BIOPROCESS ENGINEERING STUDY PROGRAM

1. **Program Learning Outcomes (PLO):**

a. Graduates acquire professional leadership roles in bioprocess engineering and related fields leading to successful career.
b. Graduates establish commitment and contributes toward sustainable and bio-based economy development for better society.
c. Graduates engange in lifelong learning in conducting practical engineer tasks.

2. **Intended Learning Outcomes (ILO)**

a. Able to acquire a sound knowledge in mathematics and natural science and apply engineering principles in determining and solving contemporary and complex problems related to bioprocessing.
b. Able to formulate and operate conversion processes of biological resources into bio-based value added materials related to food, feed, fuels, pharmaceutical, nutraceutical, biomaterials or biochemicals.
c. Able to design biological reaction and reactors including its materials, instrumentation, control, and modeling.
d. Able to communicate creative idea and works effectively within professional community and larger society.
e. Able to demonstrate an ability to work in multidisciplinary and multicultural teams in developing innovative engineering solutions using complex problem-solving skills.
f. Able to conduct practice-based tasks related to bioprocessing in a responsible, safe, voluntary, self-motivated and ethical manner.
g. Able to appraise bioprocessing and bioproducts manufacturing and valorization using entrepreneurship principles.

COMPULSORY COURSES IN BIOPROCESS ENGINEERING STUDY PROGRAM

Code	Subjects	Credits				Description / Prerequisites
		K	Pr	R	Σ	
SEMESTER I						
MPK60001	Religion (Islam)	2	0	0	2	Taking the course according to the religion of the student
MPK60002	Religion (Catholic)	2	0	0	2	
MPK60003	Religion (Christian)	2	0	0	2	
MPK60004	Religion (Hinduism)	2	0	0	2	
MPK60005	Religion (Buddhism)	2	0	0	2	
MPK60006	Civic Education	2	0	0	2	
UBU60004	English	2	0	0	2	
TPF61003	Basic Chemistry	2	0	0	2	
TPF61004	Practical of Basic Chemistry	0	1	0	1	
TPF61001	Biology	2	0	0	2	
TPF61002	Practical of Biology	0	1	0	1	
TPO61001	Introduction to Bioprocess Engineering	2	0	0	2	
TPE61002*$^{\phi}$	Basic Mathematics	2	0	0	2	
TPE61003*	Physics	3	0	0	3	
TPF61006	Practical of Basic Physics	0	1	0	1	
	Total	**17**	**3**	**0**	**20**	
SEMESTER II						
MPK60007	Indonesian Language	2	0	0	2	
MPK60008	Pancasila	2	0	0	2	
TPF62008	Organic Chemistry	2	0	0	2	
TPF62009	Practical of Organic Chemistry	0	1	0	1	
TPO62002	Engineering Mechanics	2	0	1	3	
TPO62003	Food Chemistry	2	0	0	2	
TPO62004*	Essential Microbiology	2	0	0	2	
TPO62005	Practical of Essential Microbiology	0	2	0	2	
TPO62006**	Introduction to Computer Application	2	0	0	2	
TPO62007	Practical of Introduction to Computer Application	0	1	0	1	
TPE60004*$^{\phi}$	Calculus I	2	0	0	2	TPE61002
	Total	**16**	**4**	**1**	**21**	
SEMESTER III						
TPF60011	Engineering Economics	3	0	0	3	
TPF61012	Biomaterial	2	0	0	2	
TPF61013	Practical of Biomaterial	0	1	0	1	
TPO61008**	Transport Phenomena 1	2	0	0	2	TPE61003
TPO61009	Computer Aided Design (CAD)	2	0	0	2	
TPO61010	Practical of Computer Aided Design (CAD)	0	1	0	1	
TPO61011*	Automation 1	2	0	0	2	

