LOG BOOK
## Preliminary Design

<table>
<thead>
<tr>
<th>No.</th>
<th>Date</th>
<th>Subject</th>
<th>Sign</th>
<th>Annotation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Semarang, ................................................

Supervisors,

______________________  ____________________
ID                      ID
3.2 TKK 381: INDUSTRIAL TRAINING (3 CREDIT HOURS)

GENERAL INSTRUCTIONAL OBJECTIVES

The main objective of the Industrial Training is to experience and understand real life situations in industrial organizations and their related environments and accelerating the learning process of how student’s knowledge could be used in a realistic way. In addition to that, industrial training also makes one understand the formal and informal relationships in an industrial organization so as to promote favorable human relations and teamwork. Besides, it provides the exposure to practice and apply the acquired knowledge “hands-on” in the working environment. Industrial training also provides a systematic introduction to the ways of industry and developing talent and attitudes, so that one can understand how Human Resource Development works.

Moreover, students can gain hands-on experience that is related to the students majoring so that the student can relate to and widen the skills that have been learnt while being in university. Industrial training also exposes the students to the real career world and accustoms them to an organizational structure, business operation and administrative functions.

Furthermore, students implement what they have learned and learn more throughout this training. Besides, students can also gain experience to select the optimal solution in handling a situation. During industrial training students can learn the accepted safety practices in the industry. Students can also develop a sense of responsibility towards society.

In conclusion, there is strong evidence that industrial training is highly beneficial to students’ development, and it is highly valued. The students are well equipped to manage the period of industrial training successfully and undoubtedly gain useful experience of applying their specialist and technical skills, as well as developing their personal and communications skills. This internship also helps students to prepare for the work environment and also teach the ergonomics of organizations in the real world.
SPECIFIC INSTRUCTIONAL OBJECTIVES
After carrying out industrial training, students are expected to:
1. Describes the specifications raw materials and products that produced by the factory.
2. Draw a process flow diagram correctly.
3. Explain the concept and process steps completely.
4. Explains the specifications and workings of some main equipment.
5. Explain the workings of the utility units.
6. Explain the laboratory program and principles of raw materials and products analysis.
7. Draw and explain the organizational structure of the plant.
8. Explain the reason for the plant site selection.
10. Complete the special task by using chemical engineering tools for the evaluation of the process equipment performance or process efficiency.
11. Prepare a written report in accordance with the applicable rules and format.

REQUIREMENT
1. The students has obtained at least 110 credit hours
2. Registered in KRS.
3. At Industrial training implementation, students should have been taking all the courses the semester I to semester VI except General Basic Courses and Elective Courses.
4. If a plant requires the submission within a one or more year periods, then at the time of application letter submission to the plant
5. The students have to write a proposal after accepted
6. Industrial training duration at least one month.

PLANT CRITERIA AS INDUSTRIAL TRAINING OBJECT
2. Industries that process raw materials into finished or semi-finished materials.
3. Have the unit process and / or unit operations.
4. Have the utilities such as water treatment, steam generation, and power generation.

**INDUSTRIAL TRAINING APPLICATION PROCEDURE**

1. Register to Industrial Training Coordinator by showing a certificate from Academic Counselor (PK-1 form).
2. Industrial Training Coordinator prepare Industrial Training Supervisor appointment letter (PK-2 form).
4. After the proposal approved, Industrial Training Coordinator prepare introduction letter to department teaching division in order to make Industrial Training application letter to the factories.
5. If the application was disapproved, the student back to supervisor to prepare a new proposal.

**INDUSTRIAL TRAINING PROCEDURE**

1. Student overlooks the Supervisor to get special assignment.
2. Students carry out industrial training at the plant in at least 1 (one) month with a Letter of Assignment (PK-3 form).
3. Field Supervisor (from the factory) is also permitted given the task and / or scores to the student while not deviating from the curriculum.
4. After completing the industrial training, the student must immediately report to the Supervisor for Industrial training and special assignment report guidance.
5. Report assessment refers to the PK-4 form that is given after the report declared completed and submitted to the department teaching division.
6. Students must submit a report that has been approved in print and CD (PDF file) to the Industrial Training Coordinator.

