CURRICULUMS

OF

THE CHEMICAL INDUSTRY TRAINING &

DEVELOPMENT CENTER IN INDONESIA

JULY. 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

Subject; Mathematics

For Faculty of Chemical Engineering
For Faculty of Mechanical Engineering

	Curriculums	Lecturing Hours
1.	Number and Formulas	7
	1.1 Real Numbers	
	(1) Caluculation of Real Numbers	
	(2) Caluculation of Square Roots	
	(3) Real Numbers and Number Lines	
	1.2 Polynominals	
	(1) Four Operations of Polynominals	
	(2) Expansions and Factorizations	
	(3) Measures and Multiples	
	1.3 Fractional Expressions and Proportional Expressions	
	(1) Fractional Expressions and its Calculations	
	(2) Proportional Expressions	
2.	Equations and Inequalities	10
	2.1 Quadratic Equations	
	(1) Complex Numbers	
	(2) Formulas of Solutions of Quadratic Equations	
	(3) Relationship of Solutions and Coefficients	
	2.2 Various Equations	
	(1) Equations of Degree more than Three and Factor Theorem	

(1) Points and Coordinates

(2) Straight Lines

7.2 Quadratic Curves

(1) Equations of Circles

(2) Circles and Straight Lines

(3) Quadratic Curves

7.3 Various Expression of Curves

(1) Parametric Representations

(2) Polar Coordinates

7.4 Domains Expressed by Inequalities

(1) Domains Expressed by Inequalities

(2) Applications in Domains Expressed by Inequalities

8. Vectors 8

8.1 Vectors and the Calculations

(1) Geometrical Vectors

(2) Addition of Vectors and Scalar Multiple of Vectors

(3) Number Vectors

(4) Linear Independence

8.2 Inner Products and Outer Products

(1) Inner Products

(2) Outer Products

9. Matrix and Determinant 10

9.1 Linear Transformation and Matrix

(1) Linear Transformation and Matrix

9.2 Calculation of Matrixes

(1) Definition of Matrixes

(2) Equality, Sum and Scalar Multiple of Matrixes

(3) Product of Matrixes

(4) Square Matrixes

9.3 Quadratic, Cubic Determinants

(1) Linear Transformation Matrixes and Determinants

(2) Properties of Determinants

(3) Quartic Determinants

10. Differential and Integral 13

10.1 Differential Calculus

(1) Increase and Decrease of Functions

(2) Average Rate of Changes

(3) Limits of Functions

(4) Differential Coefficients

(5) Derivatives

(6) Increase and Decrease of Functions and Derivatives

(7) Maximum and Minimum of Functions

10.2 Integral Calculus

(1) Definite Integral

(2) Indefinite Integral

(3) Applications of Definite Integral

11. Differential Calculus and its Applications 20

11.1 Limit and Continuance

(1) Limit of Functions

(2) Continuance of Functions

11.2 Differential Calculus

(1) Derivatives

(2) Derivatives of Quotient

(3) Derivatives of Composite Functions

(4) Derivatives of Inverse Functions

11.3 Applications of Derivatives

(1) Mean Value Theorem

(2) Increase and Decrease of Functions

(3) Concavity and Covexity of Curves

(4) Applications for Physics

(5) Approximate Expression

(6) Approximate Values of Real Root of Equations

(7) Differential

12. Integral Calculus 19

12.1 Indefinite Integral

(1) Basic Formulas of Indefinite Integral

(2) Integration by Substitution and Integration by Parts

(3) Simple Differential Equations and their Applications

12.2 Definite Integral

(1) Definite Integral

(2) Properties of Definite Integral

(3) Definite Integration by Substitution and Definite Integration by Parts

(4) Integral in the Wider Sense

12.3 Applications for Definite Integral

(1) Area

(2) Volume of Solids

(3) Length of Curved Lines

(4) Surface Area of Solids of Revolution

(5) Curvatures of Curved Lines and Circles of Curvature

(6) Mean Value, Center of Gravity, Moment of Inertia

(7) Other Applications

.3. Partial Differentiation 8

13.1 Partial Derivatives

(1) Functions of Two Variables

(2) Partial Derivatives

(3) Partial Derivatives of Higher Order

(4) Total Differential

13.2 Applications of Partial Differentiation

(1) Implicit Functions

(2) Maximum and Minimum

14. Ordinary Differential Equations of First Order 10

14.1 Direction Fields which are most Simple and Integrable

(1) Direction Fields and Solution Curves

(2) Seperation of Variables

(3) Similar Figure Differential Equations

(4) Simple Cases Reducible to Similar Figure

14.2 Linear Differential Equations of First Order

(1) Homogeneous Equations, Inhomogeneous Equations and Trivial Solutions

(2) Solutions of Homogeneous Equations

(3) Solutions of Inhomogeneous Equations

Total 150 HRS

Subject; Physics

For Faculty of Chemical Engineering
For Faculty of Mechanical Engineering

	Curriculums	Lecturing Hours	Exercising Hours
1.	Forces and Motion		
	1.1 Motion	10	2
	(1) Relativity of Motion and Material Particle		
	(2) Units		
	(3) Linear Motion of Uniform Velocity		
	(4) Motion of Falling Objects		
	(5) Velocity and Acceleration of General Linear Motion		
	(6) Vectors and Scalar, Motion of Material Particles on a Plane		
	1.2 Forces and Laws of Motion	6	2
	(1) Concept of Forces		
	(2) The First Law of Motion		
	(3) The Second Law of Motion		
	(4) Units of Forces and Inertial System		
	(5) The Third Law of Motion		
	1.3 Other Various Motions	6	2
	(1) Projectile Motion		
	(2) Uniform Velocity Circle Motion		
	(3) Motion of Planets and Universal Gravitation		
	(4) Force of Inertia		
	(5) Centrifugal Force, Rotation of the Earth and Gravity		

1.4	Momentum	6	1
(1)	Momentum and Impulse		
(2)	The Law of Conservation of Momentum		
(3)	Collision Coefficient		
(4)	Dimension		
1.5	Forces which Act on Objects	6	1
(1)	Resultant Force and Component of Force		
(2)	Solids and Atom		
(3)	Tension and the Opposed Force		
(4)	Eleasticity in Streching		
(5)	Shearing Modulus		
(6)	Friction Forces		
1.6	Forces which Act on Rigid Bodies	8	2
(1)	Rigid Bodies		
(2)	Moments of Forces		
(3)	Composition of Forces Acting on a Rigid Body		
(4)	Balance of Forces Acting on a Rigid Body		
1.7	Reposing Fluid	4	1
(1)	Pressures inside of Fluid		
(2)	Pressures by Gravity		
(3)	Buoyancy		
1.8	Mechanical Energy	6	1
(1)	Works		
(2)	Mechnical Energy		
1.9	Simple Harmonic Motion and The Law of Mechanical Energy Conservation	4	1
1.10	Motion of Fluid and The Law of Mechnical Energy Conservation	2	1

2.	Temperature and Heat	16	6
	2.1 Natures of Heat		
	(1) Heat Balance and Temperature		
	(2) Heat Capacity and Specific Heat		
	(3) The Gas Law		
	(4) Molecular Motion of Gas		
	(5) Heat Quantity and Work		
	(6) The First and The Second Law of Thermodynamics		
	2.2 Physical Properties of Heat		
	(1) Heat Expansion		
	(2) Heat Conduction		
3.	Wave Motion	10	4
	3.1 Waves		
	(1) Transverse Wave and Longitudinal Wave		
	(2) Wave Length, Period and Frequency		
	(3) Sine Wave		
	3.2 Mechanism of Waves and Velocity of Waves		
	(1) Elastic Waves		
	(2) Sound Waves		
	(3) Water Waves		
	3.3 Combinations of Waves		
	(1) Principles		
	(2) Standing Wave		
	(3) Beat		
	3.4 Traveling Way of Waves		
	(1) Heugens' Principle		
	(2) Reflection and Refraction		
	(3) Doppler Effect		

4.	Light	10	4
	4.1 The Speed of Light		
	4.2 Interference of Light		
	(1) Newton's Rings		
	(2) Interference by Thin Layers		
	4.3 Diffraction of Light		
	(1) Diffraction by a Single Slit		
	(2) Diffraction by Two Slits		
	(3) Diffraction by Multi Slits		
	4.4 Polarized Light		
	(1) Polarized Light		
	(2) Polarized Light by Reflection		
	4.5 Optical Devices		
	(1) Lenses		
	(2) Conbinations of Lenses		
	(3) Aberration		
	(4) Resolving Power		
	(5) New Optical Devices		
5.	Electromagnetism	32	7
	5.1 Electrostatic Field		
	(1) Electric Charge		
	(2) Coulomb's Law		
	(3) Electric Field and Electirc Potential		
	(4) Electrostatic Capacity		
	(5) Dielectrics		
	5.2 Stationary Electric Current		
	(1) Electric Potential Difference and Electric Current		
	(2) Direct Current Cercuits		
	(3) Work done by Current		

5.3 Electric Current and Magnetic Field

(1) Magnetic Charge

(2) Magnetic Field of Magnets

(3) Magnetization of Magnetic Bodies

(4) Magnetic Field Generated by Current

(5) Forces which Current is affected by Magnetic Field

(6) Electromagnetic Induction

5.4 Alternating Current

(1) Sine Wave Alternating Current

(2) Alternating Current Circuits

(3) Electric Power of Sine Wave Alternating Current

(4) Transformer

(5) Three-phase Current

5.5 Electromagnetic Wave

(1) Electric Oscillation

(2) Electromagnetic Wave

(3) Classification of Electromagnetic Wave

6. The World of Atoms 14

6.1 Atomic Constitutions of Substances

(1) Existence of Atoms and Molecules

(2) X-ray Diffraction and Disposition of Atoms

6.2 Electrical Properties of Ions and Electrons

(1) Existence of Elementary Charge

(2) Measurement of Specific Charge and Discovery of Electrons

(3) Electric Conductance

(4) Applications of Thermoelectronic Emission

(5) Semiconductors and their Applications

6.3 Structure of Atoms

(1) Hypothesis about Structure of Atoms

(2) Scattering of α-rays and Rutherford Model

6.4 Corpuscular Character of Light and Wave Nature of Electrons

(1) Corpuscular Character of Light

(2) Wave Nature of Electrons

(3) Relationship of Corpuscular Character and Wave Nature

(4) Electrons within Atoms

6.5 Elementary particle

(1) Elementary Particle

(2) Cosmic Ray

(3) Cyclotron

Total	140 HRS	35 HRS

Subject; Experiments of Physics

For Faculty of Chemical Engineering
For Faculty of Mechanical Engineerin

	Curriculums	Experimenting Hours
1.	Measurment of Gravitational Acceleration Speed	3
2.	Hooke's Law and Vibration of Spring	3
3.	Measurment of Specific Gravity of Solids	3
4.	Measurment of Specific Heat of Solids	3
5.	Measurment of Vibration Frequency of a Tuning Fork	3
6.	Measurment of Focal Distance of Lenses	2
7.	Measurment of Electromotive Force and Internal Resistance of Batteries	3
8.	Measurment of Electric Resistance of Metals	3
9.	Measurment of Heat Equivalent by Electric Current	3

10.	Discrimination of Types and Electrodes of Transistors	2
	Total	28 HRS

Subject; Chemistry

For Faculty of Chemical Engineering
For Faculty of Mechanical Engineering

	Curriculums	Lecturing Hours
1.	Particle of a Gas	14
	1.1 Volume Change of Gases	
	(1) Pressure-Volume relationships of Gases	
	(2) Temperature-Volume relationships of Gases	
	(3) Temperature-Volume-pressure relationships of Gases	
	1.2 Molecular Model of a Gas	
	(1) Movement of Gaseous Molecules	
	(2) Molecular Model	
	1.3 Atoms and Molecules	
	(1) Atoms	
	(2) Molecules	
	1.4 Avogadro's Hypothesis and Molecular Weight, Atomic Weight	
	(1) Avogadro's Hypothesis	
	(2) Avogadro's Number and Molecular Weight	
	(3) Atomic Weight and Molecular Weight	
	1.5 Equation of State of Gases and Molecular Weight	
	(1) Equation of State of Gases	
	(2) Real Gas and Ideal Gas	
	(3) Pressure of a Mixture of Gases	

1.6 Molecular Formulas and Equations for Chemical Reaction

(1) Determination of Molecular Formular

(2) Equation for Chemical Reaction

2. Solids and Liquids 2

2.1 Changes of State of Matter

(1) Volume of Solid and Liquid

(2) Changes of State and Energy

(3) Equilibrium and Phase Rule in Phase Changes

2.2 Particles composing Solids and Liquids

(1) Crystals and Amorphous Solids

(2) Structure of Crystal

(3) Particles composing Crystals

(4) Ions and Atoms

2.3 Nature of Matter and Bonding of Particles

(1) Nature of Matter

(2) Bonding of Particles

2.4 Solution

(1) Mechanism of Dissolution

(2) Movement of Particles in a Solution

3. Atomic Structure and Chemical Bonds 4

3.1 Spectrum of Hydrogen

3.2 Atomic Model

(1) Orbitals in the Structure of the Atom

(2) Electron Configurations of Atoms

3.3 Ionization Energy

3.4 Chemical Bonds
(1) Ionic Bond
(2) Covalent Bond
(3) Coordinate Bond
(4) Dipole Moments of Molecules

3.5 Atomic Nucleses

4. Periodic Law of Elements 8
4.1 Stability of Inert Gases

4.2 Characteristics of Alkali Metals
(1) Properties of Alkali Metals
(2) Chemical Reactions of Alkali Metals

4.3 Characteristics of Halogens and Hydrogen
(1) Properties of Halogens
(2) Chemical Reactions of Halogens
(3) Properties and Chemical Reactions of Hydrogen