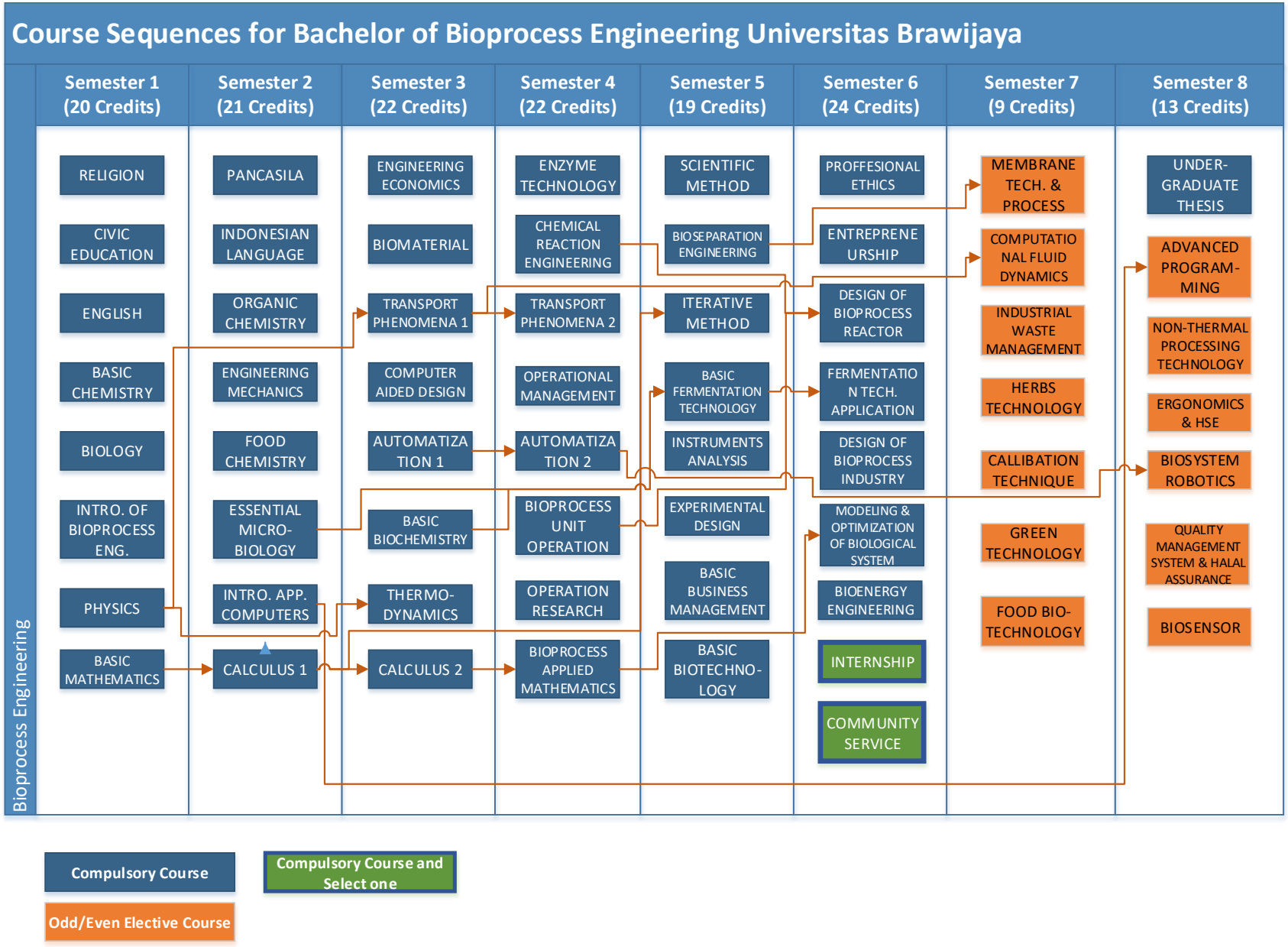
TPO61012	Practical of Automation 1	0	1	0	1	
TPO61013*	Basic Biochemistry	2	0	0	2	
TPE61010*	Thermodynamics	2	0	1	3	TPE61003, TPF61006
TPE61018*$^{\phi}$	Calculus 2	2	0	1	3	TPE60004
	Total	**17**	**3**	**2**	**22**	
SEMESTER IV						
TPO62014**$^{\phi}$	Applied Mathematic in Bioprocess	2	0	1	3	TPE61018
TPO62015*	Chemical Reaction Engineering	2	0	1	3	
TPO62016	Transport Phenomena 2	2	0	0	2	TPO61008
TPO62017**	Automation 2	2	0	0	2	TPO61011
TPO62018	Practical of Automation 2	0	1	0	1	TPO61012
TPO62019	Operational Management	2	0	0	2	
TPO62020	Practical of Operational Management	0	1	0	1	
TPO62021	Bioprocess Unit Operation	2	0	0	2	
TPO62022	Practical of Bioprocess Unit Operation	0	1	0	1	
TPE62043	Operations Research	2	0	0	2	
TPB62007	Enzyme Technology	3	0	0	3	
	Total	**17**	**3**	**2**	**22**	
SEMESTER V						
TPF61014	Scientific Method	2	0	0	2	
TPO61023**	Bioseparation Engineering	2	0	0	2	
TPO61024	Practical of Bioseparation Engineering	0	1	0	1	
TPO61025$^{\phi}$	Iteration Method	2	0	0	2	TPE60004
TPO61026*	Basic Fermentation Technology	2	0	0	2	TPO62004, TPO61013
TPO61027	Instruments Analysis	3	0	0	3	
TPO61028**	Experimental Design	2	0	0	2	
TPO61029	Practical of Experimental Design	0	1	0	1	
TPO61030	Fundamental of Business Management	2	0	0	2	
TPO61031	Basic of Biotechnology	2	0	0	2	
	Total	**17**	**2**	**0**	**19**	
SEMESTER VI						
TPF60007	Personal Development and Professional Ethics	2	0	0	2	
UBU60003	Entrepreneurship	2	0	0	2	
TPF60015	Practical of Entrepreneurship	0	1	0	1	
TPO62032$^{\alpha}$	Design of Bioprocess Reactor	3	0	0	3	TPO62015, TPO62021
TPO62033$^{\alpha}$	Practical of Bioprocess Reactor Design	0	1	0	1	TPO62015, TPO62021

TPO62034$^{\alpha}$	Industrial Bioprocess Manufacturing	3	0	0	3	
TPO62035	Application of Fermentation Technology	3	0	0	3	TPO61026
TPO62036$^{\phi}$	Modelling and Optimation of Biological Systems	2	0	1	3	TPO62014
TPO62037	Bioenergy Engineering	2	0	0	2	
UBU60002	Internship	0	3	0	3	Choose One and have taken 80 credits
UBU60005	Community Service Program	0	4	0	4	
	Total	**17**	**6**	**1**	**24**	
SEMESTER VII						
	Elective Subject 1	2	1	0	3	
	Elective Subject 2	2	1	0	3	
	Elective Subject 3	2	0	0	2	
	Total	**6**	**2**	**0**	**8**	
SEMESTER VIII						
UBU60001	Undergraduate Thesis	6	0	0	6	
	Elective Subject 1	2	1	0	3	
	Elective Subject 2	2	0	0	2	
	Elective Subject 3	2	0	0	2	
	Total	**12**	**1**	**0**	**13**	
	Total Credits				**144**	

ELECTIVE COURSE IN BIOPROCESS ENGINEERING STUDY PROGRAM

Code	Subjects	Credits				Description / Prerequisites
		K	Pr	R	Σ	
ODD SEMESTER						
TPO61038	Membrane Technology and Processes	2	0	0	2	TPO61023
TPO61039	Practical of Membrane Technology and Processes	0	1	0	1	TPO61023
TPO61040	Computational Fluid Dynamics	2	0	1	3	TPO61008
TPO61041	Industrial Wastewater Treatment	2	0	0	2	
TPO61042	Herbs Technology	2	0	0	2	
TPO61043	Calibration in Engineering	2	0	0	2	
TPO61044	Practical of Calibration in Engineering	0	1	0	1	
TPL61043	Clean Technology	2	0	0	2	
TPB61014	Food Biotechnology	2	0	0	2	
EVEN SEMESTER						
TPO62045	Advanced Programming	2	0	0	2	TPO62006
TPO62046	Non Thermal Processing Technology	2	0	0	2	
TPE62029	Ergonomics, Occupational Health and Safety	2	0	0	2	