**SUPERVISING GUIDELINE**

1. Industrial Training Supervisor in charge of assign tasks to students adjusted to Plant condition (based proposal that have been made). Guidance and assessment reports refer to the PK-4 form.
2. Industrial Training report and special assignment report prepared in accordance with the report writing guidelines that published by the Department.

EXAMINATION GUIDELINE
1. Examinations held in the specific period and was adjusted to the academic calender.
2. Students, who have completed industrial training assignment, eligible to take the exam.
3. Before the exam, students must fulfill the administrative requirements, such as :
   a. industrial training reports that have been signed by supervisor (4 exp)
   b. special assignment report that have been signed by supervisor (4 exp)
   c. college transcript
4. After completing the administrative requirements, Industrial Training Coordinator establish the examiner.
5. The exam led by Chief Examiners
6. Examination performed independently
7. Examiners right to postpone the exam, if the student is not considered feasible to take the exam.
8. Basically, the exam is conducted openly, if the place allows
9. The examination take place for 2 hours (maximum), with allocation of time :
   - 30 minutes for presentation
   - 90 minutes for question and answer
10. Student must prepare a process flow chart with an easily readable size and supporting literature.
11. Students required to wear a white long sleeve shirt, tie, and black skirt/pants.
12. Minutes and scores of examination submitted to the Coordinator
13. Students can be declared to have passed Industrial Examination when the average scores of supervisors and the examiners greater than or equal to 60.
ASSESSMENT GUIDELINE

Industrial Training valuation consist of two components: industrial training report and special assignment report with the each percentage

1. Industrial Training report : 30%
2. Special assignment report : 70%
APPLICATION LETTER
Industrial Training

Dear Coordinator of Industrial Training
Department of Chemical Engineering
Diponegoro University
Semarang

Sign below is the Academic Supervisor of the students:

Name : .................................................
ID : ...........................................................

It is notified that the students have the qualification to apply for Industrial Training.

Semarang,
Academic Counselor,

_________________________
ID.
Dear __________________

Supervisor of Industrial Training
Department of Chemical Engineering
Diponegoro University
Semarang

We kindly willingness to provide guidance of Industrial Training to students:

Name / ID : ........................................................................................................
Name / ID : ........................................................................................................
Industry : ...........................................................................................................
Date start guidance : ........................................................................................

Thank you very much for the attention.

Semarang,
Coordinator of Industrial Training

________________________________________
ID.
INDUSTRIAL TRAINING ASSIGNMENT LETTER

Number:

Dean of the Faculty of Engineering, University of Diponegoro ordered to Students:

1. Name : .................................................................
2. ID : .................................................................
3. Program : ............................................................
4. Home Address : ...................................................

To perform Duty of Industrial Training for ... (.........) month, starting from date ............. in Industry ....
We hope all relevant agencies to provide assistance as necessary, and report to us if the student is not performing their duties properly Industrial Training.

Semarang,
On behalf of Dean
Head of Dept. of Chemical Engineering

Dr. Ir. Budiyono, M.Si.
NIP. 196602201991021001
# Log Book
## Industrial Training

**Name:** .................................................................

**ID:** ..................................................................

**Industry:** ..................................................................

**Date start guidance:** ..................................................................

**Supervisor:** ..................................................................

<table>
<thead>
<tr>
<th>No.</th>
<th>Date</th>
<th>Description</th>
<th>Sign</th>
<th>Annotation</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Semarang,
Supervisor,

_________________________
ID.
CHAPTER 1 INTRODUCTION
1.1 Background
1.2 TIU
1.3 TIK

CHAPTER 2 PROCESS DESCRIPTION
2.1 Process Concept
2.2 Process Flow Diagram
2.3 Step of Process

CHAPTER 3 ACTIVITY PLAN

References
Appendix
Industrial Training Proposal cover format

INDUSTRIAL TRAINING PROPOSAL

INDUSTRIAL TRAINING PROPOSAL IN ____________

By:

(Name of Student)
ID. ......................................................