4.4 The Periodic Table of the Elements

4.5 Electron Configurations of Typical Elements

5. Chemical Reaction and Energy 8
5.1 Heat of Reaction, Heat of Formation

5.2 Thermochemical Equation

5.3 Heat Content of Substance

7. Solubility Equilibrium and Properties of Solution 8

7.1 Solubility Equilibrium

(1) Mechanism of Disolution and Solubility

(2) Factors which Decide Solubility of Solids

(3) Factors which decide Solubility of Gases

(4) Equilibrium of Electrolytes Solution

(5) Concentration of Solution

7.2 Properties of Solutions

(1) Elevation of Boiling Point and Depression of Freezing Point

(2) Osmotic Pressure

(3) Colloid

8. Reactions of Acids and Bases 14

8.1 Degree of Acidity and Basicity

(1) Acids and Bases

(2) Degree of Acidity and Basicity

8.2 Electrolytic Dissociation of Water

8.3 Concentration of H^+ and pH

(1) Relation between Concentration of H^+ and pH

(2) Measurement of pH

8.4 Neutralization of Acids and Bases

(1) Equivalent weight of Acids and Bases

(2) Normality

(3) Neutralization Titration

8.5 Hydrolysis of Salts and Buffer Solutions

(1) Hydrolysis of Salts

(2) Buffer Solutions

8.6 Reactions of Salts

8.7 Acids and Bases in a Wide Sense

9. Oxidation-Reduction Reactions 10

9.1 Oxidation, Reduction and Electron Transfer

9.2 The Chemistry of an Electrochemical Cell

9.3 Oxidation Number

10. Elements of Period 3 10

10.1 Physical Properties

10.2 Comparison as Oxidizing Agents and Reducing Agents

(1) Sodium, Magnesium, Alminium (Strong Reducing Agents)

(2) Silicon, Sulphur (Moderate Oxidizing, Reducing Agents)

(3) Chlorine (Strong Oxidizing Agents)

10.3 Acidity and Basicity of Hydroxides

(1) Sodium Hydroxides and Magnesium Hydroxides (Strong Base)

(2) Aluminium Hydroxides (Amphoteric)

(3) Hydroxides of Silicon, Phosphorus, Sulphur, Chlorine (Oxyacid)

11. Transition Elements 8

11.1 Transition Elements and Electronic Configurations

11.2 General Properties of Transition Elements

11.3 Complex Ions and Complex Salts

11.4 Structures and Functions of Complexes

(1) Structures of Complexes

(2) Functions of Complexes

(3) Chelate Compounds

11.5 Transition Metals and Those Compounds

(1) Iron

(2) Copper

(3) Other Metals

12. Atomic Nucleus 2

(1) Structure of Atomic Nucleus

(2) Radioactivity

(3) Artificial Nuclear Transition

13. Properties of Carbon Compounds 12

13.1 Characteristics of Carbon Compounds

13.2 Saturated Hydrocarbons

(1) Alkanes

(2) Derivatives of Alkanes

13.3 Unsaturated Hydrocarbons

(1) Single Bond and Double Bonds

(2) Alkenes

(3) Acetylene

(4) Petroleum

13.4 Aromatic Hydrocarbons

(1) Structure of Benzene and the Series of Aromatic Hydrocarbons

(2) Reaction of Aromatic Hydrocarbons

(3) Coal

14. Classification of Carbon Conpounds and Chemical Properties derived from those Functional Group — 12

14.1 Functional Groups and Classification of Carbon Compounds

14.2 Chemical Reactions of Carbon Compounds

14.3 Compounds Containing Oxygen

(1) Alcohols and Ethers

(2) Phenols

(3) Aldehydes and Ketones

(4) Carboxylic Acids and Esters

(5) Fats and Oils

(6) Essential Oils

(7) Surface Active Agents

14.4 Compounds which Contain Nitrogen and Other Elements

(1) Nitro-Compounds

(2) Amines

(3) Compounds which Contain Sulfer and Silicon, etc.

(4) Heterocyclic Compounds

15. Synthetic Macromolecular Compounds — 8

15.1 Synthesis of Macromolecular Compounds

(1) Addition Polymerization

(2) Condensation Polymerization

15.2 Configurations of Macromolecular Compounds

(1) Bonding Forms of Monomers

(2) Structural Isomerism

(3) Crosslinking Structure

(4) Crystallinity and Amorphism

15.3 Properties of Macromolecular Compounds

(1) State Transitions

(2) Mechanical Properties

(3) Thermoplasticity and Rubberlike Elasticity

16 Natural Macromolecular Compounds 8

16.1 Starch and Cellulose

(1) Glucose

(2) Sucrose and Maltose

(3) Starch

(4) Cellulose

16.2 Proteins

(1) Amino acids

(2) Configurations of Proteins

(3) Classification of Proteins

(4) Properties of Proteins

(5) Enzymes

16.3 Neucleic Acids

Total 142 HRS

Subject: Experiment of Chemistry

For Faculty of Chemical Engineering
For Faculty of Mechanical Engineering

	Curriculums	Experimenting Hours
1.	Basic Chemical Experiment	
1.1	Measurement of Boiling Point	6
1.2	Measurement of Melting Point	6
2.	Chemical Analysis	
2.1	Neutralization Analysis	9
2.2	Oxidation-Reduction Titration	9
2.3	Qualitative Analysis of Cation	21
2.4	Analysis of Anion	6
2.5	Analysis by Precipitation Method	6
2.6	Chelate Titration	6
2.7	Identification of Organic Compounds	36
	Total	105 HRS

Subject: Metallurgy and Industrial Minerals

For Faculty of Chemical Engineering
For Faculty of Mechanical Engineering

	Curriculums	Lecturing Hours
1.	Fundamentals of Metals	16
	1.1 Crystal Structures of Metals	
	(1) Metallic Bond	
	(2) Crystal Structure of Metals and those Characteristics	
	(3) Expression of Faces of Crystal Lattices and Directions of Crystallographic Axis	
	1.2 Transformation of Metals and Structures of Alloys	
	(1) Allotropic Transformation and Magnetic Transformation	
	(2) Structures of Solid Solutions	
	(3) Super Lattice	
	1.3 Phase Rule and Equilibrium Diagrams of Two Components System	
	(1) Phases, Components and Phase Rule	
	(2) Constitutions of Equilibrium Diagram	
	(3) One Component System (Pure Metal)	
	(4) Various Basic Equilibrium Diagrams (Eutectic, Eutectoid, Peritectic Reactions etc.)	
	1.4 Plastic Deformation of Metals	
	(1) Plastic Deformations	
	(2) Deformations by Slip	
	(3) Strain Hardening and Recovery, Recrystallization	
	(4) Creep, Fatigue and Failure	

1.5 Testing Methods of Metallic Materials

(1) Observations of Microstructure of Metal

(2) Material Testing (Hardness, Tensile Strength, Impact Strength, Bending Test, Creep Test and Fatigue Test)

(3) Nondestructive Inspection Method

2. Irons and Steels 28

2.1 Fundamentals of Carbon Steels

(1) Properties of the Pure Iron

(2) Equilibrium Diagrams and Microstructures of Carbon Steels

2.2 Steel Ingots

(1) Classification of Steel Ingots

(2) Segregation of Steel Ingots

(3) Segregation of Rolled Steels

(4) Non-metallic Inclusions

2.3 Plastic Deformation of Steels

(1) Cold Working of Steels

(2) Hot Working of Steels

(3) Brittleness of Steels

2.4 Heat-treatments of Carbon Steel

(1) Annealing

(2) Normalizing

(3) Mechanical Properties of Annealed or Normalized Steel

(4) Quenching

(5) Tempering

(6) Isothermal Transformation of Steels

(7) Continuous Cooling Transformation Curve

(8) Hardenability of Steels

(9) Stress and Deformation by Heat-treatment

2.5 Fundamentals of Special Steels
(1) The Definition of Special Steels
(2) Quenching of Special Steels
(3) Tempering of Special Steels

2.6 Low Alloy Special Steels
(1) Special Steels for Structure
(2) High Strength Steels
(3) Other Various Steels for Structure

2.7 High Alloy Special Steels
(1) Special Steel for Tools
(2) Stainless Steels
(3) Heat Resisting Steels

2.8 Cast Irons
(1) Structures of Cast Irons
(2) Solidification Process of White Cast Iron
(3) Solidification Process of Gray Cast Iron
(4) Structural Diagrams of Cast Irons
(5) Heat-treatment of Cast Irons
(6) Classifications of Cast Irons
(7) Properties of Cast Irons

3. Non-ferrous Metals 18
3.1 Aluminum Alloys
(1) Aluminum
(2) Heat-treatment of Aluminum Alloys
(3) Classification of Aluminum Alloys
(4) Processing Aluminum Alloys
(5) Casting Aluminum Alloys
(6) Sintered Aluminum Alloys

3.2 Magnesium Alloys and Titanium Alloys

3.3 Copper Alloys

(1) Copper

(2) Copper Alloys

(3) Heat-treatment of Copper Alloys

3.4 Tin, Lead, Zinc and those Alloys

4. Corrosion of Metals and Anticorrosion and Surface Treatment 8

4.1 Corrosion and Anticorrosion of Metals

4.2 Surface Treatment of Metals

(1) Purposes of Surface Treatments and Classifications of the Treatments

(2) Plating

(3) Coating or Lining with Non-metallic Materials

(4) Other Surface Treatment for Metals

(5) Surface Hardening

5. Industrial Minerals 6

5.1 Introduction of Mineralogy

5.2 Minerals of Industrial Values

5.3 Description of Some Indonesian Minerals

5.4 Use and Application of Indonesian Minerals

Total 76 HRS

Subject: Experiment of Metallurgy and Industrial Minerals

For Faculty of Chemical Engineering
For Faculty of Mechanical Engineering

	Curriculums	Practicing Hours
1.	Measuring of Transformation points by Thermal Analysis of Metals and Drawing of Basic Equilebrium Diagrams	12
2.	Observiation of Microstructure of Metals	6
3.	Heat Treatment Exercise	9
	3.1 Quenching, Tempering and Annealing	
	3.2 Observations of Strength Changes and Structure Changes after Heat Treatment	
	3.3 Drawing Transformation Curves	
4.	Experiment of Corrosion	18
	4.1 Measuring of Metal Corrosion by Electrochemical Methods	
	(1) Measuring of Electrode Potential	
	(2) Measuring of Polarization Curves	
	4.2 Measuring of Weight Loss	
	4.3 Measuring of Generated Gas Volume	
	4.4 Oxidation Test by a Thermobalance	
	Total	45 HRS

Subject: Basic Technical Drawing

For Faculty of Chemical Engineering
For Faculty of Mechanical Engineering

	Curriculums	Lecturing Hours	Practicing Hours
1.	Basic of Drawing	3	
	1.1 Introduction		
	1.2 Drawing Instruments		
	1.3 Size, Scale, Lines & Letters		
	1.4 Graphic Methods		
2.	Pattern Expressions	3	
	2.1 Projection		
	2.2 Auxiliary Drawing		
	2.3 Abbreviated Drawing		
	2.4 Differences in U.S.A. and European Projection		
3.	Dimensioning	3	
	3.1 Dimensions and Angles		
	3.2 Rules of Drawing and Placement		

3.3 Symbols

3.4 Shorter Dimensions

3.5 Expedient Expression of Dimensioning

3.6 Special Attention to some Matters

4. Drawing of Main Machine Parts 3

4.1 Screws, Bolts & Nuts

4.2 Springs

4.3 Gears

4.4 Antifriction Bearing

4.5 Sliding Bearing

5. Dimension Tolerance and Fitting 2

5.1 Dimension Tolerance

5.2 Types of Fitting

5.3 Expressions of Fitting

5.4 Expressions of Dimension Tolerance except Fitting

5.5 Commercial Tolerance

5.6 Geometric Tolerance and Positional Tolerance

5.7 Surface Roughness and Waviness

5.8 Expressions of Surface Roughness

5.9 Expressions of Waviness

6. Welding Symbols 2

6.1 Types of Welded Joints

6.2 Expression of Welding Symbols

6.3 Special Attention in Welding Drawing

7. Control of Drawings 3

7.1 Introduction

7.2 Numbering of Parts

7.3 Titles & Lists

7.4 Drawing Revisions

7.5 Expression of Materials

7.6 Reproduction of Drawings

7.7 Inspection of Drawings

8. Sketch Drawing 2

8.1 Singnificance of Sketches

8.2 Tools for Sketching

8.3 Process of Sketching

8.4 Sketching of Form and Dimensioning

8.5 Distinguishing of Materials

8.6 Finishing Symbols of Sketches

8.7 Sketches of Fitts

8.8 Special Attention to Sketching

9. Flow Sheets 4

9.1 Process Flow Sheets

9.2 Engineering Flow Sheets (P & I)

9.3 Symbols

10. Piping Drawing 3

10.1 Classification

10.2 Piping Drawing

10.3 Piping Flow Sheet

10.4 Isometric Drawing

10.5 Symbols for Vacuum Apparatus

11.	Workshop Drawing	4	
	11.1 Interpreting Workshop Drawing		
	11.2 Calculation of Material Needs		
	11.3 Construction Details		
12.	Practice		64
	12.1 Drawing Basics		
	12.2 Dimensioning		
	12.3 Machine Parts Drawing		
	12.4 Sketch Drawing		
	12.5 Flow Sheets		
	12.6 Piping Drawing		
	Total	32 HRS	64 HRS
	All Total	96 HRS	