TPE62058	Robotics in Biosystems	2	0	0	2	TPO62017, TPO62018
TPE62059	Practical of Robotics in Biosystems	0	1	0	1	TPO62017, TPO62018
TPP62014	Quality Management System and Halal Assurance	2	0	0	2	
TPB62012	Biosensor	2	0	0	2	


Course Sequences for Bachelor of Bioprocess Engineering Universitas Brawijaya
Bioprocess Engineering
Semester 1 (20 Credits)
RELIGION
CIVIC EDUCATION
ENGLISH
BASIC CHEMISTRY
BIOLOGY
INTRO. OF BIOPROCESS ENG.
PHYSICS
BASIC MATHEMATICS
Semester 2 (21 Credits)
PANCASILA
INDONESIAN LANGUAGE
ORGANIC CHEMISTRY
ENGINEERING MECHANICS
FOOD CHEMISTRY
ESSENTIAL MICRO-BIOLOGY
INTRO. APP. COMPUTERS
CALCULUS 1
Semester 3 (22 Credits)
ENGINEERING ECONOMICS
BIOMATERIAL
TRANSPORT PHENOMENA 1
COMPUTER AIDED DESIGN
AUTOMATIZATION 1
BASIC BIOCHEMISTRY
THERMO-DYNAMICS
CALCULUS 2
Semester 4 (22 Credits)
ENZYME TECHNOLOGY
CHEMICAL REACTION ENGINEERING
TRANSPORT PHENOMENA 2
OPERATIONAL MANAGEMENT
AUTOMATIZATION 2
BIOPROCESS UNIT OPERATION
OPERATION RESEARCH
BIOPROCESS APPLIED MATHEMATICS
Semester 5 (19 Credits)
SCIENTIFIC METHOD
BIOSEPARATION ENGINEERING
ITERATIVE METHOD
BASIC FERMENTATION TECHNOLOGY
INSTRUMENTS ANALYSIS
EXPERIMENTAL DESIGN
BASIC BUSINESS MANAGEMENT
BASIC BIOTECHNO-LOGY
Semester 6 (24 Credits)
PROFFESIONAL ETHICS
ENTREPRENEURSHIP
DESIGN OF BIOPROCESS REACTOR
FERMENTATION TECH. APPLICATION
DESIGN OF BIOPROCESS INDUSTRY
MODELING & OPTIMIZATION OF BIOLOGICAL SYSTEM
BIOENERGY ENGINEERING
INTERNSHIP
COMMUNITY SERVICE
Semester 7 (9 Credits)
MEMBRANE TECH. & PROCESS
COMPUTATIONAL FLUID DYNAMICS
INDUSTRIAL WASTE MANAGEMENT
HERBS TECHNOLOGY
CALLIBATION TECHNIQUE
GREEN TECHNOLOGY
FOOD BIO-TECHNOLOGY
Semester 8 (13 Credits)
UNDER-GRADUATE THESIS
ADVANCED PROGRAM-MING
NON-THERMAL PROCESSING TECHNOLOGY
ERGONOMICS & HSE
BIOSYSTEM ROBOTICS
QUALITY MANAGEMENT SYSTEM & HALAL ASSURANCE
BIOSENSOR
Compulsory Course
Compulsory Course and Select one
Odd/Even Elective Course

COURSE SYLLABUS OF BIOPROCESS ENGINEERING STUDY PROGRAM

TPO61001	**INTRODUCTION TO BIOPROCESS ENGINEERING**	**2 (2-0)**
This course contains the development of bioprocesses in an interdisciplinary perspective. Basic engineering calculations applied in biological processes, physical process processes, fluid flow, heat, mass transfer and operating units. Principles of bioreactors, bioreactor systems, basic bioreactor design, bioprocess scale multiplication, and bioprocess controlling.		
Course Learning Outcomes (CLO): 1. Able to understand and explain the definition of bioprocess techniques and their position in the scientific tree, including biosystem engineering 2. Able to explain aliphatic compounds, functional groups and organic compounds. 3. Able to analyze and present the principles of bioprocess engineering. 4. Able to understand and explain the development of bioprocess engineering in educational world and industry to support a bio-based economy.		
TPO61002	**ENGINEERING MECHANICS**	**3 (2-1)**
This course studies the equilibrium that affects bioreactor system (concurent, parallel, non-concurent non-parallel), work and energy in the bioreactor, and analysis of bioreactor strength materials.		
Course Learning Outcomes (CLO): 1. Able to explain, make schemes, and calculate the concept of vector operation in a force-balanced system. 2. Able to explain, make schemes, and calculate dynamic system parameters / moving objects.		
TPO62003	**FOOD CHEMISTRY**	**2 (2-0)**
This course studies the knowledge about chemical structure, physico-chemical properties, chemical reactions, the role / function of chemical components of food and food products including: water, carbohydrates, proteins, fats, vitamins, minerals, and other components. Changes in the physico-chemical characteristics of food in the form of molecules, granules and processed products due to food processing such as denaturation, rancidity, retrogradation, syneresis, gelatinization, hydro-colloid properties, off-flavor, browning. This course also briefly discusses the interactions between chemical components in food products.		
Course Learning Outcomes (CLO): 1. Able to mention and explain chemical compounds in food ingredients. 2. Able to explain the interactions that occur between chemical components in food products during processing. 3. Able to apply the principles of food chemistry to design food bioproducts.		
TPO62004	**ESSENTIAL MICROBIOLOGY**	**2 (2-0)**
This course studies the basics of microbiology, understanding and scope of microbiology, types of microbes, biochemical principles, structure and composition of prokaryotic and eukaryotic cells, microbial nutrition, microbial cultivation, microbial growth, microbial metabolism, microbial control,		

microbial genetics and microbial applications in the industry.