DEPARTMENT OF CHEMICAL ENGINEERING
UNIVERSITAS DIPONEGORO
SEMARANG
2013
Name  :

ID  :

Industry  :

Semarang,
Supervisor

____________________
ID.
FRAMEWORK OF THE INDUSTRIAL TRAINING REPORT

Title Page
Endorsement Page
Preface
Contents
Table of contents
List of pictures
Abstract
CHAPTER 1  INTRODUCTION
  1.1  The background of factory building
  1.2  Location of factory
  1.3  Raw material and products
  1.4  Structure of organization
CHAPTER 2  DISCRIPTION OF PROCESS
  2.1  Concepts of process
  2.2  Design structure for process
  2.3  Description of process
CHAPTER 3  SPECIFICATION OF TOOLS
  3.1  Main Equipment
  3.2  Proponent Equipment
CHAPTER 4  UTILITY
  4.1  Water Supply
  4.2  Steam Supply
  4.3  Electricity Supply
  4.4  Compressed Air Supply
  4.5  Waste Treatment
CHAPTER 5  LABORATORY
  5.1  The Work Program of Laboratory
  5.2  The main equipment in the laboratory
REFERENCES
APPENDICES
INDUSTRIAL TRAINING REPORT

INDUSTRIAL TRAINING REPORT IN PT PUPUK KALTIM

by:

(Student name)
ID. ..........................................................
FRAMEWORK OF THE SPECIAL ASSIGNMENT REPORT

Title Page
Endorsement Page
Preface
Content
Abstract
CHAPTER 1 INTRODUCTION
  1.1 Background
  1.2 Problem Definition
  1.3 Purpose
  1.4 Benefit
CHAPTER 2 LITERATURE REVIEW
  (Content a relevant basic theory with the problems)
CHAPTER 3 PROBLEM SOLVING
  3.1 Technical data
  3.2 Data processing
CHAPTER 4 RESULT AND DISCUSSION
  4.1 Result
  4.2 Discussion
CHAPTER 5 CLOSING
  5.1 Conclusion
  5.2 Recommendation
REFERENCES
APPENDICES
SPECIAL ASSIGNMENT REPORT

PERFORMANCE EVALUATION OF THE CATALYST IN THE PRIMARY REFORMER KALTIM III

By:

(Student Name)
ID. ..............................................

FACULTY OF ENGINEERING
DEPARTMENT OF THE CHEMICAL ENGINEERING
DIPONEGORO UNIVERSITY
SEMARANG
2013
Name : 
ID : 
Title : 

Semarang, 
Supervisor 

____________________ 
ID.
INDUSTRIAL TRAINING ASSESSMENT

Name : ...........................................................................
NIM : ...........................................................................
Industry : ...........................................................................
Special Assignment Title : ...........................................................................

REPORT OF INDUSTRIAL TRAINING

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SPECIAL ASSIGNMENT REPORT

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Semarang, .........................
Academic Supervisor ,

___________________________
NIP.
5.3  TKK 357: RESEARCH PROPOSAL (1 SKS)

GENERAL INSTRUCTIONAL OBJECTIVES
The student capable to make a research proposal according to the writing rules in a research proposal.

SPECIFIC INSTRUCTIONAL OBJECTIVES
The student capable to:
1. Identify, choose, and formulate the problem.
2. Collect information from study of literature / secondary data.
3. Establish hypothesis based on logic or theory that obtained from study of literature (except for research in engineering).
4. Design an experiment (independent variable and dependent variable), the way to collect data / information, design/assemble and operate a research tools, and also choose the instruments.
5. Make a research proposal according to the rules
6. Make a presentation of the research proposal that will be held publicly.

REQUIREMENT
1. The students have been through the entire lab and the students have taken a Methodology of Research.
2. The students has obtained at least 100 credit hours
3. The students have been registered in KRS.

PROCEDURE
1. Register to the Coordinator of the Final Assignment by showing the KRS.
2. The Research Coordinator makes a letter of the appointment of lectures (form PP-1).
3. The student and the lecturer determine a title and research problem.
4. The student report to the Coordinator of the Final Assignment if there’s no duplication.
5. The student establishes a research proposal.
6. The student makes a presentation for the seminar of the research proposal.

**PROVISION**

1. Preparation of the research proposal for 1 semester, started by filling the KRS (Study Plan Card)
2. If the preparation of the research proposal is more than 1 semester, the research proposal will be included in the next KRS.

**SUPERVISING GUIDELINE**

1. The Supervisor gives a direction in the determination of the title and research problem.
2. The Supervisor has to give a direction in making the proposal and the presentation of the research proposal.