Subject: Basic Electrical Engineering

For Faculty of Chemical Engineering
For Factuly of Mechanical Engineering

	Curriculums	Lecturing Hours
1.	Electrical Circuits	5
	1.1 Batteries	
	(1) Batteries and Electrodes	
	(2) Polarization	
	(3) Dry Batteries	
	(4) Battery Capacity	
	1.2 Direct Current Circuits	
	(1) Current Directions and Electric Potentials	
	(2) Circuits and Swithces	
	(3) Ohm's Law	
	(4) Connections of Resistances in Series and Parallel	
	(5) Specific Resistances	
	(6) Connection of Batteries	
	(7) Resistors	
	(8) Wheatstone Bridge	
	(9) Measurement of Resistances	
	1.3 Heat Action of Electric Current	
	(1) Joule's Law	
	(2) Electric Power and Electric Energy	
	(3) Electric Heaters and Heating Elements	

(4) Electric Welding

(5) Electric Appliances and Current Capacity of Electric Wires

(6) Fuses

1.4 Static Electricity

(1) Capacitators (Condenser)

(2) Electrostatic Capacity

(3) Electrostatic Power and Electrostatic Fields

(4) Dielectrics

(5) High Voltage Phenomena

(6) Insulation and Grounding

1.5 Chemical Effect of Electrical Current

(1) Electrolysis

(2) Secondary Batteries

2. Electromagnetic Actions 5

2.1 Generating of Magnetic Field by Current

(1) Right-Hand Rule about Direction of the Magnetic Field

(2) Biot-Savart's Law

(3) Magnetic Field of a Cylindrical Solenoid

2.2 Magnetization and Magnetic Substances

(1) Electro Magnetic Induction

(2) Magnetic Flux Density

(3) Characteristics of Ferromagnetic Substances

2.3 Magnetic Circuits

(1) Magnetic Circuits

(2) Magnetic Circuits in Series and Parallel

(3) Magnetic Circuits having an Air Gap in a Part of the Circuit

(4) Forces Working at the Air Gaps

(5) Electromagnet

2.4 Mechanical Forces Acting on Current

(1) Interaction of Current and Magnetic Field

(2) Principles of Ammeters

2.5 Electro Magnetic Induction

(1) Electromotive Forces Generated in Moving Conductors

(2) Electromotive Forces Generated by Changes of Magnetic Flux

(3) Mutual Induction

(4) Self Induction

(5) Series Connection of Two Inductances

3. Alternating Current Circuits 15

3.1 Alternating Current

(1) Direct Current and Alternating Current

(2) Theory of A.C. Generator

3.2 A.C. Circuit Element and Net Work

(1) Resistance

(2) Inductance

(3) Electrostatic Capacity

(4) Series and Parallel Circuits

(5) Kirchhoff's Law

3.3 Impedance

(1) Series Circuit of Resistance and Inductance

(2) Series Circuit of Inductance, Electrostatic Capacity and Resistance

3.4 Electric Power of Alternating Current

(1) Electric Power of A.C.

(2) Effective Value

(3) A.C. Ammeters and A.C. Voltmenters

(4) Wattmeters

3.5 Symbol Method for Calculation

(1) Complex Numbers

(2) Impedance

(3) Calculation of Complex Numbers

(4) Complex Voltage and Current

3.6 Transformers

(1) The Ideal Transformer

(2) Characteristics of Transformers

(3) Structures of Transformers

(4) Autotransformers

3.7 Three-phase A.C.

(1) Three-phase A.C. Generators

(2) Three-phase Connection of Impedance

(3) Power of Three-phase

(4) Three-phase Transformation

4. Electric Machines 8

4.1 Generators and Motors

(1) Conversion of Power

(2) Classification of Electric Machines

4.2 D.C. Generators

(1) Theory of D.C. Generators

(2) Structure of D.C. Generators

(3) Characteristics of D.C. Generators

4.3 D.C. Motors

(1) Theory of D.C. Motors

(2) Conversion of Power

(3) Characterestics of D.C. Motors

(4) Starting of D.C. Motors

4.4 Three-phase Induction Motors

(1) Generation of Rotating Magnetic Field

(2) Theory of Induction Motors

(3) Characteristics of Induction Motors

(4) Starting Method

(5) Squirrel-cage Induction Motors

4.5 Single-phase Induction Motors

(1) Theory

(2) Starting Method

(3) Integrating Wattmeters

4.6 Electric Machines for Automatic Control

(1) D.C. Servo-motors

(2) Two-phase Servo-motors

(3) Tachometer generators

(4) Synchro

5.	Electric Power	1
	5.1 Electric Power Resources	
	5.2 Thermal Power Generation	
	5.3 Hydraulic Power Generation	
	5.4 Power Transmission and Distribution	
	5.5 Lamp and Lighting	
6.	Semiconductors	1
	6.1 Characteristics of Semiconductors	
	6.2 Semiconductor Diodes and Metal Rectifiers	
	6.3 Transistors	
	6.4 Special Semiconductor Elements	
	6.5 Power Transistors and Converters	
	Total	35 HRS

Subject; Experiment of Basic Electrical Engineering

For Faculty of Chemical Engineering
For Faculty of Mechanical Engineering

	Curriculums	Experimenting Hours
1.	Measurment of Electric Resistance by Ammeters and Voltmeters	3
2.	Measurement of Electric Resistance by Wheatstone Bridges and Potentiometers	3
3.	Measurement of Efficiency of Electric Heaters	3
4.	Wave Analysis and Frequency Measurement by Electromagnetic Oscillographes and Synchroscopes	3
5.	Magnetization Characteristics of Magnets	2
6.	Experiment of Mutual Inductance and Resonance Circuits	3
7.	Measurement of Electric Resistance by A C Wheatstone Bridges and A C Potentiometers	3
8.	Characteristics of Transformers	3

9.	Characteristics of A C Compound Generators	3
10.	Characteristics of D C Shunt Motors	3
11.	Characteristics of Three Phase Induction Motors	3
12.	Measurement of Static Characteristics of Transistors	3
	Total	35 HRS

Subject; Instrumentation and Control Engineering

For Faculty of Chemical Engineering
For Faculty of Mechanical Engineering

	Curriculums	Lecturing Hours
1.	Fundamentals of Instrumentation	2
	1.1 Purpose of Instrumentation	
	1.2 Quantity and Unit	
	1.3 Error of Measurement	
	1.4 Handling of Measured Value	
2.	Structure and Principles of Control Instruments	10
	2.1 Measuring Method	
	(1) Null Method and Deflection Method	
	(2) Compensation Method and Substitution Method	
	2.2 Composition of Measuring Instruments	
	2.3 Conversion	
	(1) Detection, Conversion and Magnification	
	(2) Mechanical Conversion	
	(3) Optical Conversion	
	(4) Fluid Conversion	
	(5) Electrical Conversion	
	2.4 Indication, Recording and Counting	

2.5 Functioning of Measuring Instruments
(1) Static Characteristics
(2) Dynamic Characteristics
(3) Automation of Null Method

2.6 Control Valves
(1) Classification of Control Valves
(2) Single, Double Seated Valves
(3) Valve Construction

3. Measurements of Length and Angle 8
3.1 Measuring Instrument of Length

3.2 Measurement of Length
(1) Influence of Temperature
(2) Measuring Pressure
(3) Selection of Measuring Instruments

3.3 Measurements of Surface Roughness
(1) Expression of Surface Roughness
(2) Measurement of Surface Roughness

3.4 Measurements of Thickness and Defect Detecting
(1) Ultrasonic Wave Method
(2) Magnetic Method
(3) X-ray Method
(4) Isotope Method

3.5 Measurements of Angle
(1) Standard of Angle
(2) Measuring Instruments of Angle

4. Measurements of Time, Mass and Force 12

4.1 Measurements of Time and Revolution Speed

(1) Unit of Time

(2) Clocks

(3) Measurements of Short Time

(4) Tachometer

(5) Stroboscope

4.2 Measurements of Mass, Weight and Force

(1) Fundamental Unit of Mass

(2) Balances

(3) Measurements of Force

(4) Strain Meter

4.3 Measurements of Power

(1) Power

(2) Brake Dynamometer

(3) Reaction Dynamometer

(4) Transmission Dynamometer

4.4 Measurements of Vibration, Noise and Balancing

(1) Measurements of Vibration

(2) Measurements of Noise

(3) Unbalancing of Revolving Bodies

(4) Balancing

5. Measurements of Fluid 15

5.1 Measurements of Pressure

(1) Measurements of Pressure

(2) Pressure Gauges of Weight Balancing Type

(3) Pressure Gauges of Elasticity Type

(4) Selection of Pressure Gauges

(5) Vacuum Gauges

5.2 Measurements of Velocity and Quantity of Flow

(1) Measurements of Flow Velocity

(2) Measurements of Quantity of Flow

(3) Differential Pressure Type Flowmeters

(4) Area Flow Meters

(5) Weirs

(6) Displacement Meters

5.3 Measurements of Liquid Level

(1) Measurements of Liquid Level

(2) Gauge Glasses

(3) Float Type Liquid Level Gauges

(4) Hydrostatic Pressure Type Liquid Level Gauges

(5) Isotope Type Liquid Level Gauges

5.4 Measurements of Viscocity

(1) Viscocity

(2) Industrial Viscometers

6. Measurements of Temperature and Humidity 6

6.1 Measurements of Temperature

(1) Unit of Temperature

(2) Expansion Type and Pressure Type Thermometers

(3) Electrical Thermometers

(4) Radiation Type Thermometers

(5) Inspection of Thermometers

(6) Notices in Measuring of Temperature

6.2 Measurements of Quantity of Heat

(1) Unit of Quantity of Heat

(2) Calorimeters

6.3 Measurements of Humidity

(1) Humidity

(2) Measurements of Humidity

7. Measurements of Components 12

7.1 Unit of Amount of Substance

7.2 Measurements of Gas Concentration

7.3 Measurements of Solution Concentration

(1) Measurements of Specific Gravity

(2) Opticcal Method

(3) Electric Conductivity Method

7.4 Measurements of pH

7.5 Spectrum Analysis

7.6 Measurement of Radioactive Rays

8. Instrumentation in Chemical Plants 8

8.1 Constitution of Industrial Instrumentation

8.2 Control Apparatus

(1) Mechanism of Process Control

(2) Indicating Controllers

(3) Operating Units

9. Automatic Control 27

9.1 Constitution of Automatic Control Devices

(1) Feedback

(2) Target Values and Disturbances

(3) Constitution of Automatic Control Devices and Functions of Each Part

(4) Block Diagram

9.2 Sequential Control

(1) Oil Pressure Sequential Control

(2) Basis of Relay Circuits

(3) Air Pressure Sequential Control

9.3 Feedback Control

(1) Constitution of Feedback Control System

(2) Classification of Feedback Control

(3) Servo-mechanism

(4) Process Controll

(5) Movement Characters of Automatic Control System and its Elements

Total 100 HRS

Subject: Experiment of Instrumentation and Control Engineering

For Faculty of Chemical Engineering
For Faculty of Mechanical Engineering

	Curriculums	Practicing Hours
1.	Measurements of Length	2
2.	Measurements of Surface Roughness	2
3.	Measurements of Thickness by Ultrasonic Wave and Magnetic Method	2
4.	Measurements of Angle	2
5.	Measurements of Revolution Speed	2
6.	Measurements of Strain	2
7.	Measurements of Pressure	1
8.	Measurements of Degree of Vacuum	1
9.	Measurements of Quantity of Flow	4

10.	Measurements of Liquid Level	2
11.	Measurements of Viscocity	2
12.	Measurements of Temperature	2
13.	Measurements of Quantity of Heat	2
14.	Measurements of Humidity	1
15.	Measurements of Gas Concentration	2
16.	Measurements of Concentration of Solution	2
17.	Adjustment of Instruments (Practices of P.I.D Action)	31
	Total	62 HRS

Subject: High Pressure Apparatus

For Faculty of Chemical Engineering
For Faculty of Mechanical Engineering

	Curriculums	Lecturing Hours
1.	Elements of High Pressure Apparatus	15
	1.1 Pipes and Joints	
	1.2 Screws and Bolts	
	1.3 High Pressure Valves	
	1.4 Glass Water Gauges	
	1.5 Safety Appliances	
	1.6 Setting Method of Electric Wires and Thermowells	
2.	Containers of High Pressure Gases	12
	2.1 Kinds of Gases	
	2.2 Manufacturing Processes	
	2.3 Materials	
	(1) Tension of Container Walls under the Internal Pressure	
	(2) Calculation of Wall Thicknesses of Containers	