Course Learning Outcomes (CLO):

1. Able to explain and discuss the definition of microbiology, the scope of microbiology, the properties of microbes.
2. Able to explain and apply microbiology for upstream processes in the bioprocess field.
3. Able to formulate, demonstrate and demonstrate the principles of cultivation, growth, microbial control.

TPO62005	**ESSENTIAL MICROBIOLOGY LAB WORK**	**2 (0-2)**

This course provides basic practice of identification, isolation, microbial cultivation and application to the field of bioprocess engineering.

Course Learning Outcomes (CLO):

1. Able to characterize the properties of microbes
2. Able to elaborate the principles of cultivation, growth, microbial control.
3. Able to apply microbiology for upstream processes in the bioprocess field

TPO62006	**INTRODUCTION TO COMPUTER APPLICATION**	**2 (0-2)**

This course studies about computer science and computation, the introduction of hardware in computers and software in computing. Computer application for statistical, mathematical and numerical analysis. Use of computers for the creation of graphs, tables and scientific presentations. Application of computation to solving the problems in bioprocess industry.

Course Learning Outcomes (CLO):

1. Able to explain basic concepts of computer hardware and software.
2. Able to explain and create simple algorithm schemes using flow charts.
3. Able to explain and create simple application and / or database programs.
4. Able to know and explain IC3 test.

TPO62007	**PRACTICAL OF INTRODUCTION TO COMPUTER APPLICATION**	**1 (0-1)**

This course provides a basic practice of introducing computer hardware and software computation to solve problems in bioprocess industry.

Course Learning Outcomes (CLO):

1. Able to use basic concepts of computer hardware and software.
2. Able to create simple algorithm schemes using flow charts
3. Able to create a simple database application using computer software

TPO61008	**TRANSPORT PHENOMENA 1**	**2 (2-0)**

This course explains the basic concepts and properties of fluids, fluid statics, fluid kinematics, fluid dynamics, diffusivity and mass transfer mechanisms, the distribution of concentrations in laminar and turbulent flows. Prerequisite: TPE61003.

Course Learning Outcomes (CLO):

1. Able to understand and explain the definition and principles of the movement phenomenon.
2. Able to analyze and present the basic laws of the phenomenon of movement both momentum, energy and mass.
3. Able to understand and explain the movement phenomenon in the field of bioprocess engineering.

TPO61009	**COMPUTER AIDED DESIGN (CAD)**	**2 (2-0)**

This course studies the introduction of CAD, History, Uses, and Software, Introduction to CAD program graphic interfaces (Start, Organize, Save, Control Drawing views, units, toolbars), Operating CAD software to create basic 2D drawing objects with basic tools, inclusion dimensions, format, properties, viewports, commands and image modification. Techniques for serving 2D images and plotting. The introduction of 3D objects includes definitions of functions and benefits; 3D Solid Objects (Box, Sphere, Cylinder, Cone, Wedge, Torus); Get to know 3D modification (3D VIEW, 3D SURFACE, 3D RENDERING; Advanced 3D modification for various types of objects; 3D modification with commands; Layering system; 3D image presentation and plotting techniques.

Course Learning Outcomes (CLO):

1. Able to identify the use of drawing tools
2. Able to identify principles of engineering drawing according to ISO standard
3. Able to prepare design of engineering drawing
4. Able to create design of machinery components using software

TPO61010	**PRACTICAL OF COMPUTER AIDED DESIGN (CAD)**	**1 (0-1)**

This course provides practical operation of CAD software from basic tools, image modification and presentation.

Course Learning Outcomes (CLO):

1. Able to identify the use of drawing tools
2. Able to identify principles of engineering drawing according to ISO standard
3. Able to prepare design of engineering drawing
4. Able to create design of machinery components using software

TPO61011	**AUTOMATION 1**	**2 (2-0)**

This course studies the basics of electronics and instrumentation, data acquisition and data processing, the principles of physical, chemical and biological measurement in bioreactors, an understanding of analog and digital data, and the basic principles of electronic components and instrumentation.

Course Learning Outcomes (CLO):

1. Able to explain the working concept of basic electronic components.
2. Able to explain, make diagrams, calculate, assemble, and measure by applying the basic theory of electronics.

3. Able to explain, make diagrams, discuss parts of the instrumentation system.
4. Able to explain, create schemes, arrange, evaluate instrumentation systems.

TPO61012	**PRACTICAL OF AUTOMATION 1**	**1 (0-1)**

This course provides basic practice of electronics and physical, chemical and biological measurements in bioreactors.

Course Learning Outcomes (CLO):

1. Able to use basic electronic components
2. Able to assemble electronic components into instrumentation determined

TPO61013	**BASIC BIOCHEMISTRY**	**2 (2-0)**

This course studies about carbohydrates, proteins, fats, glycolysis, gluconeogenesis, phentose, phosphate pathway, photosynthesis processes, metabolism, citric acid cycle, fatty acid oxidation, amino acid biosynthesis.

Course Learning Outcomes (CLO):

1. Able to understand and explain the principles of science (biochemistry) in identifying, formulating and solving problems in the field of bioprocess technology.
2. Able to analyze and present the biochemical reactions that occur in a compound.
3. Able to understand and explain knowledge about biochemistry.