**ASSESSMENT GUIDELINE**

The assessment of the research proposal consists of 2 components:

1. The Surveyor and the Examiner of the research proposal will value all the points of the valuation (PP-3 Form).
2. The Portion value of the Surveyor is 70% and the Examiner is 30%.
FRAMEWORK OF THE RESEARCH PROPOSAL

Title Page
Endorsement Page
Summary
Preface
Table of Contents
List of Tables*
List of Figures*
List of Appendices
BAB 1 INTRODUCTION
  1.1 Background
  1.2 Problem definition
  1.3 Purpose of the Research
BAB 2 LITERATURE REVIEW
BAB 3 RESEARCH METHODS
  The Experimental Design
  Materials and Equipment
  The sequence of tools figure
  Procedure
BAB 4 IMPLEMENTATION SCHEDULE
REFERENCES
APPENDICES

* If needed

=====================================================================
EXPLANATION:

- **Acknowledgements**
  Acknowledgement contains a brief description about the purpose of the research and the expression of the thankful.

- **Summary**
  Summary contain a brief description about background, problems, purpose, research method, result, and when the research begin.

- **Background**
  Background contain an explanations about why the problem looks interest, important, and needs to be examined.

- **Problem definition**
  Problem definition contains an explanation about the problem that will be examined. This part is needed to explain about the approach and concept to
answer the problem that will be examined, and to answer the hypothesis that will be examined or a suggestion that will be proven.

- **The Purpose of the Research**
The purpose of the research contains a brief statement about the purpose of the research that will be reached.

- **Literature Review**
The Literature review contains some studies that create an idea and underlie a basic in a research. The literature review explains theory, discovery and another material of the research that we can get from reference, which it is a basic to do an experiment. The content of the literature review can be a basis to establish a framework or concept that will be used in experiment. The point of the Literature review is in the Reference. Literature review should contain a new literature, relevant, and original from the scientific journal, book, papers, etc.

- **The Method of the research**
The method of the research contains the description about the method that will be used in the research. That description is included by variable in the research, the model, research design, data collection technique, and data analysis, the way of interpretation and the conclusion of the research. The research that used the qualitative method, can be explained with an approach, a process to collect and analysis information, process of interpretation and the conclusion of the research.

- **Implementation Schedule**
The Implementation schedule includes a preparation activity, implementation and preparation of research report in the form of bar-chart. The point of the Implementation schedule is in the method of the research.

- **References**
References contain a literature that referred by the presentation of the research proposal and arranged down in the last name the writer alphabetically. All writers have to show their name (there’s no et al.).

- **Appendices**
The Appendices contain:
  - Processing of data
  - Analysis procedures
RESEARCH PROPOSAL

KOEFISIEN PERPINDAHAN MASSA
PADA SISTEM CAIR-CAIR
AMYL ASETAT - AIR

By:

Name of student  NIM. ..................
Name of student  NIM. ..................

FACULTY OF ENGINEERING
DEPARTMENT OF CHEMICAL ENGINEERING
DIPONEGORO UNIVERSITY
SEMARANG
2013
Endorsement Page

RESEARCH PROPOSAL

Name / ID :

Name / ID :

Title:

Semarang,
Supervisor

__________________
ID.
SUPERVISOR APPOINTMENT LETTER

Dear _______________________

Research Supervisor
Department of Chemical Engineering
Diponegoro University
Semarang

We kindly willingness to provide mentoring and research proposal to students:

N a m e/ID : _________________________________
N a m e/ID : _________________________________

Thank you very much for the attention.

Semarang,
Coordinator of the Research

___________________
ID.
WILLINGNESS TO GUIDE A RESEARCH PROPOSAL

I hereby declare willing / unwilling *) to provide mentoring and research proposal to students:

Name / ID : ........................................................................................................
Name / ID : ........................................................................................................
Title : ........................................................................................................

........................................................................................................

................................................................

Semarang,

____________________
ID.

*) strikeout unnecessary

This sheet is returned on Research Coordinator
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Supervisor:

Date:

Declared finished:

Research Proposal

CONSULTATION SHEET

PP2 Form
# ASSESSMENT SHEET OF RESEARCH SEMINAR PROPOSAL

**Name**: ...........................................................

**ID**: ...........................................................

**Title**: ..........................................

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Semarang, ....................................