	2.4 Hydraulic Test	
3.	Reaction Vessels of High Pressure Gases	8
	3.1 Outlines	
	3.2 Ammonia Synthesis Converters	
	3.3 Methanol Synthesis Converters	
	3.4 Urea Synthesis Converters	
	Total	35 HRS

Subject; Statistical Quality Control

For Faculty of Chemical Engineering
For Faculty of Mechanical Engineering

	Curriculums	Lecturing Hours	Practicing Hours
1.	Basic Statistics	10	2
	1.1 Introduction		
	1.2 Simple Probability Distribution		
	1.3 Discrete Probability Distribution		
	1.4 Continuous Probability Distribution		
	1.5 Characteristics of Distribution		
	1.6 Sampling from Probability Distribution		
	1.7 Sampling from Finite Population		
2.	Quality Control	60	10
	2.1 Introduction		
	2.2 Frequency Distribution Method		
	2.3 Test and Estimation of Measured Value		
	2.4 Control Charts		
	2.5 Correlation and Recurrence		
	2.6 Inspection		

3.	Computer Programming	50	20
	3.1 Computer and FORTRAN		
	(1) History of Computer		
	(2) Computer Languages		
	3.2 Basic Computation		
	3.3 IF Statement and GO TO Statement		
	3.4 DO Statement and Arrangement		
	3.5 Two Dimensional Arrangement		
	3.6 Standard Functions		
	3.7 Statement Functions		
	3.8 Function Subprogramme		
	3.9 Subroutine Subprogramme		
	3.10 Logical Computation		
	3.11 Double Precision Computation		
	3.12 Complex Number Computation		
	3.13 Operation on Characters		
	3.14 Programming Applications		
	(1) Material Balance		
	(2) Heat Transfer		
	(3) Distillation		
	(4) Reaction Engineering		
	(5) Automatic Control		
	Total	120 HRS	32 HRS
	All Total	152 HRS	

Subject; Safety Engineering and Industrial Hygiene

For Faculty of Chemical Engineering
For Faculty of Mechanical Engineering

	Curriculum	Lecturing Hours
1.	Safety Engineering	
	1.1 Introduction	2
	(1) Basic of Safety	
	(2) Safety Organization and Inspection	
	(3) Human Behavior and Industrial Safety	
	1.2 Elevation of Safety Consciousness	1
	(1) Safety Education	
	(2) Public Relations and Publicity for Safety	
	1.3 Accident Analysis	2
	(1) Accident Records and Injury Rate	
	(2) Accidnet Investigations, Analysis and Costs	
	1.4 Safety for Plant Facilities and Operation	15
	(1) Industrial Buildings and Plant Layout	
	(2) Plant Construction and Maintenance	
	(3) Boilers	
	(4) Pressure Vessels	
	(5) Refrigerating Equipment	
	(6) Handling and Storage of Materials	
	(7) Hoisting Apparatus and Conveyors	
	(8) Elevators and Plant Railways	
	(9) Power Trucks and Tractors	
	(10) Ropes, Chains and Slings	
	(11) Guarding and Transmission Guards	
	(12) Power Press and Forging Operations	
	(13) Machine Tools	

(14) Foundry Operations
(15) Welding and Cutting
(16) Hand Portable Power Tools
(17) Electrical Hazards
(18) Flammable Liquids
(19) Personal Protective Equipment

1.5	Fire Prevention	1
(1)	Fire Prevention	
(2)	Fire Extinguishment and Control	
1.6	Emergency Action Plans	1
1.7	Government Regulations	2

2. Industrial Hygiene

2.1	Introduction	1
2.2	Industrial Hazard and Poisons	6
(1)	Industrial Poisons	
(2)	Industrial Hazards	
(3)	Ionizing Radiation	
2.3	Waste Treatment and Disposal	6
(1)	Sewage	
(2)	Solid Waste	
(3)	Gaseous Waste	
2.4	Government Regulations	2
	Total	39 HRS

Subject; Industrial Management

For Faculty of Chemical Engineering
For Faculty of Mechanical Engineering

	Curriculums	Lecturing Hours
1.	Administration and Management	2
	(1) Top Management and Lower Management	
	(2) New Managing and Controlling Techniques	
2.	Organization of Enterprise	3
	(1) Organization and Function	
	(2) Fundamental Principle of Organization	
	(3) Form of Organization	
3.	Basic Plan and Equipment for Production	12
	3.1 Product Planning	
	(1) Research and Development of Products	
	(2) Product Design	
	(3) Standardization	
	3.2 Production Planning	
	(1) Market Research	
	(2) Production Planning	
	(3) Selection of Manufacturing Methods	
	3.3 Plant Planning	
	(1) Plant Location	

(2) Plant Buildings
(3) Layout of Plant Equipments

3.4 Automation
(1) Mechanical Automation
(2) Process Automation
(3) Office Automation

4. Process Control 5
4.1 Planning
(1) Operation Planning
(2) Material Planning
(3) Investigation of Remaining Capacity of Operators and Equipment
(4) Day's Program

4.2 Execution and Control

5. Properties Management 2
5.1 Purchasing Management

5.2 Warehouse Management

6. Equipment Maintenance Management 2
6.1 Maintenance of Equipment and Record Management

6.2 Tools Management

7. Quality Control 3

7.1 Statistical Quality Control

(1) Frequency Table and Diagram

(2) Median, Mode and Dispersion

(3) Stratification

7.2 Sampling Inspection

(1) Total Inspection and Sampling Inspection

(2) Sampling

7.3 Designe of Experiments

7.4 Control Charts

8. Safety Control 2

(1) Causes of Accidents

(2) Safety and Fatigue

(3) Prevention of Accidents and Emergency Measures

(4) Safety Control Organization

9. Personnel Management 1

10. Industrial Accounting 2

10.1 Accounting of Operation Results

(1) Income and Expenditure

(2) Composition of the Cost Price

10.2 Statements of Profit and Loss

10.3 Cost Accounting

11.	Laws Concerning Industries	3
	11.1 Industrial Licenses	
	11.2 Domestic Capital Investment	
	11.3 Foreign Capital Investment	
12.	Laws Concerning Employment	7
	12.1 Basic Law of Man-Power	
	12.2 Placement of Man-Power	
	(1) Law or Regulation of Employment Contract	
	(2) Law or Regulation of Labour	
	(3) Law of Work	
	12.3 Social Insurance	
	(1) Workman's Compensation Act	
	(2) Government's Regulation Concerning Social Insurance	
	12.4 Law of Severance of Employment Contract	
	Total	44 HRS

II. SPECIAL SUBJECTS FOR THE FACULTY OF CHEMICAL ENGINEERING

CONTENTS

1. COMMON SUBJECTS

Subject; Physical Chemistry

For Faculty of Chemical Engineering

	Curriculums	Lecturing Hours
1.	Gases, Liquids, Solids	6
	1.1 Gases	
	(1) Characteristics of Gases	
	(2) Boyle's Law, Charles' Law	
	(3) The Equation of State for The Ideal Gas	
	(4) Densities and Molecular Weights of Gases	
	(5) Equations of State for Gas Mixtures; Dalton's Law of Partial Pressure	
	(6) The Kinetic Theory of Gas Molecules	
	(7) Molecular Velocities	
	(8) The Rate of Diffusion of a Gas; Graham's Law	
	(9) The van der Waals Equation for a Real Gas	
	(10) Liquefaction of Gases, Critical Phenomena	
	1.2 Liquids	
	(1) Characteristics of Liquids	
	(2) Vapor Pressure and Boiling Point of Liquids	
	(3) Clapeyron-Clausius Equation, Trouton's Rule	
	1.3 Solids	
	(1) Characteristics of Solids	
	(2) Sublimation and Melting of Solids	
	(3) Transition of Solids	

2. Solutions 5

2.1 Concentenration of Solutions

2.2 Solubility of Gases, Henry's Law

2.3 The Laws of Dilute Solutions

(1) Vapor-pressure Depression, Raoult's Law

(2) Boiling-point Elevation

(3) Freezing-poing Depression

(4) Osmotic Pressure

(5) Partition Law

3. Multi-phases Equilibrium 6

3.1 Phase Rule

3.2 Equilibrium of One-component System

3.3 Equilibrium of Two-components System

3.4 Equilibrium of Three-components System

3.5 The Ideal Solution and Non-ideal Solution

3.6 Liquid-gas Equilibrium

3.7 Liquid-liquid Equilibrium

3.8 Solid-liquid Equilibrium

4. Electrolytic Solutions 10

4.1 Ionization

(1) Electrolytes and Ionizations

(2) Unusual Osmotic Pressure

(3) Electrical Conductivity

(4) Electrolysis

4.2 Strong Electrolytes and Weak Electrolytes

4.3 Faraday's Laws of Electrolysis

4.4 Electrical Conductivity in Electrolytic Solutions

4.5 Kohlrausch's Law of Independent Migration of Ions

4.6 Transport Number of Ions, Mobility of Ions

4.7 Acids and Bases

4.8 Ionization Equilibrium of Weak Electrolytes, Ostwald's Dilution Law

4.9 Hydrolysis

4.10 Buffer Action

4.11 Solubility Product

4.12 Solubility Product and Analysis of Metal Ions

8. Electromotive Force of Cell, Electrolysis 8

8.1 Electromotive Force of Cell

8.2 Half Cells

(1) Metal Electrode

(2) Gas Electrode

(3) Oxydation and Reduction Electrode

(4) Metal-Insoluble Salt-Anion Electrode

8.3 Chemical Reactions in The Cell

8.4 Electromotive Force of Cell and Gibbs Energy Change

8.5 Activity

8.6 Activity Coefficients from Cell Electromotive Forces

8.7 Liquid Junction Potential

8.8 Electrode Potentials

8.9 Concentration Cell

(1) Electrolyte-Concentration Cell

(2) Gas-Concentration Cell

(3) Amalgam Cell

8.10 Measurement of pH

8.11 Decompostion Voltage

8.12 Overvoltage

9. Chemical Reaction Velocity 8

9.1 Reaction Velocity and Concentration

9.2 Reaction of The First Order

9.3 Reaction of The Second Order

9.4 Complex Reactions

9.5 Temperature Dependance of Reaction Velocity, Activation Energy

9.6 Mechanism of Chemical Reaction

9.7 Catalysts

9.8 Photochemical Reactions

10. Surface Chemistry 3

10.1 Surface Tension of Liquids

10.2 Adsorption on Solids

11. Colloids 4

11.1 Colloids

11.2 Dispersed System

11.3 Colloidal Dispersion

(1) Lyophilic and Lyophobic Colloids

(2) High-molecular Colloids

(3) Micelle Colloids

11.4 Optical Characteristics of Colloids

11.5 Brownian Movement

11.6 Diffusion

11.7 Sedimentation

11.8 Electrical Characteristics of Colloids

11.9 Coagulation by Electrolytes and Other Means

11.10 Viscosity of Colloid

Total 80 HRS

Subject: Experiment of Physical Chemistry

For Faculty of Chemical Engineering

	Curriculums	Experimenting Hours
.	Introduction	
1.1	Experimental Values and Errors	4
1.2	Indefinite Errors and Mean Values	
1.3	Significant Figures	
1.4	Arrangement of Experiment Results	
.	Thermochemistry	
2.1	Calibration of Thermometers (Mercury Thermometers, Thermocouples)	6
2.2	Measurement of Heat of Reaction (Dissolution Heat of Sodium Thiosulfate)	6
.	Multi-phase Equilibrium	
3.1	Measurement of Vapor Pressure and Boiling Point of Acetone	6
3.2	Measurement of Boiling Point of Two Components System (Methylalcohol - Benzene Mixture)	6
3.3	Partition Law (Benzoic Acid in Water - Benzene System)	6

3.4	Phase Diagram of Alloy (Pb - Sn System)	6
4.	Molecular Constants	
4.1	Measurement of Molecular Weight (Victor Meyer's Method, Freezing-point Depression Method)	12
4.2	Measurement of Refraction Index (Benzene, Etylalcohol)	6
4.3	Measurement of Optical Rotatory Power (Surcrose)	6
4.4	Measurement of Molar Extinction Coefficient (Copper Sulfate Ammonia Solution)	6
5.	Electrochemistry	
5.1	Measurement of Equivalent Conductivity and Determination of Dissociation Constant (Acetic Acid)	6
5.2	Measurement of Pottential Difference between Copper and Copper Sulfate Solution	6
5.3	Polarography	6
5.4	Measurement of Ionic Concentration of Hydrogen	6
5.5	Measurement of Transference Number of Ions	6

6.	Reaction Velocity		
	6.1	Measurement of Reaction Velocity at Homogeneous Reaction of the First Order (Inversion Reaction of Sucrose)	6
	6.2	Measurement of Viscocity (Colloid)	6
7.	Surface Chemistry		
	7.1	Drawing of Adsorption Isotherm Curve (Oxalic Acid Adsorption on Activated Carbon in Oxalic Acid Solution)	6
	7.2	Measurement of Surface Tension	3
8.	Spectral Analysis		6
9.	Gas and Liquid Chromatography		12
		Total	139 HRS