TPO62014	**APPLIED MATHEMATICS IN BIOPROCESS**	**3 (2-1)**

This course provides knowledge about the review of Ordinary and Partial Differential Equations. Application of Order 1 Ordinary Differential Equations in Fluid Problems, Heat Transfer Problems, Kinematics and dynamics, Electrical Problems, Growth and Death Models of Microorganisms, Application of PD to reaction rates, First order reaction kinetics, Review of Order 2 Differential Equations. Application of Order 2 Ordinary Differential Equations in 2nd order reaction kinetics problems, RCL circuit electrical problems, problems in the form of partial differential equations, 1-dimensional conduction cases in Cartesian coordinates and cylinder coordinates.
Prerequisite: TPE61018

Course Learning Outcomes (CLO):

1. Able to elaborate all of the knowledge in basic mathematics, calculus 1 and 2 to solve problems in engineering field.
2. Able to make a model from various engineering problems in the form of differential equations.
3. Able to solve differential equation models that involve both boundary conditions and initial conditions, both in the form of ordinary differential equations and in the form of partial differential equations.
4. Able to demonstrate list structures, tuple and dictionary.
5. Able to make dynamic equations from the model.

TPO62015	**CHEMICAL REACTION ENGINEERING**	**3 (2-1)**

This course consists of several subjects which include an introduction: understanding kinetics review and thermodynamic review, chemical reaction kinetics, chemical reaction thermodynamics, catalysts, biocatalysts, bioreactors, enzymatic reaction kinetics.

Course Learning Outcomes (CLO):

1. Able to explain and discuss the definition of chemical reactions, types and properties.
2. Able to formulate, show and demonstrate technical problems in chemical reactions.
3. Able to explain and apply chemical reaction kinetics, chemical reaction thermodynamics, catalysts, biocatalysts, bioreactors, enzymatic reaction kinetics.
4. Able to analyze and present research results in relation to the formulation of Chemical Reaction Engineering individually and in groups.

TPO62016	**TRANSPORT PHENOMENA 2**	**2 (2-0)**

This course is a continuation of the transport phenomenon 1 which explains more about thermal conductivity and heat transfer mechanisms; thermal conductivity of gases, liquids and solids; Natural convection and forced convection; heat distribution in solids; Heat distribution in laminar and turbulent flow; viscosity theory and moving momentum; velocity distribution in laminar and turbulent flow; equations of continuity, motion and mechanics; theory and properties of liquid polymers.
Prerequisite: TPO61008

Course Learning Outcomes (CLO):

1. Able to explain and elaborate on mass flow including mass concentration, velocity and flux.
2. Able to explain and understand about Fick's Law related to the diffusivity coefficient.
3. Able to explain and discuss solid material concentration distribution in laminar flow.
4. Able to explain the equation of change for multicomponent systems related to the diffusion process associated with energy, pressure, force and simultaneous equations for heat and mass transfer.
5. Able to explain the distribution of velocity, temperature and concentration in laminar conditions with a number of variables more than one (in steady and unstable state).
6. Able to explain about the transport of momentum, energy and mass in turbulent conditions with two variables (in a steady and unstable state).

TPO62017	**AUTOMATION 2**	**2 (2-0)**

This course studies the basics of control systems, various control algorithms, monitoring and control of the fermentation process, feedback control, indirect metabolic control, programmatic control, artificial intelligence applications in bioprocess control, bioreactor control applications from the measurement results of physical, chemical and biology.
Prerequisite: TPO61011.

Course Learning Outcomes (CLO):

1. Able to explain, make diagrams, calculate mathematical models of systems.
2. Able to explain, and calculate dynamic system response.
3. Able to design and analyze control systems for bioreactor cases.
4. Able to explain various kinds of up-to-date concepts of modern bioprocess control systems.

TPO62018	**PRACTICAL OF AUTOMATION 2**	**1 (0-1)**

This course provides basic practice of control systems from the measurement results of physical, chemical and biological quantities.
Prerequisite: TPO61012

Course Learning Outcomes (CLO):

1. Able to identify characteristics sensor and actuator
2. Able to create a simple control system using sensor and actuator

TPO62019	**OPERATIONAL MANAGEMENT**	**2 (2-0)**

This course discusses the definition and scope of operations management in the bioprocess industry, operations strategy, product design and selection processes (manufacturing and services), methods of determining factory locations, capacity planning, forecasting, aggregate and disaggregation planning, inventory control (deterministic, probabilistic and uncertainty), MRP II and CRP, scheduling (labor and machinery), production on time**.**

Course Learning Outcomes (CLO):

1. Able to understand and explain the operational management function and its relationship with the organization's operating strategy adopted by the organization.
2. Able to explain, analyze and discuss product design and development.
3. Able to understand and explain quality concepts, quality management principles and quality management implementation.
4. Able to explain and calculate site selection methods, capacity planning, scheduling, aggregate planning, inventory management and forecasting.
5. Able to explain, calculate and evaluate operational activities in the organization.

TPO61020	**PRACTICAL OF OPERATIONAL MANAGEMENT**	**1 (0-1)**

This course provides operational management practices in the bioprocess industry.

Course Learning Outcomes (CLO):

1. Able to apply the capacity planning, scheduling, aggregate planning, inventory management and forecasting using several computer software

TPO61021	**BIOPROCESS UNIT OPERATIONS**	**2 (2-0)**

This course provides knowledge and understanding of the definition of bioprocess operation units with a discussion of: black box diagram philosophy, dimensional units, engineering approach methods, basics of momentum transfer, basics of thermodynamics and heat transfer, heat exchangers, evaporation, drying, mixing. and homogeneation, solid-liquid separation (crystallization, filtration, adsorption), liquid-liquid separation (extraction, distillation, filtration membrane). Bioprocess production lay out.

Course Learning Outcomes (CLO):

1. Able to explain and discuss the definition of unit operations in bioprocess.
2. Able to formulate, demonstrate and demonstrate various operating units in bioprocess.
3. Able to explain and apply the principles of the bioprocess operation unit to produce bioproducts.

TPO61022	**PRACTICAL OF BIOPROCESS UNIT OPERATIONS**	**1 (0-1)**

This course provides operational practice for basic units in the field of bioprocess engineering, especially for upstream processes.

Course Learning Outcomes (CLO):

1. Able to carry out experiments by sundry unit operations

TPO61023	**BIOSEPARATION ENGINEERING**	**2 (2-0)**

This course explains several separation techniques in the bioprocess industry both in the upstream and downstream processes, the principles of bioseparations and their differences with chemical separation, including the separation of solids, liquids, solids-liquids such as sedimentation, centrifugation, distillation, absorption and adsorption, chromatography, ordinary filtration, membrane filtration and crystallization.