Examiner

_________________________

ID.
5.4 TKK 366: RESEARCH (2 SKS)

OVERVIEW

Research is intended to provide experience to students to undertake a series of activities / experiments in order to answer the problems associated with chemical engineering, based on scientific principles and research methodology. The activity is initiated from problem identification, problem definition, hypotheses, designing experiments, methods, analyzes, to conclusions. The type of research done in accordance with the field of chemical engineering is experimental research, which can be classified in the field of fundamental research as well as applied research. According to the area concerned, the method of analysis or data processing can be performed descriptively, statistically, and modeling.

Some things are expected from research in Department of Chemical Engineering are:
- The topic is up to date,
- The results of the research may be published on the seminars and journals, both national and international,
- The research is an ongoing process,
- It is the work of student researchers and supervisor lecturers,
- Train students to think creatively, systemic, analysis, and synthesis as a basis of further studies.

Implementation of research conducted through two stages, namely the writing research proposals and conducting research. Some basic rules of supervision and evaluation process needs to be set, namely:
- It is preferably that research topic related to elective subject taken by students
- Seminar of research proposal and research result is open
- Seminar of research proposal and research result is leaded by research supervisor and examined by other lecturers (1-2 lecturers)

Flow of final assignments started from Research Proposal to Research Implementation is outlined in Figure 2.

GENERAL INSTRUCTIONAL OBJECTIVES

Students are able to carry out the steps of the scientific research in accordance with the proposals that have been presented at seminar.
SPECIFIC INSTRUCTIONAL OBJECTIVES

Students are able to:
1. Design and assemble equipment of research,
2. Use the instrument / equipment for analysis,
3. Collect data / information,
4. Prepare, process, and analyze data,
5. Interpret, discuss and conclude the research,
6. Create a research report in accordance with applicable regulations,
7. Writing a research output in the form of article.

PREREQUISITE

1. Passed the Proposal Research.
2. Registered in KRS

PROCEDURE

1. Conducting experiments in the laboratory according research proposal.
2. Reporting experimental results to the Supervisor in the form of journal (form TP-1).
3. Preparing a written report.

REQUIREMENT

1. The timing of Research is 1 semester.
2. If the time of Research exceeds 1 semester then Research is continued at the next semester and registered in KRS.
3. Research is conducted at the Laboratory in the Department of Chemical Engineering.

SUPERVISING GUIDELINE

1. Supervisor shall supervise the implementation of the research.
2. Supervisor shall direct at the time of data analysis, discussion, and conclusion.
3. Observation data to be signed by the Laboratory Assistant daily / weekly (form TP-1).
EXAMINATION GUIDELINE
1. Examinations held in the specific period and was adjusted to the academic calendar.
2. Students, who have completed research assignment, eligible to take the exam.
3. Students are required to write a paper that will be presented in front the examiner and the other examinees.
4. Writing a paper:
   Basically, contents of paper does not vary much to research report. The difference lies in the format. Paper does not require the introduction and summary, but it requires abstract. The number of pages of paper are less than the research report.
5. Before the exam, students must fulfill the administrative requirements, such as :
   a. Paper that have been signed by supervisor (4 exp)
   b. College transcript
6. After completing the administrative requirements, Research Coordinator establish the examiner.
7. The exam guided by Supervisor and attended at least one other examiner and ten students
8. Allocation of time, 20 minutes for presentation and 10 minutes for question and answer.
9. Students required to wear a white long sleeve shirt, tie, and black skirt/pants.
10. Minutes and scores of examination submitted to the Research Coordinator
11. Students can be declared to have passed Industrial Examination when the average scores of supervisors and the examiners greater than or equal to 60.

SYSTEMATICS PAPERS
1. Title: capital letters
2. Abstract: consisting 75 – 250 words
3. Introduction
4. Experiment
5. Result and discussion
6. Conclusions
7. Acknowledgments
8. References
**ASSESSMENT GUIDELINE**
Assessment of Final Assignment/Thesis consists of two components:

1. Supervisor and Examiners of Thesis assess all assessment points.
2. Portion of Supervisor 70% while Examiner 30%.
THE FRAMEWORK OF RESEARCH REPORT