Subject; Organic Industrial Chemistry

For Faculty of Chemical Engineering

	Curriculums	Lecturing Hours
1.	Coal and Coal Chemical Industry (1) Fuel and Combustion (2) Coal Chemistry (3) Coal Carbonization (4) Coal Gasification (5) Coal Tar (6) Coal Chemical Industry (7) Coal Liquidification	4
2.	Petroleum Industry (1) Production of Petroleum (2) Components of Petroleum and Theories for the formation of Petroleum (3) Petroleum Refining (4) Cracking Processes (5) Reforming Processes (6) Polymerization and Alkylation (7) Isomerization and Dealkylation	4
3.	Petrochemical Industry and Natural Gas Chemical Industry 3.1 Natural Gas Chemical Industry (1) Natural Gases (2) Synthetic Gas Manufacture (3) Acetylene Manufacture (4) Hydrogen Manufacture (5) Synthesis of Methanol	8

(6) Synthesis of Folmaldehyde

(7) Synthesis of Ammonia

(8) Synthesis of Urea

(9) Synthesis of Melamine

(10) Synthesis of Hydrogen Cyanide

3.2 Petrochemical Industry

(1) Cracking of Petroleum and Separation of the Products

(2) Utilization of Olefins from Petroleum

(3) Utilization of Aromatic Hydrocarbons from Petroleum

4. Dye Industry 3

(1) Development of Dye Industry

(2) Synthetic Dyes

(3) Dye Intermediates

(4) Detailes of Dyes

5. Oils and Fats Industry 3

(1) Classifications and Properties of Oils and Fats

(2) Processing and Refining Oils and Fats

(3) Hydrogenation of Oils and Fats

(4) Hydrolysis of Oils and Fats, and Production of Esters of Faty Acids

6. Surfactants Industry 3

6.1 Introduction of Surfactants

6.2 Soap

(1) Soap

(2) Raw Materials and Manufacture

6.3 Synthetic Surfactants

(1) Anionic Surfactants

(2) Cationic Surfactants

(3) Other Surfactants

(4) Detergent Builders and Additives

7. Paint Industry 3

(1) Film Formation Process of Paints

(2) Materials of Paints

(3) Classification and Uses of Paints

(4) Manufacture of Paints

8. Pulp and Paper Industries 4

(1) Chemical Nature of Wood

(2) Classification of Pulps and Papers and those Production

(3) Sulfite Process

(4) Sulfate Process

(5) Other Pulping Processes

(6) Mechanical Pulping Process

(7) Semi-chemical Pulping Process

(8) Paper Manufacture

9. Man-made Textile Fibers Industry 4

9.1 Classification and Properties of Man-made Textile Fibers

(1) Rayon

(2) Cellulose Acetate

(3) Nylon

(4) Polyesters

(5) Acrylics

(6) Polyolefin Fibers

(7) Elastomeric Fibers

9.2 Non-wov'en Cloths

9.3 Synthetic Leather

10. Plastics Industry 10

10.1 Manufacturing Processes, Properties and Applications of Plastics

(1) Polyethylenes

(2) Polypropylenes

(3) Polyvinylchlorides

(4) Polystyrenes

(5) Polyacrylates

(6) Polyesters

(7) Phenolics

(8) Urea and Melamines

10.2 Special Plastics

10.3 Molding of Plastics

11. Rubber Industry 4

(1) Rubber and Rubberlike Elasticity

(2) Latex of Natural Rubber and its Applications

(3) Chemistry of Rubber (Components, Molecular Structure etc.)

(4) Rubber Technology (Kneading, Mixing, Vulcanization, Molding)

(5) Synthetic Rubbers

12. Adhesives Industry 3

(1) Classification of Adhesives and those Properties and Applications

(2) Special Adhesives

13. Fermentation Industry 7

Total 60 HRS

Subject; Experiment of Organic Industrial Chemistry

For Faculty of Chemical Engineering

	Curriculums	Experimenting Hours
1.	Synthesis of Benzoic Acid	9
2.	Synthesis of Nitrobenzene	9
3.	Synthesis of Aniline	9
4.	Synthesis of Acetic Acid Ethyl Ester	9
5.	Polymerization of Styrene	8
6.	Flash Point Test of Petroleum	3
7.	Synthesis of Dyestuff	9
8.	Preparation of Soap	9
9.	Preparation of Detergents	9
10.	Purification of Organic Substances	9
	Total	83 HRS

Subject; Inorganic Industiral Chemistry

For Faculty of Chemical Engineering

	Curriculums	Lecturing Hours
1.	Inorganic Chemical Industry	
1.1	Reactions of Acids, Bases, Salts and Corrosion Resistant Materials	2
(1)	Characteristics of Inorganic Chemical Industry	
(2)	Acids, Bases and their Reactions	
(3)	Salts and their Reactions	
(4)	Reactions of Acids and Bases at High Temperature	
(5)	Classification of Corrosion Resistant Materials	
(6)	Metallic Materials	
(7)	Non-metallic Materials	
1.2	Sea Salt Industry and Potassium Salts	4
(1)	Salts and Brine	
(2)	Salt Manufacturing Processes	
(3)	Bittern	
(4)	Natural Potassium Salts	
(5)	Seawater Magnesia	
(6)	Bromine	
1.3	Soda Industries and Chlorine Industries	9
(1)	Products of Soda Industries	
(2)	Lebranc Process	
(3)	Solvay Process	
(4)	Properties and Applications of Sodium Carbonate	
(5)	Caustic Soda	
(6)	Chlorine	

(7) Bleaching Agents made of Chlorine Compounds
(8) Hydrochloric Acid
(9) Other Chlorine Derivatives

1.4 Surfuric Acid 2
(1) Properties and Applications of Surfuric Acid
(2) Raw Materials
(3) Manufacture by Chamber Process
(4) Manufacture by Contact Process

1.5 Ammonia and Nitric Acid 6
(1) Development of Nitrogen Industry
(2) Theory of Ammonia Synthesis
(3) Manufacture of Synthesis Gas
(4) Ammonia Synthesis Plant
(5) Nitric Acid

1.6 Inorganic Chemicals and Pigments 2
(1) Various Inorganic Chemicals
(2) Silicon Compounds
(3) Pigments

1.7 Chemical Fertilizers 2
(1) Indispensable Elements for Plants
(2) History of Chemical Fertilizer Industry
(3) Classification of Fertilizers
(4) Changes of Fertilizer Component in Soil and Absorption Rate of Plants
(5) Moisture Absorbing Property of Fertilizer
(6) Caking of Fertilizer

1.8 Nitrogen Fertilizers 6
(1) Constituents of Main Nitrogen Fertilizers
(2) Ammonium Sulfate
(3) Urea

(4) Other Ammonium Fertilizers
(5) Slow Release Nitrogen Fertilizers
(6) Calcium Cyanamide

1.9 Phosphoric Acid and Phosphate Fertilizers 7
(1) Phosphate Ore
(2) Phosphorus and Thermal Phosphoric Acid
(3) Condensed Phosphoric Acid
(4) Wet-process Phosphoric Acid
(5) Calcium Superphosphate
(6) Triple Superphosphate
(7) Fused Phosphate and Calcined Phosphate

1.10 Potassium Fertilizer, Complex Fertilizers and Other Fertilizers 6
(1) Patassium Fertilizer
(2) Classification of Complex Fertilizers
(3) Blend Fertilizer
(4) Compound Fertilizer

2. Electrochemical Industry

2.1 Electrochemical Industry and Basic Theories 3
(1) Classification of Electrochemical Industry
(2) Cell Reaction and Electromotive Force
(3) Electrode Reaction and Electrode Potential
(4) Electrolysis and Overvoltage

2.2 Battery 3
(1) Transformation of Energy
(2) Fundamentals of Battery
(3) Primary Cell
(4) Secondary Cell (Storage Battery)

(5) Other Batteries

2.3 Electrolytic Industry 2

(1) Classification and Characteristics of Electrolytic Industry

(2) Efficiency of Electrolysis and Electrolysis Conditions

(3) Electrolytic Bath

(4) Electrolysis of Water

(5) Electrolysis of Common Salt

(6) Electrolytic Oxidation and Reduction

(7) Electrometallurgy

(8) Fused Salts Electrolysis

2.4 Electrothermic Chemical Industry 2

(1) Classification and Characteristics of the Industry

(2) Electric Furnace

(3) Calcium Carbide

(4) Ferroalloy

(5) Other Products

3. Metal Industry 9

3.1 Metals and their Properties

(1) Classification of Metals

(2) Alloys

(3) Physical Properties of Metals

(4) Chemical Properties of Metals

3.2 Metal Refining

(1) Ores

(2) Dry Refining Process

(3) Wet Refining Process

3.3 Iron and Steel

(1) Classification of Iron and Steel

(2) Iron Manufacture

(3) Steel Manufacture

(4) Properties of Iron and Steel

(5) Heat-treating and Work Hardening of Steels

(6) Special Steels and the Applications

(7) Properties and Applications of Pig Iron

3.4 Copper and Aluminum

(1) Copper Refining

(2) Properties and Applications of Copper and its Alloys

(3) Aluminum Refining

(4) Properties and Applications of Aluminum and its Alloys

3.5 Other Non-ferrous Metals

3.6 Manufacture of High-purity Metals

4. Ceramic Industry 18

4.1 Fundamentals of Ceramic Industry

(1) Charcteristics of Ceramic Industry

(2) Structure and Classifications of Silicates

(3) Main Ores and those Components

(4) Two Components System and Three Components System

(5) State Changes of Ores by Heat

(6) Sintering

(7) Solid Reaction Velocity

4.2 Raw Materials of Ceramic

(1) Silicate Stone

(2) Clay

(3) Structures of Clay Ores

(4) Clay Ores of Alumina Group

(5) Limestone

(6) Dolomite, Magnesite

(7) Gypsum

(8) Other Materials

4.3 Cements

(1) Definition and Classification of Cement

(2) Composition of Portland Cement

(3) Manufacture of Portland Cement

(4) Setting and Hardening of Portland Cement

(5) Properties of Concrete

(6) Other Special Cements

4.4 Glasses and Enamels

(1) Composition and Characteristics of Glass

(2) Manufacture of Glass

(3) Special Glasses

(4) Enamel

4.5 Refractories and Insulators

(1) Various High Melting Point Substances and their Uses

(2) Classification and Properties of Refractories

(3) Manufacturing Processes

(4) Various Refractories

(5) Insulators

4.6 Potteries

(1) Classification of Potteries

(2) Raw Materials

(3) Manufacture of Potteries

(4) Special Potteries

4.7 Graphite and Carbon Products

(1) Graphite and Amorphous Carbon

(2) Raw Materials

(3) Electrical Use and Uses for Refractories

(4) Carbonblack

(5) Activated Carbon

(6) Other Special Carbon Products

5.	Other Inorganic Chemical Industries	4
	5.1 Electric and Electronic Materials	
	(1) Electric Conductive Materials	
	(2) Electric Insulator	
	(3) Dielectric Materials	
	(4) Magnetic Materials	
	(5) Semiconductors	
	(6) Fluorescent Materials	
	5.2 Composite Materials	
	(1) Classification of Composite Materials	
	(2) Reinforcement with Fibers	
	(3) Other Composite Materials	
	Total	87 HRS

Subject; Experiment of Inorganic Industrial Chemistry

For Faculty of Chemical Engineering

	Curriculums	Experimenting Hours
1.	Manufacture of Potassium Permanganate	9
2.	Electrolysis of Water Solution of Sodium Chloride	6
3.	Copper Plating	3
4.	Purification of Sodium Chloride	6
5.	Preparation of Complex Salts and Double Salts	12
	Total	36 HRS

Subject: Chemical Engineering

For Faculty of Chemical Engineering

	Curriculums	Lecturing Hours	Exercising Hours
1.	Dealing of the Numerical Value	10	8
	1.1 Useful Mathematical Methods		
	(1) Graphical Intergration Method		
	(2) Graphical Differenciation Method		
	(3) Trial-and-Error Solution		
	(4) Conversion of Units		
	1.2 Making Procedure of Experimental Equations		
	(1) General Methods		
	(2) Dimentional Analysis		
	1.3 Handling of Statistical Data		
	(1) Estimation of Accuracy of Measured Values		
	(2) Mean Values and Confidence Limits of Variances		
	(3) Examination of Measured Values		
2.	Processes and Plants in Chemical Industries	12	
	2.1 Outline of Chemical Plants		
	(1) Chemical Processes		
	(2) Chemical Plants		
	(3) Machineries and Equipments		
	2.2 Outline of Utility Plant		
	(1) Introduction		
	(2) Boiler		
	(3) Power Generating Plant		