Course Learning Outcomes (CLO):

1. Able to explain and discuss the definition of bioseparations and types of separation.
2. Able to formulate, show and demonstrate various types of separation techniques that can be applied in the separation process.
3. Able to explain and apply the principles of bioseparations techniques in identifying, formulating and solving problems in the field of bioprocess technology.
4. Able to analyze and present the most suitable separation method to solve problems related to separation in the field of bioprocess technology.

TPO61024	**PRACTICAL OF BIOSEPARATION ENGINEERING**	**1 (0-1)**

This course provides operational practice for separation units in bioprocess field.

Course Learning Outcomes (CLO):

1. Able to perform presentation of data, measures of central tendency and variability
2. Able to use the concept of probability and probability distribution

TPO61025	**ITERATION METHOD**	**2 (2-0)**

This course provides descriptions of the differences between analytic and iterative methods, interpolation, extrapolation, partial differential equations, differential integral iterations, roots of equations and non-linear equations, examples of applications of iterative solving in differential and integral equations. Prerequisite: TPE61004.

Course Learning Outcomes (CLO):

1. Able to explain the fundamental difference between iterative solving and analytic solving.
2. Able to explain, solve, mathematical problems using iteration methods.
3. Able to apply and discuss the use of iteration methods on bioprocess problems.
4. Able to evaluate the advantages and disadvantages of using comparative methods.

TPO61026	**BASIC FERMENTATION TECHNOLOGY**	**2 (2-0)**

This course provides an understanding of the importance of fermentation in industry. The principle of fermentation, types of fermentation. Biological materials / agents for the fermentation process,

microorganisms in fermentation. Fermentation methods and techniques, substrate handling, starter, medium and inoculation. Sterilization. Fermenter design and control, fermentation kinetics, process control, separation equipment in fermentation. Fermentation technology applications in industry (food, biomass, non-food). Prerequisite: TPO62004, TPO61013.

Course Learning Outcomes (CLO):

1. Able to understand and explain the principles of science (fermentation) in identifying, formulating and solving problems in the field of bioprocess technology.
2. Able to analyze and design bioreactors (fermenters) and their components, systems and processes.
3. Able to understand and explain problems related to fermentation technology in the field of bioprocess technology.

TPO61027	**INSTRUMENT ANALYSIS**	**3 (3-0)**

This course provides basic knowledge to do an analysis using instruments. Components, working principles, interpretation of the results of several component analysis tools (FTIR, GC, LC, MS, HPLC, NMR, XRD, XRF), microscopy (SEM, TEM), thermal analysis (DSC, DTA, TGA), porosity (BET, surface area analyzer), texture (texture analyzer).

Course Learning Outcomes (CLO):

1. Able to explain the definitions and working principles of various instruments for analysis of physical, chemical and biological quantities.
2. Able to explain the application of various instruments for analysis of bioprocess and biomaterial.
3. Able to analyze and present the selection of appropriate instruments for the characterization of materials and processes in the bioprocess field.

TPO61028	**EXPERIMENTAL DESIGN**	**2 (2-0)**

This course provides an introduction to statistics; Regression and correlation analysis; ANOVA; Experimental design (DOE); Evaluate research topics and problem boundaries; Factor selection, level and response; Measurement errors on factors and responses; Ranking of factors; basic experiments and mathematical models; full and partial factorial based experiments; statistic analysis; optimization (RSM, Taguchi).

Course Learning Outcomes (CLO):

1. Able to explain, use, and demonstrate statistical methods for experimental design.
2. Able to explain, and operate experimental design software.

TPO61029	**PRACTICAL OF EXPERIMENTAL DESIGN**	**1 (0-1)**

This course learn about research design practice and statistical analysis in the field of bioprocess engineering.

Course Learning Outcomes (CLO):

1. Able to explain waste treatment technology according to waste type and characteristics
2. Able to calculate needs and design aerobic and anaerobic waste treatment systems

TPO61030	**FUNDAMENTALS OF BUSINESS MANAGEMENT**	**2 (2-0)**

This course provides an explanation of the basics of business management, business definitions, the nature and types of business activities, the role of bioprocess business in bioeconomic development, business characteristics in the bioprocess field and factors affecting business performance in the bioprocess industry.

Course Learning Outcomes (CLO):

1. Able to explain and detail the application of management functions in managing business.
2. Able to determine alternative strategic actions that are most effective in certain business environment situations.
3. Able to explain roles and determine how human resources and physical resources are managed in a company.
4. Able to describe marketing concepts and marketing strategies.
5. Able to evaluate and discuss cases of HR management, business strategy, marketing and the environment in a company.

TPO61031	**BASIC OF BIOTECHNOLOGY**	**2 (2-0)**

This course discusses knowledge including: genetic material, vector cloning, restriction assurance, recombinant DNA technology, introduction to molecular methods for DNA amplification, polymerase chain reaction, DNA synthesis, DNA sequencing, genetic manipulation, mutagenesis, expression optimization, repair of microbial strains. Genetically modified products (bioplastics, polymers, biodiesel and pharmaceuticals), Bioprocesses (renewable fuels: ethanol, methanol, biogas; organic acids)..

Course Learning Outcomes (CLO):

1. Able to explain and discuss definitions of genes, genomes, microorganism cell structure, DNA and RNA.
2. Able to formulate, demonstrate and demonstrate the history of genetic engineering, a type of genetic engineering consisting of mutations, cloning and others.
3. Able to explain and re-apply plant biotechnology related to the definition and history of plant biotechnology, transgenic plants, and transgenic plant applications.
4. Able to analyze and evaluate biotechnology in health, namely detecting and diagnosing human diseases, medical products using biotecchnology and gene therapy.

