Republic of the Philippines
OFFICE OF THE PRESIDENT
COMMISSION ON HIGHER EDUCATION

CHED MEMORANDUM ORDER
No. 94
Series of 2017

SUBJECT: POLICIES, STANDARDS, AND GUIDELINES FOR THE BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING (BSABE) PROGRAM EFFECTIVE ACADEMIC YEAR 2018-2019

In accordance with the pertinent provisions of Republic Act (RA) No. 7722, otherwise known as the *"Higher Education Act of 1994,"* in pursuance of an outcomes-based quality assurance system as advocated under CMO 46 s. 2012 (Policy-Standard to Enhance Quality Assurance (QA) in Philippine Higher Education through an Outcomes-Based and Typology-Based Quality Assurance) and as addendum to CMO 37, s. 2012 (Establishment of an Outcomes-Based Educational System in Higher Education Institutions offering Engineering Programs), and by virtue of Commission *en banc* Resolution No. 788-2017 dated October 24, 2017, the following Policies, Standards and Guidelines (PSG) are hereby adopted and promulgated by the Commission.

ARTICLE I
INTRODUCTION

Section 1. Rationale

Based on the *Guidelines for the Implementation of CMO No. 46 series of 2012* and CMO 37 s. 2012, this PSG implements shift to outcomes based education leading to competency based standards. It specifies the "core competencies" expected of BS Agricultural and Biosystems Engineering graduates "regardless of the type of Higher Education Institutions (HEI) they graduate from." However, in recognition of outcomes-based education (OBE) and the typology of HEIs, this PSG also provides ample space for HEIs to innovate in the curriculum in line with the assessment of how best to achieve learning outcomes in their particular contexts and their respective missions.

ARTICLE II
AUTHORITY TO OPERATE

Section 2. Government Recognition

All private higher education institutions (PHEIs) intending to offer BS Agricultural and Biosystems Engineering (BSABE) must first secure proper authority from the Commission in accordance with this PSG. All PHEIs with an existing BSABE program are required to shift to an outcomes-based approach based on CMO 37 s. 2012 and guided by this PSG. State universities and colleges (SUCs), and local universities and colleges (LUCs) should likewise strictly adhere to the provisions in these policies and standards.

Higher Education Development Center Building, C.P. Garcia Ave., UP Campus, Diliman, Quezon City, Philippines
Web Site: www.ched.gov.ph Tel. Nos. 441-1177, 385-4391, 441-1169, 441-1149, 441-1170, 441-1216, 392-5296, 441-1220
441-1228, 988-0002, 441-0750, 441-1254, 441-1235, 441-1255, 411-8910, 441-1171, 352-1871

ARTICLE III
GENERAL PROVISIONS

Based on Section 13 of R.A. 7722, the higher education institution shall exercise academic freedom in its curricular offerings but must comply with the minimum requirements for specific academic programs, the general education distribution requirements, and the specific professional courses.

Section 3. Minimum Standards

The Articles that follow give minimum standards and other requirements and guidelines. The minimum standards are expressed as a minimum set of desired program outcomes which are given in Article IV Section 6. CHED designed a curriculum to attain such outcomes. This curriculum is shown in Article V Section 10 and Section 11 as **sample curriculum**. The number of units of this curriculum is hereby prescribed as the "minimum unit requirements" as per Section 13 of RA 7722. To assure alignment of the curriculum with the program outcomes, this PSG provides a sample curriculum map in Article V Section 12 for the HEI to refer to in compliance with the implementing guidelines of CMO 37, s. 2012.

Using a learner-centered/outcomes-based approach, CHED provided a description of Outcomes-Based Teaching and Learning delivery method in Article V Section 13. The suggested contents of an OBE course syllabus are also given in Article V Section 14 as support to the outcomes-based delivery method. Based on the curriculum and the means of its delivery, CHED determines the physical resource requirements for the library, laboratories and other facilities and the human resource requirements in terms of Administration and faculty. These are provided for in Article VI.

Section 4. Curriculum Design

The HEIs are allowed to design curricula suited to their own contexts and missions provided that they can demonstrate that the same leads to the attainment of the required minimum set of outcomes, albeit by a different route. In the same vein, they have latitude in terms of curriculum delivery and in terms of specification and deployment of human and physical resources as long as they can show that the attainment of the program outcomes and satisfaction of program educational objectives can be assured by the alternative means they propose.

The HEIs can use the **CHED Implementation Handbook for Outcomes-Based Education (OBE) and the Institutional Sustainability Assessment (ISA)** as a guide in making their submissions for Sections 19 to 24 of Article VII.

ARTICLE IV
PROGRAM SPECIFICATIONS

Section 5. Program Description

5.1 Degree Name

The degree program described herein shall be called Bachelor of Science in Agricultural and Biosystems Engineering (BSABE).

5.2 Nature of the Field of Study

The BSABE program is designed to produce graduates who possess knowledge, skills, and attitudes in the application of engineering science and designs to the processes and systems involved in the sustainable production, post production, and processing of safe food, feed, fiber, timber, and other agricultural and biological materials; the efficient utilization, conservation, and management of natural and renewable resources; and development of climate change mitigation measures, in order to enhance human health in harmony with the environment. Agricultural and Biosystems (AB) consist of crops, poultry, livestock, fisheries and aquaculture resources, forestry and other plants, new and renewable energy, wastes, natural resources, and climate.

The graduates of BSABE are expected to understand and apply engineering science and designs to identify, analyse, and create solutions for problems concerning land development; irrigation and drainage including dams, farm roads and bridges; AB production machinery; new and renewable energy; AB buildings and structures; postharvest and processing technologies; climate change, and natural resources, environmental and waste management.