(4) Cooling Water System

(5) Water Treatment

(6) Others

2.3 The Unit Operations

(1) Functions of the Unit Operations

(2) Machineries and Equipments for the Unit Operations

2.4 Instrumentation and Process Control

2.5 Historical Changes of Processes and Plants

(1) Historical Changes of Processes

(2) Tendency of Large Scale Plant

3.	Material Balances	8	6

3.1 Material Flows and Material Balances

(1) Material Flows

(2) Calculation of Material Balances

3.2 Material Balances in Physical Processes

(1) Kinds of Physical Processes

(2) Material Balances in Processes of Seperation and Mixing

(3) Material Balances in Contact Process of Counter or Parallel Flow

3.3 Material Balances in Processes of Chemical Reactions

4.	Flow of Fluids	11	8

4.1 Transportation of Fluids

(1) Pipe

(2) Transporting Equipments of Fluids

4.2 Material Balances of Flow

(1) Quantity of Flow and Velocity of Flow

(2) Mass Flux

4.3 States of Fluid Flow

(1) Viscosity of Fluids

(2) Laminar Flow and Turbulent Flow

4.4 Energy Balances in Fluid Flow

(1) Energy of Fluids

(2) Mechanical Energy Balances of Fluids

(3) Power for Fluid Transportation

4.5 Head Losses

(1) Measurement of Head Losses

(2) Friction Head Losses

4.6 Measurement of Quantity of Flow

(1) Orifice Meter

(2) Pitot-tube

(3) Rotameter

(4) Other Flow Meters

5.	Powder	12	4

5.1 Chemical Industry and Powder

5.2 Size of Powder Particles

(1) Screen Analysis

(2) Particle Size Distribution

(3) Sedimentation of Particles

(4) Measurement of Particle Size Distribution by Sedimentation Analysis

5.3 Layers of Powder

(1) Fixed Bed

(2) Fluidized Bed

5.4 Seperation of Powder Particles

(1) Seperation Efficiency

(2) Classifying

(3) Precipitation Condensation

(4) Centrifugal Sedimentation Seperation

(5) Filtration

(6) Dust Collecting

5.5 Comminution

(1) Comminution

(2) Crushers and Grinders

6.	Flow of Heat	18	14

6.1 Chemical Industries and Heat

(1) Generation and Utilization of Heat in Chemical Industries

(2) Water Vapor and Heat Transmitting Medium

6.2 Heat Exchangers

(1) Processes of Heat Transfer (Conduction, Convection, Radiation)

(2) Structures of Heat Exchangers

(3) Heat Balances of Heat Exchangers

6.3 Rate of Heat Transfer

(1) Heat Conduction

(2) Overall Heat Transmission

(3) Heat Radiation

6.4 Evaporative Condensation

(1) Evaporators

(2) Heat Balance Calculations of Evaporators

(3) Heat Economy of Evaporators

(4) Vacuum Evaporation

6.5 Gas Conditioning

(1) Humidity

(2) Properties of Humidified Air

(3) Humidity Chart

(4) Conditioning of Humidity

6.6 Cooling of Water

(1) Water Cooling Apparatus

(2) Minimum Air Volume for Cooling Tower

6.7 Drying

(1) Dryer

(2) Drying Mechanism of Solids

6.8 Furnace

(1) Calculations of Combustion

(2) Basics of Combustion

(3) Combustion Devices

(4) Ventilation and Static Pressure in Furnace

(5) Classification of Furnaces

(6) Heat Balance

7. Mass Transfer 12 6

7.1 Towers and Tanks

(1) Towering Apparatus

(2) Tank Apparatus

(3) Stirring Vessels

7.2 Absorption

(1) Solubility of Gases

(2) Calculation of Absorption

(3) Size and Structure of Absorption Tower

7.3 Distillation

(1) Principle of Distillation

(2) Vapor-liquid Equiribrium

(3) Simple Distillation and Partial Condensation

(4) Rectification

(5) Distillation of Azeotropic Mixtures

(6) Vacuum Distillation and Steam Distillation

7.4 Extraction

8.	Reactors	16	14
	8.1 Types of Reactors		
	8.2 Batch Reactors		
	8.3 Continuous Reactors		
	8.4 Management of Heat of Reaction		
	8.5 Reactors of Catalytic Reaction		
	(1) Fixed-bed Reactors		
	(2) Fluidized-bed Reactors		
9.	Process Analyses	12	8
	9.1 Process Analyses		
	(1) Materials and Products		
	(2) Processes		
	(3) Operating Conditions		
	(4) Operation Results and Yield		
	(5) Inference of Reaction States and Process Analyses		
	(6) Estimation of Temperature Rise by Heat of Reaction		
	(7) Analyses of Flow Diagrams		
	9.2 Process Design		
	(1) Factors in Selection of Reaction Phase		
	(2) Quantity of Reaction Heat (Plus or Minus) and Controling Method of Reaction Temperature		
	(3) Preheating Processes of Fluid Materials		
	(4) Cooling and Collecting Processes of Fluid Products		
	Total	111 HRS	68 HRS
	All Total	179 HRS	

Subject: Experement of Chemical Engineering

For Faculty of Chemical Engineering

	Curriculums	Experimenting Hours
1.	Dimensional Analysis (Study of Waterdrop)	3
2.	Measurement of Friction Loss of Fluid in Pipes	9
3.	Inspection of Gas and Fluid Orifice Meters	9
4.	Sedimentation Analysis	9
5.	Performance Test of Boilers	9
6.	Measurement of Over-all Heat Transfer Coefficient of Heat Exchangers	9
7.	Measurement of Thermal Conductivity of Heat Insulators	9
8.	Measurement of Heat Transfer Coefficient of Tube Wall	9
9.	Drying of Solids	9
10.	Agitation and Dissolution	9

11.	Vaporization of Water in a Wetted-wall Column	9
12.	Vapor-Liquid Equilibrium Distillation	9
13.	Simple Distillation	9
14.	Agitated Tank Reactor	9
15.	Tubular Reactor	9
16.	Analysis of Catalytic Reaction in a Packed Bed	9
17.	Measurement of Pressure Loss in a Packed Tower	9
18.	Measurement of Pressure Loss in a Fluidized Bed	9
19.	Process Analysis (Manufacturing Process of Synthesis Gas from Natural Gas)	9
	Total	165 HRS

Subject; Introduction of Mechanical Engineering

For Faculty of Chemical Engineering

	Curriculums	Lecturing Hours
1.	Engineering Materials	5
	1.1 Metallic Materials	
	(1) Metal and Alloys	
	(2) Strength of Metals	
	1.2 Nonmetallic Materials	
	(1) For Machining	
	(2) For Other Engineering Purpose (Plastics, Rubber, Wood etc)	
2.	Machine Works	16
	2.1 Casting	
	(1) Mold and Casting	
	(2) Particular Casting (Centrifugal Casting, Die Casting, Precision Casting)	
	2.2 Forging	
	(1) Forging Work	
	(2) Rolling, Drawing, Extruding	
	2.3 Sheet Metal Work	

2.4 Welding and Brazing

(1) Gas Welding

(2) Arc Welding

(3) Resistance Welding

(4) Types of Welded Joint

(5) Safety Measure for Welding Work

(6) Gas Cutting

(7) Brazing

2.5 Machine Tools

(1) Machining

(2) Lathe Operations

(3) Standard Lathes

(4) Shapers

(5) Planers

(6) Milling Machines

(7) Boring Machines

(8) Grinders

2.6 Fine Surface Finshing

(1) Fitting Work

(2) Various Surface Finshing Method

(3) Honing

(4) Lapping

3. Machine Elements 14

3.1 Machine Elements

(1) Screws

(2) Bolts, Nuts

(3) Keys, Pins

(4) Rivet Joints

(5) Shaft Couplings

(6) Bearings

(7) Brakes, Springs

(8) Pipes and Valves

3.2 Driving Devices

(1) Power Transmission

(2) Gear Drive

(3) Cam Mechanism

(4) Link Work

(5) Belt Transmission

3.3 Forces Acting on Machine Elements

(1) Stresses and Strains

(2) Strength of Materials and Safety Factor

(3) Forces Acting on Beams

(4) Forces Acting on Shafts

(5) Rotating Disks and Thick Cylinders

Total 35 HRS

Subject; Practices of Machine Works

For Faculty of Chemical Engineering

	Curriculums	Practicing Hours
1.	Strength Measurements of Metallic Materials (Demonstration)	
2.	Welding	
	(1) Gas Welding	
	(2) Arc Welding	
	(3) Nondestructive Inspections of Welded Parts	
3.	Lathe Machining	
4.	Accuracy Inspections of Machine Tools	
5.	Surface Roughness Measurements of Variously Machined Pieces (Demonstration)	
6.	Measurement of Elastic Modulus (Demonstration)	
7.	Strain Measurement with a Resistance Wire Strain Gauge (Demonstration)	
	Total	36 HRS

Subject; Fluid Mechanics

For Faculty of Chemical Engineering

	Curriculums	Lecturing Hours
1.	Fundamentals of Fluid Mechanics	4
1.1	Basic Concepts: Viscosity, Momentum, Momentum Flux	
1.2	Mechanical Energy Balance, Bernoulli Equation, Flow Equation	
1.3	Laminar & Turbulent Flow	
1.4	Flow in Pipes, Reynolds Number, Friction Factor	
1.5	Flow Meters Basics	
2.	Transportation of Liquids	6
2.1	Pumps: its Characteristics & Requirements	
2.2	Types of Pump: Reciprocating, Rotary, Centrifugal	
2.3	Pump Problems: Cavitation, Water Hammering, Surging	
2.4	Hydraulic Equipment	

3.	Transportation of Compressible Fluids	6
	3.1 Basic Thermodynamics	
	3.2 Compression of Gases	
	3.3 Compressors: Reciprocating, Rotary, Centrifugal	
	3.4 Blowers & Fans	
4.	Steam and its Generation	4
	4.1 Steam and its Properties	
	4.2 Steam Generators: Types, Operating Principles, Auxilliaries	
5.	Prime Movers	12
	5.1 Steam Turbines: Types, Operating Principles, Auxilliaries	
	5.2 Gas Turbines: Types, Operating Principles, Auxilliaries	
	5.3 Gasoline Engines: Types, Operating Principles, Auxilliaries	
	5.4 Diesel Engines: Types, Operating Principles, Auxilliaries	
	Total	32 HRS

Subject; Experiment of Fluid Mechanics

For Faculty of Chemical Engineering

	Curriculums	Experimenting Hours
1.	Simple Fluid Flow Experiment, Employing Flow and Pressure Meters	8
2.	Characteristics Tests of Pumps, Compressors, Blowers	18
3.	Vibration Measurements	6
	Total	32 HRS

Subject; Practice by the Practical Training Facility

For Faculty of Chemical Engineering

	Curriculums	Lecturing Hours	Praticing Hours
1.	Orientation	3	3
	(1) Contents of Training Program and Schedule		
	(2) Observation of Training Facility		
	(3) General Rules to be Observed		
2.	Safety	29	10
	(1) Safety Rules		
	(2) Personal Safety		
	(3) Hazards in Handling Materials		
	(4) Handling of Safety Measuring Devices		
	(5) Handling of Fire Extinguishers		
	(6) Oxygen Deficiency Hazards		
	(7) Static Electricity Hazards		
	(8) Prevention of Electric Shock		
	(9) Safety in Maintenance Work		
3.	Basic Skill	0	30
	(1) Valve Operation		
	(2) Pump Operation		
	(3) How to Loosen and Tighten Flanges		
	(4) Checkup for Leakage		
	(5) Connection of Hoses		
	(6) Handling of Drum Containers and Cylinders		
	(7) Cleaning of Strainers		

4.	Basic Knowledge	60	30
	(1) How to Read Process Flow Diagram		
	(2) How to Read Piping & Instrument Diagram		
	(3) How to Read Equipment Drawing		
	(4) Outline of Plant Operation		
	i) Start-up		
	ii) Routine Work		
	iii) Normal Shutdown		
	iv) Emergency Shutdown		
	v) Preparation for Maintenance Work		
5.	Instrumentation	6	23
	(1) Types and Functions of Panel Instruments		
	(2) Handling of Field Instruments		
	(3) Zero Adjustment		
	(4) Instrumentation Loop		
	(5) Interlock and Alarm Systems		
	(6) Construction and Function of Control Valves		
6.	Construction and Function of Utilities Equipment	16	40
	(1) Air Compressor		
	i) Construction		
	ii) Operation		
	Start-up and Stop		
	Routine Inspection		

(2) Nitrogen Line

(3) Demineralizer

i) Construction

ii) Operation

Start-up and Stop

Regeneration

Routine Inspection

(4) Boiler

i) Construction

ii) Operation

Start-up and Stop

Routine Inspection

(5) Cooling Tower

i) Construction

ii) Operation

Start-up and Stop

Routine Inspection

7.	Operation of Distillation Tower	20	90

(1) Distillation Process and Construction

(2) Operation Manual

(3) Check on Equipment and Instrument Position

(4) Preparation for Start-up

i) Overall Leak Test

ii) Nitrogen Purging

iii) Introduction of Utilities

iv) Lining-up

(5) Start-up

i) Operation Manual

ii) Procedure for Start-up

(6) Normal Operation

i) Operation Manual

ii) Patrol

iii) Record Keeping of Data
iv) Sampling and Analysis
v) Quality Control
Preparation of Quality Control Diagram
Change of Reflux Ratio
Switchover of Tank Lineup
vi) Shift Hand-over

(7) Normal Shutdown
i) Operation Manual
ii) Procedure for Shutdown

(8) Operation under Varied Conditions
i) Feed-up
ii) Feed-down
iii) Change of Reflux Ratio

(9) Emergency Shutdown
i) Instrument Air Failure
ii) Cooling Water Failure
iii) Steam Failure
iv) Power Failure

8.	Operation Analysis	42	0
	(1) Calculation of Material Consumption		
	(2) Material Balance		
	(3) Heat Balance		
	(4) Calculation of Overall Heat Transfer Coefficient		
	(5) Calculation of Theoretical Number of Trays and Tower Efficiency		
9.	Maintenance	6	12
	(1) Disassembly and Reassembly of Pump		
	(2) Disassembly and Reassembly of Air Compressor		
	(3) Hydraulic Test		
	(4) Leak Test		