TPO62032	**DESIGN OF BIOPROCESS REACTOR**	**3 (3-0)**

This course is one of the top courses that discusses the notion of bioprocess reactor design, microorganisms, bioractor equilibrium, yield, design equations, heat and mass transfer in bioreactors, fluid dynamics in bioreactors, bioreactor configuration, bioreactor construction, monitoring and control of bioreactors, ideal reactor operation, sterilization, scale up of the bioreactor, development of new reactors. Prerequisite: TPO62015, TPO62021

Course Learning Outcomes (CLO):

1. Able to elaborate knowledge about mathematics and natural science materials to plan bioreactors.
2. Able to formulate and operate the process of converting biomass materials into high value derivative products.
3. Able to design a bioreactor and master biochemical reactions which include: control of material / material requirements and criteria, process mechanisms, instrumentation, process control.
4. Able to communicate and collaborate with various multidisciplinary groups in developing bioreactor

designs.

5. Able to evaluate and assess the performance of a bioreactor as a whole (economic, technical, social).

TPO62033	**PRACTICAL OF BIOPROCESS REACTOR DESIGN**	**1 (1-0)**

The course studies about elaborate knowledge about mathematics and natural science materials to plan bioreactors and create it which include: control of material / material requirements and criteria, process mechanisms, instrumentation, process control.

Course Learning Outcomes (CLO):

1. Able to design a bioreactor and master biochemical reactions which include: control of material / material requirements and criteria, process mechanisms, instrumentation, process control.
2. Able to communicate and collaborate with various multidisciplinary groups in developing bioreactor designs.
3. Able to evaluate and assess the performance of a bioreactor as a whole (economic, technical, social).

TPO62034	**INDUSTRIAL BIOPROCESS MANUFACTURING**	**3 (3-0)**

This course is one of the top courses, where students must be able to elaborate on all the courses that have been obtained to design a Bioprocess Industry. The courses in question are courses that contain soft skills, Economics and Management as well as Technical which includes planning, testing and evaluation. Lecture materials include: Professional Ethical Values and Law in Industrial Planning (understanding of ISO, Law, Regulation, etc.), Natural Resources Analysis (raw materials), Market Analysis, Business Feasibility Planning, Planning for Human Resources and Financial Needs, Themes regarding types of non-food food products or commodities for case studies, factory layout planning, complete planning and analysis of operational unit needs, evaluation planning, maintenance planning, dynamic operation simulations, large tasks of bioprocess industrial planning with output in the form of technical drawings and feasibility documents effort.

Course Learning Outcomes (CLO):

1. Able to design a processing system.
2. Able to analyze capacity requirements, machines, utilities, mass and energy balances in bioprocess-based plant design.
3. Able to compile and discuss bioprocess industry design proposals.

TPO62035	**APPLICATION OF FERMENTATION TECHNOLOGY**	**3 (3-0)**

This course discusses the importance of fermentation in industry. The principle of fermentation, types of fermentation. Biological materials / agents for the fermentation process, microorganisms in fermentation. Fermentation methods and techniques, substrate handling, starter, medium and inoculation. Sterilization. Fermenter design and control, fermentation kinetics, process control, separation equipment in fermentation. Fermentation technology applications in industry (food, biomass, non-food).
Prerequisite: TPO61011

Course Learning Outcomes (CLO):

1. Able to explain the definitions and principles of various fermentation technology applications in food and non-food.

2. Able to explain the basis of fermentation technology in food and non-food processing and its application.
3. Able to analyze and present research that produces fermentation-based food and non-food products (bioproducts) to solve problems related to the field of Bioprocess Technology.

TPO62036	**MODELLING AND OPTIMATION OF BIOLOGICAL SYSTEMS**	**3 (2-1)**

This course provides knowledge and an introduction to the application of the basics of modeling so that students have an understanding of how to make models from translating biological systems to mathematical equations. Application of basic engineering principles through flowchart making to mathematical equations then solving these equations and simulating in a computer program.
Prerequisite: TPO62007.

Course Learning Outcomes (CLO):

1. Able to elaborate various scientific disciplines in solving biological systems.
2. Able to compile a bioconversion process algorithm and describe it in the form of a mathematical model.
3. Able to complete the model into a response function, both analytically and iteratively.
4. Able to show the accuracy and accuracy of the model by performing simulations.

TPO62037	**BIOENERGY ENGINEERING**	**2 (2-0)**

Bioenergy engineering courses provide an understanding of biomass-based energy. Including knowledge about introduction and bioenergy material. World and national energy needs, as well as energy availability, energy planning and human needs, energy sources and energy needs in the future. Energy from biomass sources, benefits of biomass utilization, energy conversion from biomass through direct combustion, pyrolysis, fermentation, anaerobic digestion, esterification and transesterification.

Course Learning Outcomes (CLO):

1. Able to make products variation.
2. Able to arrange operational process map, assembly map, routing sheet, multiple product process chart, organizational structure and workforce plan, floor area calculation, from-to chart of material handling cost, inflow-outflow map, and priority scale, activity relationship diagram and area allocation diagram.

TPO61038	**MEMBRANE TECHNOLOGY AND PROCESSES**	**2 (2-0)**

This course provides an explanation of the basics of membrane technology, the principles of separation with membranes, membrane preparation made from ceramics, metals and polymers, characterization of membrane materials, membrane processes and systems, membrane applications for food processing (fruit industry, milk and its derivatives.), supply of drinking water and purification of waste and by-products. Membrane applications in the bioprocess field.
Prerequisite: TPO61023

Course Learning Outcomes (CLO):

1. Able to explain and discuss membrane definitions, basic terms in membrane processes, and types of membrane processes.

2. Able to explain and discuss membrane synthesis methods and their characterization.
3. Able to explain and apply membrane technology and processes in the bioprocess field.
4. Able to formulate, demonstrate and demonstrate methods of synthesis and membrane characterization.