Title Page
Endorsement page
Summary
Foreword
List of Content
List of Table*
List of Figure*
List of Appendix*
CHAPTER 1 INTRODUCTION
  1.1 Background
  1.2 Problem Definition
  1.3 Objectives
CHAPTER 2 LITERATURE REVIEW
CHAPTER 3 RESEARCH METHOD
  3.1 Experimental Design
  3.2 Material and Equipment
  3.3 Procedure
CHAPTER 4 RESULT AND DISCUSSION
CHAPTER 5 CONCLUSION (AND RECOMMENDATION*)
Reference

Appendices:
  - Research data
  - Processing data
  - Supporting data
  - Analysis procedures

* If needed

EXPLANATION:

- **Introduction to Chapter 3**
  Explanation same as those in the Research Proposal

- **Result and Discussion**
Result can be presented in processed tables, charts, photos, or equation/model. The discussion can be done through theoretical explanations qualitatively, quantitatively, or statistically. It is preferably that result is compared with the result of previous similar studies.

- **Conclusion and Recommendation**
  Conclusion and recommendation should be stated separately. Conclusion is a brief statement to answer the problem based on the result and discussion. Recommendation is made based on experience and consideration of writer, addressed to other researchers, who want to continue or develop the research. Recommendation is not a necessity.

- **Reference**
  The literature contains only the libraries referenced in the presentation of research and compiled down alphabetically by author last name first.

  **Books**: author’s name, tittle of book, edition, publisher, city publisher, year, the reference page
  Example:

  **Journals**: author’s name, tittle of book, name of the journal with the official abbreviation, year, and the reference page
  Example:

  **Patent**: author’s name, country, patent code, and year
  Example:
ENDORSEMENT PAGE

RESEARCH REPORT

Name/ID : 
Name/ID : 
Title : 

Approved, 
Supervisor

_____________________
NIP.

Leader of Examiner Team

_____________________
NIP.

Approved, 
Vice Dean I Faculty of Engineering

Ir. Bambang Pudjianto, M.T. 
NIP. 19521205 198503 1 001
## LOGBOOK

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Semarang, ....................................
Supervisor

_________________________
ID.
# ASSESSMENT FORM

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**NIM**: ...........................................................

**Title**: .................................................................................................................................

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Semarang, .............................................

Examiner

.............................................

ID.
AIS OVERVIEW

Academic Information System (AIS) is an application designed and built to process data related to academic administration. AIS meets the needs of the parties relating to the academic process at all levels. AIS is an academic information system that integrated to the entire Faculty of Engineering, University of Diponegoro (students, faculty, and department managers).

AIS is made to be accessible by multiple levels of users. Each user will get a limited menu in accordance with access rights. Students as one of the users have access rights to run applications that relate to students, such as information on class schedules, course, CPC, exam results, and student transcripts. The menu is also provided facilities for the students fill out the on-line CPC.

STARTED WITH AIS

- On the computer that is connected to the network of AIS, the initial appearance will be as Figure A.1 with the address: http://sia.ft.undip.ac.id:

![Initial Appearance of AIS](image)

Figure A.1 The initial appearance of Academic Information System

- Next select your department or program of study; to be selected in Chemical Engineering: Regular I or Regular II by directing your pointer on the program and left click once, then it will appear as Figure A.2.
Enter the Login ID and password with your Student Identification Number (SIN).

Next, you will get the required information, as shown in Figure A.3.

Caution: you are expected to change your password and fill out your personal data.

If you get in trouble for not being able to access, then you can contact the admin of Chemical Engineering Study Program.

Facility of Entry Menu and Information for the group of students is as follows:

**FILLING COURSE PLAN CARD (CPC)**

This sub menu is used to fill the course plan card (CPC) of student in active semester. If the student in active semester has not filled CPC and the filling time is still allowed, then the initial display after submenu option of course plan card (CPC) filling is clicked can be shown in Figure A.4.

Figure A.4 is a submenu for the old students, meaning students who have taken previous courses. For new students, the course has not yet appeared. Then student follows the following steps.

- First cancel the courses last semester, by checking all the existing courses, followed by clicking Cancel checked courses button (Figure A.5).
- Then select the above course (Figure A.4) and click the Add to list button.
- Set class status (if any).
- To cancel, click the cancel button at the lower side.
- Once all filled, save by clicking the Save changes button.
Then select the above courses (Figure A.4) and click the Add to the list button.

- Set class status (if any).
- To cancel, click the cancel button at the lower side.
Once all filled, save by clicking the Save changes button.