(5) Checkup Procedure
(6) Routine Maintenance Work
(7) Maintenance Work during Scheduled Shutdown
(8) Record Keeping of Maintenance Work
(9) Spare Parts Supply Control
(10) Essentials for Test Operation

Total	182 HRS	238 HRS
All Total	420 HRS	

III. SPECIAL SUBJECTS FOR THE FACULTY OF MECHANICAL ENGINEERING

Subject; Basic Mechanical Engineering

For Faculty of Mechanical Engineering

	Curriculums	Lecturing Hours
1.	Machine Elements	14
	1.1 Machine Elements	
	(1) Screws	
	(2) Bolts, Nuts	
	(3) Keys, Pins	
	(4) Rivet Joints	
	(5) Shaft Couplings	
	(6) Bearings	
	(7) Brakes, Springs	
	(8) Pipes and Valves	
	1.2 Driving Devices	
	(1) Power Transmission	
	(2) Gear Drive	
	(3) Cam Mechanism	
	(4) Link Work	
	(5) Belt Transmission	
	1.3 Forces Acting on Machine Elements	
	(1) Stresses and Strains	
	(2) Strength of Materials and Safety Factor	
	(3) Forces Acting on Beams	
	(4) Forces Acting on Shafts	

2. Thermodynamics 20

2.1 Heat and Work

(1) Basic concepts and definitions

(2) Work in a closed system

(3) Work in a steady state flow system

2.2 First Law of thermodynamics

(1) Application to a closed system

(2) Application to a steady state flow system

(3) Enthalpy and internal energy

(4) Potential and kinetic energy

(5) Heat capacities

2.3 Second law of thermodynamics

(1) Introduction

(2) Heat engine

(3) Reversible & irreversible processes

(4) Carnot engine

(5) Carnot refrigerator & pump

(6) The second law of thermodynamics

(7) Carnot principle

(8) Thermodynamics scales of temperature

(9) Entropy

(10) Entropy changes in irreversible processes

(11) The perfect gas

(12) Joule-Thomson expansion

(13) Free energy functions

(14) Availability and maximum work

2.4 Gases, Liquids and Solids

(1) P.V.T. Surface of a pure substance

(2) P-V diagram

(3) P-T diagram

(4) Compression factor

(5) Van der Waals Equation

(6) Caluculation of thermodynamics properties

(7) Thermodynamic tables and charts

2.5 Devices for transfer of heat and work

(1) Heat and work effects in the compression and expansion of fluids

(2) Classification of compressors and expanders

(3) Reciprocating piston compressors

(4) Rotary compressors

(5) Reciprocating expansion engines

(6) Dynamic compressors and expanders

(7) Turbines

(8) Turbo-compressors

(9) Refrigeration and gas liquefaction

(10) Refrigeration cycles

3. Strength of Materials

3.1 Stress and Strain 6

(1) External Force and Internal Force

(2) Normal Stress and Normal Strain

(3) Shearing Stress and Shearing Strain

(4) Stress-Strain Relationship

(5) Elastic Defromation and Plastic Deformation

(6) Ultimate Strength

(7) Allowable Stress and Factor of Safty

3.2 Tension and Compression 10

(1) Rods of Non-uniform Cross Sections

(2) Frameworks

(3) Bodies under Fluid Pressure

(4) Bodies Supporting their Own Weight

(5) Bodies under Centrifugal Force or Force of Inertia

(6) Statically Indeterminate Problem

(7) Thermal Stress

(8) Stress and Deflection of Cables

3.3 Bending Stress of Beams 12

(1) Shearing Force and Bending Moment

(2) Beams under Moving Load

(3) Bending Stress

(4) Center of Figure

(5) Second Moment of Area

(6) Section Modulus

(7) Symmetrical Bending of Beams

(8) Rods under Normal Force and Bending Moment

3.4 Deflection of Beams 6

(1) Differential Equation of Deflection Curve

(2) Method of Superposition and Cutting Method

(3) Beams of Uniform Strength, Beams of Non-uniform Cross Section

(4) Area Moment Method

3.5 Statically Indeterminate Problem about Beams 8

(1) Statically Indeterminate Beam

(2) Statically Indeterminate Rahmen

(3) Composite Beam

(4) Continuous Beam

3.6 Non-symmetrical Bending of Beams 6

(1) Principal Axis of Cross Section

(2) Determination of Principal Axis

(3) Product of Inertia of Area

(4) Non-symmetrical Bending

(5) Calculation of Bending Stress without Determination of Principal Axis

(6) Core of Section

3.7 Shearing Stress of Beams 4

(1) Shearing Stress of Beams

(2) Deflection of Beams by Shearing Stress

3.8 Curved Beams 6

(1) Stress of Curved Beams

(2) Deflection of Curved Beams

(3) Thine Curved Beams

3.9 Torsion 6

(1) Torsion of Rod

(2) Torsion of Rods of Various Sections

(3) Coiled Spring

3.10 Buckling of Long Columns 4

(1) Euler's Buckling Load

(2) Determination of Backling Load Assuming Existance of Some Defect

(3) Empirical Formula of Buckling of Long Columns

3.11 Stress Components and Strain Componenets 8

(1) Stress Components

(2) Strain Components

3.12 Failure and Fracture of Materials 4

(1) Failure and Fracture

(2) Failure by Combined Stress

3.13 Rotating Disks and Thick Cylinders 6

(1) Basic Formula of Elasticity

(2) Disks under Pressures at their Both Sides

(3) Thick Cylinders under Pressures at their Internal and External Surfaces

(4) Rotating Disks

(5) Rotating Disks of Uniform Thickness

(6) Rotating Disks of Uniform Strength

(7) Thermal Stress of Cylinders

(8) Stationary Thermal Stress of Cylinders which have Temperature Differences at Internal and External Surfaces

3.14 Bending of Planes 4

(1) Bending of Beams and Bending of Planes

(2) Axisymmetrical Bending of Disks

(3) Disks under Uniform Load

(4) Disks under Concentrated Load at the Center

(5) Disks without Load on their Plate Surfaces

3.15 Strain Energy 6

(1) Strain Energy

(2) Maxwell's Theorem

(3) Castigliano's Theorem

(4) Torsion of Rods

(5) Bending of Beams

(6) Bending of Thine Curved Beams

(7) Stress and Defromation by Impact Load

3.16 Stress Concentration 4

(1) Rods of Non-uniform Cross Sections

(2) Stress Concentration around Holes in a Plate

(3) Tension of Plates with Notch

(4) Plain Bending of Plates with Circular Holes

(5) Stress Concentration by Existence of Sphere Cavity

(6) Round Bar with Circumferential Notch

(7) Rods with Transversed Hole

(8) Other Stress Concentration

(9) Interference of Notches

(10) Minimizing Method of Stress Concentration

3.17 Mechanical Properties of Materials 6

(1) Mechanical Properties

(2) Properties under Tensile Stress

(3) Properties under Compressive Stress

(4) Properties under Shearing Stress

(5) Properties under Bending Stress

(6) Strainhardening

(7) Elastic Aftereffect

(8) Hysteresis and Bauchinger Effect

(9) Properties under Impact Load

(10) Residual Stress

(11) Fatigue of Materials

(12) Various Factors Affecting on Fatigue Fracture

(13) Fatigue and Lifetime

(14) Strength at High or Low Temperature

(15) Creep

(16) Allowable Stress and Decision of Safety Factor

4. Material Testing 2

Total 142 HRS

Subject; Experiment of Basic Mechanical Engineering

For Faculty of Mechanical Engineering

	Curriculums	Experimenting Hours
1.	Experiment of Stress Concentration	12
2.	Measurement of Modulus of Longitudinal Elasticity	12
3.	Material Testing	36
	Total	60 HRS

Subject: Chemical Engineering

For Faculty of Mechanical Engineering

	Curriculums	Lecturing Hours	Exercising Hours
1.	Dealing of the Numerical Value	10	8
	1.1 Useful Mathematical Methods		
	(1) Graphical Intergration Method		
	(2) Graphical Differenciation Method		
	(3) Trial-and-Error Solution		
	(4) Conversion of Units		
	1.2 Making Procedure of Experimental Equations		
	(1) General Methods		
	(2) Dimentional Analysis		
	1.3 Handling of Statistical Data		
	(1) Estimation of Accuracy of Measured Values		
	(2) Mean Values and Confidence Limits of Variances		
	(3) Examination of Measured Values		
2.	Processes and Plants in Chemical Industries	12	
	2.1 Outline of Chemical Plants		
	(1) Chemical Processes		
	(2) Chemical Plants		
	(3) Machineries and Equipments		
	2.2 Outline of Utility Plant		
	(1) Introduction		
	(2) Boiler		
	(3) Power Generating Plant		

(4) Cooling Water System
(5) Water Treatment
(6) Others

2.3 The Unit Operations
(1) Functions of the Unit Operations
(2) Machineries and Equipments for the Unit Operations

2.4 Instrumentation and Process Control

2.5 Historical Changes of Processes and Plants
(1) Historical Changes of Processes
(2) Tendency of Large Scale Plant

3.	Flow of Fluids	11	8

3.1 Transportation of Fluids
(1) Pipe
(2) Transporting Equipments of Fluids

3.2 Material Balances of Flow
(1) Quantity of Flow and Velocity of Flow
(2) Mass Flux

3.3 States of Fluid Flow
(1) Viscosity of Fluids
(2) Laminar Flow and Turbulent Flow

3.4 Energy Balances in Fluid Flow
(1) Energy of Fluids
(2) Mechanical Energy Balances of Fluids
(3) Power for Fluid Transportation

3.5 Head Losses
(1) Measurement of Head Losses
(2) Friction Head Losses

3.6 Measurement of Quantity of Flow

(1) Orifice Meter

(2) Pitot-tube

(3) Rotameter

(4) Other Flow Meters

4.	Powder	12	4

4.1 Chemical Industry and Powder

4.2 Size of Powder Particles

(1) Screen Analysis

(2) particle Size Distribution

(3) Sedimentation of Particles

(4) Measurement of Particle Size Distribution by Sedimentation Analysis

4.3 Layers of Powder

(1) Fixed Bed

(2) Fluidized Bed

4.4 Seperation of Powder Particles

(1) Seperation Efficiency

(2) Classifying

(3) Precipitation Condensation

(4) Centrifugal Sedimentation Seperation

(5) Filtration

(6) Dust Collectin

4.5 Comminution

(1) Comminution

(2) Crushers and Grinders

5.	Flow of Heat	18	12

5.1 Chemical Industries and Heat

(1) Generation and Utilization of Heat in Chemical Industries

(2) Water Vapor and Heat Transmitting Medium

5.2 Heat Exchangers

(1) Processes of Heat Transfer (Conduction, Convection. Radiation)

(2) Structures of Heat Exchangers

(3) Heat Balances of Heat Exchangers

5.3 Rate of Heat Transfer

(1) Heat Conduction

(2) Overall Heat Transmission

(3) Heat Radiation

5.4 Evaporative Condensation

(1) Evaporators

(2) Heat Balance Calculations of Evaporators

(3) Heat Economy of Evaporators

(4) Vacuum Evaporation

5.5 Gas Conditioning

(1) Humidity

(2) Properties of Humidified Air

(3) Humidity Chart

(4) Conditioning of Humidity

5.6 Cooling of Water

(1) Water Cooling Apparatus

(2) Minimum Air Volume for Cooling Tower

5.7 Drying

(1) Dryer

(2) Drying Mechanism of Solids

5.8 Furnace

(1) Calculations of Combustion

(2) Basics of Combustion

	(3) Combustion Devices		
	(4) Ventilation and Static Pressure in Furnace		
	(5) Classification of Furnaces		
	(6) Heat Balance		
6.	Mass Transfer	8	-
	6.1 Towers and Towers		
	(1) Towering Apparatus		
	(2) Tank Apparatus		
	(3) Stirring Vessels		
	6.2 Absorption		
	6.3 Extraction		
	6.4 Distillation		
7.	Reactors	2	-
	7.1 Types of Reactors		
8.	Process Analyses	6	4
	8.1 Process Analyses		
	(1) Materials and Products		
	(2) Processes		
	(3) Operating Conditions		
	(4) Operation Results and Yield		
	(5) Inference of Reaction States and Process Analyses		
	(6) Estimation of Temperature Rise by Heat of Reaction		
	(7) Analyses of Flow Diagrams		
	Total	79 HRS	36 HRS
	All Total	115 HRS	

Subject: Experiment of Chemical Engineering

For Faculty of Mechanical Engineering

	Curriculums	Experimenting Hours
1.	Dimensional Analysis (Study of Waterdrop)	3
2.	Measurement of Friction Loss of Fluid in Pipes	9
3.	Inspection of Gas and Fluid Orifice Meters	9
4.	Measurement of Over-all Heat Transfer Coefficient of Heat Exchangers	9
5.	Measurement of Thermal Conductivity of Heat Insulators	9
6.	Measurement of Heat Transfer Coefficient of Tube Wall	9
7.	Performance Test of Boilers	9
8.	Agitation and Dissolution	9
9.	Agitated Tank Reactor	9
10.	Tubular Reactor	9
11.	Measurement of Pressure Loss in a Packed Tower	9
12.	Measurement of Pressure Loss in a Fluidized Bed	9
	Total	102 HRS