TPO61039	**PRACTICAL OF MEMBRANE TECHNOLOGY AND PROCESSES**	**1 (0-1)**

This course provides practice of measuring basic quantities/parameters in membrane processes such as flux, rejection, manufacture of polymer membranes and basic characterization of membrane materials.
Prerequisite: TPO61023

Course Learning Outcomes (CLO):

1. Students are able to make production plan which starting from determining the location, determining the production capacity, composing demand forecasting and making aggregate plan
2. Students are able to handle deterministic and probabilistic inventory control
3. Students are able to make material requirements planning

TPO61040	**COMPUTATIONAL FLUID DYNAMICS**	**3 (2-1)**

This course explains the basics of CFD, Navier-Stokes equations, mathematical models and boundary conditions, mesh and grid generation, discretization (Finite Element Methods, Finite Difference Methods and Finite Volume Methods), introduction to CFD software.
Prerequisite: TPO61008

Course Learning Outcomes (CLO):

1. Able to explain the definition of basic principles of fluid dynamics and their computations.
2. Able to explain fluid dynamics computational procedures and some mathematical model approaches used.
3. Able to analyze and present the results of fluid dynamics computational analysis about problems in the field of bioprocess engineering.

TPO61041	**INDUSTRIAL WASTEWATER TREATMENT**	**2 (2-0)**

This course explains the principles of industrial wastewater treatment, covering the basics of physical waste treatment (filtration, sedimentation), chemistry (flocculation, coagulation), biology (activated sludge), the use of advanced technology in waste treatment (MBR, IFASS etc.), application of control and optimization in waste treatment. Characterization of liquid waste and its treatment standards; Dissolved, organic and inorganic pollutants; Colloids and oil emulsions; BOD, COD and TOC; Organic degradation by aerobic systems and activated sludge; Bioreactors and aeration systems; Aerobic treatment with a biofilm system; Anaerobic degradation; Biodegradation of certain organic compounds; Nitrification, denitrification and phosphorus separation; Integrated waste treatment.

Course Learning Outcomes (CLO):

1. Able to understand and explain the quality of clean water for industry and sources of water pollutants in the industrial world.
2. Able to understand and explain the principles of industrial wastewater treatment and its operating units in physics, biology, chemistry and advanced technology in industrial wastewater treatment.

3. Able to analyze and present the selection of bioprocess industrial wastewater treatment units.

TPO61042	**HERBS TECHNOLOGY**	**2 (2-0)**

This course includes an introduction to: Introduction, development, and use of natural ingredients (herbs) as medicinal ingredients. Diversity of herbal medicinal ingredients and their active ingredients. Identification and characterization of the physical, chemical and biological properties of herbal ingredients. Herbal remedies and preparations. Capsule formulations for herbal medicinal preparations. Introduction of separation (extraction) and purification (isolation) techniques of active herbal ingredients, Mixing preparation technology. Testing the efficacy of herbal ingredients and their toxicology. Drug preparation formulations. Case studies: current issues related to herbal medicines.

Course Learning Outcomes (CLO):

1. Students are able to have an insight into the application of Bioprocess technology in herbal processing.
2. Students are able to analyze herbal ingredients and their pharmacological benefits.
3. Students are able to explain the formulation of medicinal preparations from herbal ingredients.
4. Students have skills in the design of bioproduct conversion based on herbal ingredients.

TPO61043	**CALIBRATION IN ENGINEERING**	**2 (2-0)**

This course provides knowledge and introduction to Measurement and Calibration, Mass Calibration, Temperature Calibration, Volume Calibration, Electrical Calibration, Dimensional Calibration.

Course Learning Outcomes (CLO):

1. Able to explain the concept of performing calibration.
2. Able to explain, make diagrams, calculate, the uncertainty value of a calibration.
3. Able to explain, make calibration procedures.
4. Able to explain, make and issue calibration certificates.

TPO61044	**PRACTICAL OF CALIBRATION IN ENGINEERING**	**1 (0-1)**

This course provides basic practice of measuring and calibrating various quantities of mass, temperature, volume and electricity.

Course Learning Outcomes (CLO):

1. Able to make diagrams, calculate, the uncertainty value of a calibration.
2. Able to apply calibration procedures.

TPO62045	**ADVANCED PROGRAMMING**	**2 (2-0)**

This course explains the Matlab program and its similar programs and its benefits. Introduction to Matlab, basic computer programming, variables and constants, operators, formulas and functions, matlab toolboxes. Introduction to Matlab work environment, signs and variables, working with workspaces, storing and retrieving data, examples of simple math problems. General rules in matlab (variables and operators), introduction to help matlab. Review of Linear Algebra, Arrays and Matrices, Polynomials. Computer programming. Matlab programming. Variable string, M-File script. Relations, Logic and

program control. Data analysis (std deviation, mean, etc.), interpolation. Making the M-File function. 2D and 3D visualization. Read and write data, graphic layouts, and scripts. Standard algebraic operations, differential and integral, search with Solve. Introduction to GUI and Simulink. Numerical simulation. Prerequisite: TPO62005.

Course Learning Outcomes (CLO):

1. Able to comprehend the concept of industrial project planning and the strategies in estimating the project.
2. Able to analyze industrial management aspects in sustainable agroindustry project planning.

TPO62046	**NON THERMAL PROCESSING TECHNOLOGY**	**2 (2-0)**

The Non-Thermal Processing Technology course provide the explanation about non-thermal processing techniques for agricultural materials, especially for food. The non-thermal techniques described in this course include: 1. Physical processes such as High Preseure Processing (HHP), 2. Electromagnetic processes such as Pulsed Electric Field (PEF), 2. Irradiation and UV treatment, 3. ozone treatment, 4. gas phase chlorine dioxide treatment etc. 5. Combination with thermal or non-thermal technology, 6. commercialization of this technology.

Course Learning Outcomes (CLO):

1. Able to understand and explain types of non-thermal processing, general comparison with thermal processing technology.
2. Able to explain, assemble, and calculate with physical processing techniques.
3. Able to explain, assemble, and calculate with processing techniques using electromagnetic processes.
4. Able to explain, make designs and discuss non-thermal technology combinations.