- Hopefully, you fill out your data on the entry menu | Entry title of thesis and other data. On this submenu students can fill out their personal data included parents. To store entry data, the save button is pressed and will automatically return to the main menu. If you want entry data is not stored, then the cancel button is pressed, and the display will also return to the main menu. Both buttons are located above and below have the same function.

On the Information menu, student can see the necessary information and contact with other students.
All reports (Industrial Training Report, Special Assignment Report, Research Proposal, and Thesis) prepared by following the format as described below.

MATERIAL AND SIZE
- For manuscripts in hard copy form, must be printed on A4 paper 70 g/m² HVS one face, bound in hard cover with a cover of dark blue color (‘Engineering Faculty’ blue).
- For manuscripts in soft copy form, the file must be saved in pdf format.

LANGUAGE
- The language used is standard Indonesian.
- If use foreign terms, then the term should be italicized.

TYPING
- Font:
  - Text : Times New Roman 12 point
  - Chapter title : Times New Roman 16 point, capital, bold
  - Subchapter title : Times New Roman 12 point, capital, bold
- Line spacing:
  - Text : 1.5 space
  - Intisari/Ringkasan/Summary: 1 space
  - Tabel/figure title : 1 space
  - Chapter title and text : 3 space
  - Move subchapter : 2 space
- Margins:
  - Top : 3 cm; bottom : 2 cm; left : 3 cm; right : 2 cm;
  - New paragraph started 1 cm from the left margin.
- No header/footer.
- The letter that represents a quantity should be printed in italics.
- Number, symbol, or chemical formula that begins a sentence should be spelled, e.g.: Ten kilograms ............

PAGE NUMBERING
- The initial report, from the title page to the summary page, is numbered with small Roman numerals.
- The main part, from Chapter I to the end, is numbered with Arabic numerals.

**TABLE**
- Table is placed in the middle of text.
- There is no vertical lines separating columns.
- There is no horizontal lines separating rows except on the column headings and the bottom of tables.
- Table title is placed above the table with centered mode and numbered in order including the chapter number.
- If necessary, place footnote at the bottom of the table and write as superscript with lowercase letters.
- Example:

  ![Table 2.1](image)

**FIGURE**
- Figure is placed in the middle of text.
- Figure title is placed under the figure centered mode and numbered in order including the chapter number.

**EQUATION**
- Chemical reaction and mathematical equation are placed 1 cm from left margin.
- Chemical reaction and mathematical equation are numbered including the chapter number written in parenthesis and placed on the right edge.
- Example:

  \[ A + B \rightarrow C + D \]

  \[ P = \frac{RT}{V} \]
REFERENCES

- **Citation in the text**
  - Any reference cited in the report should appear in the References, and vice versa.
  - References in the form of research result that have not been published and personal communications must be written by replacing the date of issue with “unpublished result”, or “personal communication”, or “in press”.

- **References from web**
  - The full URL should be listed along with the date of access.
  - More information, if known (DOI / Digital Object Identifier, the name of the author, date, etc.) should be included.

- **Writing method**
  - **In text**
    All citations in the text must follow the rules:
    - Single author: name of author and followed by publication year. Example: ”..........as reported (West, 2008).”
    - Two authors: names of two authors and followed by publication year. Example: ”.......... as reported (Sudirman and West, 2008).”
    - Three or more authors: name of first author followed by “et al.” and publication year. Example: ”.......... as reported (Sudirman et al., 2008).”
    - The reference group should be sorted alphabetically, then chronologically. Example: ”.......... as reported (West, 2007a, 2007b, 2008; Allan and Jones, 2002; Warsito et al., 2003).”
  - **In references**
    References should be sorted alphabetically, then chronologically if necessary. If more than one reference written by the author and published in the same year, the reference must be marked "a", "b", "c", etc. placed behind the year of issue.
    Example:
    - References of publication in journal
    - References of book
Macmillan, New York.

- References of a chapter in a book

- References of patent

- References of thesis/dissertation
GENERAL INSTRUCTIONS
The article was written without page numbers and structured by the sequence of topics: Introduction, Research Methods (or Model Development), Results and Discussion, Conclusions, Acknowledgments (if any), List Notation (if any) and References. Abstract is written in 2 (two) languages, namely Indonesian and English.

WRITING INSTRUCTIONS
Way of articles writing following report writing.