Subject: Fluid Mechanics

For Faculty of Mechanical Engineering

	Curriculums	Lecturing Hours
1.	Fundamentals of Fluid Mechanics	4
1.1	Basic Concepts: Viscosity, Momentum, Momentum Flux	
1.2	Mechanical Energy Balance, Bernoulli Equation, Flow Equation	
1.3	Laminar & Turbulent Flow	
1.4	Flow in Pipes, Reynolds Number, Friction Factor	
1.5	Flow Meters Basics	
2.	Transportation of Liquids	6
2.1	Pumps: its Characteristics & Requirements	
2.2	Types of Pump: Reciprocating, Rotary, Centrifugal	
2.3	Pump Problems: Cavitation, Water Hammering, Surging	
2.4	Hydraulic Equipment	

3.	Transportation of Compressible Fluids	6
	3.1 Basic Thermodynamics	
	3.2 Compression of Gases	
	3.3 Compressors: Reciprocating, Rotary, Centrifugal	
	3.4 Blowers & Fans	
4.	Steam and its Generation	4
	4.1 Steam and its Properties	
	4.2 Steam Generators: Types, Operating Principles, Auxilliaries	
5.	Prime Movers	12
	5.1 Steam Turbines: Types, Operating Principles, Auxilliaries	
	5.2 Gas Turbines: Types, Operating Principles, Auxilliaries	
	5.3 Gasoline Engines: Types, Operating Principles, Auxilliaries	
	5.4 Diesel Engines: Types, Operating Principles, Auxilliaries	
	Total	32 HRS

Subject; Experiment of Fluid Mechanics

For Faculty of Mechanical Engineering

	Curriculums	Experimenting Hours
1.	Simple Fluid Flow Experiment, Employing Flow and Pressure Meters	8
2.	Decomposition & Composition of Centrifugal Pumps, Rotary Pumps, Compressors	18
3.	Vibration Measurements	6
	Total	32 HRS

Subject; Mechanical Drawing

For Faculty of Mechanical Engineering

	Curriculums	Lecturing Hours	Practicing Hours
1.	Introduction of Machine Design	6	-
	1.1 Points of Machine Design		
	(1) Mechanism		
	(2) Strength of each part		
	(3) Economy		
	(4) Interchangeability		
	1.2 Design and Drawing of Parts		
	1.3 Assembling Drawing, Instruction Book and Inspection of Drawing		
2.	Practice of Mechanical Drawing	36	168
	(1) Water Headtank		
	(2) Pressure Vessel		
	(3) Heat Exchanger		
	(4) Centrifugal Pump		
	Total	42 HRS	168 HRS
	All Total	210 HRS	

Subject; Metal Machining

For Faculty of Mechanical Engineering

	Curriculums	Lecturing Hours
1.	Machine Tools and Machining Operations	18
	1.1 Lathe Machining	
	(1) Lathes	
	(2) Lathe Operation	
	1.2 Drilling	
	(1) Drilling Machines	
	(2) Drilling Operation	
	1.3 Shaping	
	(1) Shaping Machines	
	(2) Shaping Operation	
	1.4 Grinding	
	(1) Grinding Machines	
	(2) Grinding Operations	
	1.5 Planing	
	(1) Planing Machines	
	(2) Planing Operations	
	1.6 Milling	
	(1) Milling Machines	
	(2) Milling Operations	
	1.7 Hobbing	
	(1) Hobbing Machines	
	(2) Hobbing Operations	
	1.8 Cutting Fluids	

2. Welding 12

2.1 Arc Welding

2.2 Gas Welding

2.3 Resistance Welding

2.4 Other Electric Welding

2.5 Other Welding Methods
(Thermit Welding, Gas Pressure Welding, Friction Welding etc)

2.6 Characteristics of Welded Zone

2.7 Welding of Various Materials
(Structural Steel, Stainless Steel, Cast Iron, Non-ferrous Metals, Plastics etc)

3. Heat Treatment 10

3.1 Heat Treatment Fundamentals

3.2 Procedure of Heat Treatment

3.3 Techniques of Heat Treatment
(Annealing, Normalizing, Hardening, Tempering)

3.4 Surface Hardening

3.5 Heat Treatment Troubles

4. Casting 10

4.1 Classification of Molds

4.2 Molding Processes

4.3 Metals for Casting

	4.4 Melting	
	4.5 Procedures of Casting	
	4.6 Design and Inspection of Defects	
5.	Forging and Rolling	5
	5.1 Forging Fundamentals	
	5.2 Forging Machines	
	5.3 Furnaces for Forging	
	5.4 Finishing and Defects	
	5.5 Rolling Fundamentals	
	5.6 Rolling Mills	
6.	Pressing	5
	6.1 Pressing Fundamentals	
	6.2 Classification of Pressing	
	6.3 Molds and Presses	
7.	Hand Finishing and Assembling	3
8.	Surface Treatments	2
	8.1 Electroplating	
	8.2 Metal Spraying	
	Total	65 HRS

Subject; Practice of Metal Machining

For Faculty of Mechanical Engineering

	Curriculums	Practicing Hours
1.	Machine Work	51
2.	Arc Welding	12
3.	Gas Welding	12
4.	Basic Operation of Finishing	15
5.	Plasticity Forming and Heat Treatment	15
	Total	105 HRS

Subject: Practice by the Practical Training Facility

For Faculty of Mechanical Engineering

	Curriculums	Lecturing Hours	Praticing Hours
1.	Orientation	3	3
	(1) Contents of Training Program and Schedule		
	(2) Observation of Training Facility		
	(3) General Rules to be Observed		
2.	Safety	29	10
	(1) Safety Rules		
	(2) Personal Safety		
	(3) Hazards in Handling Materials		
	(4) Handling of Safety Measuring Devices		
	(5) Handling of Fire Extinguishers		
	(6) Oxygen Deficiency Hazards		
	(7) Static Electricity Hazards		
	(8) Prevention of Electric Shock		
	(9) Safety in Maintenance Work		
3.	Basic Skill	0	30
	(1) Valve Operation		
	(2) Pump Operation		
	(3) How to Loosen and Tighten Flanges		
	(4) Checkup for Leakage		
	(5) Connection of Hoses		
	(6) Handling of Drum Containers and Cylinders		
	(7) Cleaning of Strainers		

4.	Basic Knowledge	60	30
	(1) How to Read Process Flow Diagram		
	(2) How to Read Piping & Instrument Diagram		
	(3) How to Read Equipment Drawing		
	(4) Outline of Plant Operation		
	i) Start-up		
	ii) Routine Work		
	iii) Normal Shutdown		
	iv) Emergency Shutdown		
	v) Preparation for Maintenance Work		
5.	Instrumentation	6	23
	(1) Types and Functions of Panel Instruments		
	(2) Handling of Field Instruments		
	(3) Zero Adjustment		
	(4) Instrumentation Loop		
	(5) Interlock and Alarm Systems		
	(6) Construction and Function of Control Valves		
6.	Construction and Function of Utilities Equipment	16	40
	(1) Air Compressor		
	i) Construction		
	ii) Operation		
	o Start-up and Stop		
	o Routine Inspection		

(2) Nitrogen Line

(3) Demineralizer

i) Construction

ii) Operation

Start-up and Stop

Regeneration

Routine Inspection

(4) Boiler

i) Construction

ii) Operation

Start-up and Stop

Routine Inspection

(5) Cooling Tower

i) Construction

ii) Operation

Start-up and Stop

Routine Inspection

7. Operation of Distillation Tower 20 58

(1) Distillation Process and Construction

(2) Operation Manual

(3) Check on Equipment and Instrument Position

(4) Preparation for Start-up

i) Overall Leak Test

ii) Nitrogen Purging

iii) Introduction of Utilities

iv) Lining-up

(5) Start-up

i) Operation Manual

ii) Procedure for Start-up

(6) Normal Operation

i) Operation Manual

ii) Patrol

iii) Record Keeping of Data
iv) Sampling and Analysis
v) Quality Control
Preparation of Quality Control Diagram
Change of Reflux Ratio
Switchover of Tank Lineup
vi) Shift Hand-over

(7) Normal Shutdown
i) Operation Manual
ii) Procedure for Shutdown

(8) Operation under Varied Conditions
i) Feed-up
ii) Feed-down
iii) Change of Reflux Ratio

(9) Emergency Shutdown
i) Instrument Air Failure
ii) Cooling Water Failure
iii) Steam Failure
iv) Power Failure

8.	Maintenance	27	65

(1) Disassembly and Reassembly of Pump
(2) Disassembly and Reassembly of Air Compressor
(3) Hydraulic Test
(4) Leak Test
(5) Checkup Procedure
(6) Routine Maintenance Work
(7) Maintenance Work during Scheduled Shutdown
(8) Record Keeping of Maintenance Work
(9) Spare Parts Supply Control
(10) Essentials for Test Operation

Total	161 HRS	259 HRS
All Total	420 HRS	

IV. CURRICULUM TABLE FOR EACH SEMESTER

CURRICULUM FOR THE FACULTY OF CHEMICAL ENGINEERING

Grade	No.	Subjects	Semester I (Hours per a week)	Semester II (Hours per a week)
I	1.	Religion	2 (0)	2 (0)
	2.	Indonesian	2 (0)	2 (0)
	3.	English	2 (0)	2 (0)
	4.	Mathematics	4 (0)	4 (0)
	5.	Physics	4 (2)	4 (2)
	6.	Chemistry	4 (3)	4 (3)
	7.	Basic Technical Drawing	1 (2)	1 (2)
	8.	Basic Electrical Engineering	1 (1)	1 (1)
	9.	Instrumentation and Control Engineering	2 (1)	2 (1)
		Total	22 (9)	22 (9)

Grade	No.	Subjects	Semester III (Hours per a week)	Semester IV (Hours per a week)
II	1.	English	2 (2)	2 (2)
	2.	Military Training	- -	1 (4)
	3.	Instrumentation and Control Engineering	2 (2)	- -
	4.	Physical Chemistry	3 (4)	2 (4)
	5.	Introduction of Mechanical Engineering	1 (1)	1 (1)
	6.	Industrial Chemistry (organic & inorganic)	4 (3)	4 (3)
	7.	Chemical Engineering	5 (5)	5 (5)
	8.	Statistical Quality Control	4 (0)	3 (2)
		Total	21 (17)	18 (21)

Grade	No.	Subjects	*Semester V* (Hours per a week)	*Semester VI* (Hours per a week)
III	1.	Pancasila & G B H N	2 (0)	-
	2.	English	2 (0)	-
	3.	Metallurgy and Industrial Minerals	4 (2)	-
	4.	Safety Engineering and Industrial Hygiene	2 (0)	-
	5.	Industrial Management	2 (0)	-
	6.	High Pressure Apparatus	2 (0)	-
	7.	Fluid Mechanics	1 (1)	-
	8.	Practice by the Practical Training Facility	8 (12)	-
	9.	Factory Training	- -	0 (30)
		Total	23 (15)	0 (30)
			(8 months)	(4 months)

Note : 1. The number in the brackets indicates experimenting hours

CURRICULUMS FOR THE FACULTY OF MECHANICAL ENGINEERING

Grade	No.	Subjects	Semester I (Hours per a week)	Semester II (Hours per a week)
I	1.	Religion	2 (0)	2 (0)
	2.	Indonesian	2 (0)	2 (0)
	3.	English	2 (0)	2 (0)
	4.	Mathematics	4 (0)	4 (0)
	5.	Physics	4 (2)	4 (2)
	6.	Chemistry	4 (3)	4 (3)
	7.	Basic Technical Drawing	1 (2)	1 (2)
	8.	Basic Electrical Engineering	1 (1)	1 (1)
	9.	Instrumentation and Control Engineering	2 (1)	2 (1)
		Total	22 (9)	22 (9)

Grade	No.	Subjects	Semester III (Hours per a week)	Semester IV (Hours per a week)
II	1.	English	2 (2)	2 (2)
	2.	Military Training	- -	1 (4)
	3.	Instrumentation and Control Engineering	2 (2)	- -
	4.	Basic Mechanical Engineering	4 (2)	4 (2)
	5.	Chemical Engineering	3 (4)	3 (4)
	6.	Fluid Mechanics	1 (0)	1 (2)
	7.	Mechanical Drawing	1 (5)	1 (5)
	8.	Statistical Quality Control	4 (0)	3 (2)
		Total	17 (15)	15 (21)

Grade	No.	Subjects	Semester V (Hours per a week)	Semester VI (Hours per a week)
III	1.	Pancasila & G B H N	2 (0)	-
	2.	English	2 (0)	-
	3.	Metallurgy and Industrial Minerals	4 (2)	-
	4.	Safety Engineering and Industrial Hygiene	2 (0)	-
	5.	Industrial Management	2 (0)	-
	6.	Metal Machining	3 (5)	-
	7.	High Pressure Apparatus	2 (0)	-
	8.	Practice by the Practical Training Facility	8 (12)	-
	9.	Factory Training	- -	0 (30)
		Total	25 (19)	0 (30)
			(8 months)	(4 months)

Note : 1. The number in the brackets indicates experimenting hours

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