5.3 Program Educational Objectives

Program Educational Objectives (PEOs) are broad statements that describe the career and professional accomplishments that the program is preparing the graduates to achieve within three to five years after graduation. Table 1 gives sample program educational objectives. PEOs shall be aligned with the vision and mission of HEIs and shall be based on the needs of the program's stakeholders. These shall be determined, articulated, and disseminated to the general public by the unit or department of the HEI offering the BSABE program. The PEOs should also be reviewed periodically for continuing quality improvement.

Table 1. Sample Program Educational Objectives

After 3-5 years, the graduates of the BSABE Program shall:
1. provide leadership in planning, implementing, and monitoring ABE projects and programs; 2. occupy supervisory positions in private and public organizations; locally and internationally; 3. own and/or manage ABE-based business enterprises; 4. pursue advance studies in ABE and emerging related fields; 5. occupy responsible positions in ABE education; and 6. other PEOs unique to the institution

5.4 Specific Professions/Careers/Occupations for Graduates

The scope of the practice of Agricultural and Biosystems Engineering, as defined in R.A. 10915, *known as "The Philippine Agricultural and Biosystems Engineering Act of 2016,"* embraces services in the preparation of engineering designs, plans, specifications, project studies, feasibility studies, estimates, and supervision of the construction, operation, and maintenance of irrigation and drainage, soil and water conservation and management systems, agrometeorological systems, AB machinery and power, AB buildings and structures, farm electrification, renewable energy systems, AB processing and postharvest facilities and systems, AB waste utilization and management, AB resource conservation and management, climate change mitigation measures, AB information systems, and AB automation and instrumentation systems.

The enumeration of any work in this section shall not be construed as excluding any other work requiring AB engineering knowledge and application.

The teaching of professional AB engineering subjects in the curriculum of the BSABE degree or a subject in the AB Engineering licensure examination given in any school, college, university or other CHED recognized educational institution is also considered as practice of AB Engineering.

5.5 Allied Programs

The allied programs to ABE are Agriculture, Aquaculture and Fishery, Forest Products Engineering, Environmental Science, Mechanical Engineering, Civil Engineering, Electrical Engineering, Industrial Engineering, and Economics.

Section 6. Institutional and Program Outcomes

The minimum standards for the BS in Agricultural and Biosystems Engineering program are expressed in the following minimum set of Institutional and BSABE Program Outcomes:

6.1 Institutional Outcomes

a) Graduates of professional institutions must demonstrate a service orientation in one's profession;
b) Graduates of colleges must participate in various types of employment, development activities, and public discourses, particularly in response to the needs of the communities one serves;
c) Graduates of universities must participate in the generation of new knowledge or in research and development projects;
d) Graduates of State Universities and Colleges must, in addition, have the competencies to support "national, regional, and local development plans"; and
e) Graduates of higher educational institutions must preserve and promote the Filipino historical and cultural heritage.

6.2. BSABE Program Outcomes

By the time of graduation, the students of the program shall have the ability to:
a) apply knowledge of mathematics and science to solve complex AB engineering problems;
b) design and conduct experiments, as well as to analyze and interpret data;
c) design a system, component, or process to meet desired needs within realistic constraints, in accordance with standards;
d) function in multidisciplinary and multi-cultural teams;
e) identify, formulate, and solve complex engineering problems;
f) understand professional and ethical responsibility;
g) communicate effectively complex AB engineering activities with the engineering community and with society at large;
h) understand the impact of AB engineering solutions in a global, economic, environmental, and societal context;
i) recognize the need for, and engage in life-long learning;
j) know contemporary issues;
k) use techniques, skills, and modern engineering tools necessary for AB engineering practice;
l) know and understand engineering and management principles as a member and leader of a team, and to manage projects in a multidisciplinary environment; and
m) understand at least one specialized field of ABE practice

A PHEI, SUC, or LUC, at its option, may adopt additional mission-related Institutional and Program Outcomes that are not included in the minimum set found in sections 6.1 and 6.2.

ANNEX I presents the Competency Standard, Attributes and Competencies of an Agricultural and Biosystems Engineer which should result from the outcomes stated above.

Section 7. Sample Performance Indicators

Performance Indicators (PI) are specific and measurable statements that identify the performance(s) required to meet the program outcome; confirmable through evidence **(Table 2)**.

Table 2. Sample matrix of a Program Outcome versus Performance Indicators

Program Outcome (PO)		Performance Indicators (PI)	
a	Apply knowledge of mathematics and science to solve complex Agricultural and Biosystems (AB) engineering problems;	1	Identify specific ABE problems
		2	Determine appropriate principles of mathematics, AB science, and/or engineering to solve ABE problem
		3	Formulate strategies to solve specific ABE problem
		4	Apply appropriate strategies to solve specific ABE problem
		5	Evaluate the effectiveness of the solution

Section 8. Program Assessment and Evaluation

Program Assessment refers to one or more processes that identify, collect, and prepare data to evaluate the attainment of Program Outcomes and Program Educational Objectives.

In the case of Program Outcomes Assessment, the defined Performance Indicators shall be connected to Key Courses (usually the Demonstrating or "D" courses in the Curriculum Map), and an appropriate Assessment Method (AM) shall be applied **(Table 3)**. These methods may be direct or indirect depending on whether the demonstration of learning was measured by actual observation and authentic work of the student or through gathered opinions from the student or his peers.

Table 3. Sample matrix connecting Performance Indicators with Key Courses and Assessment Methods

Performance Indicators		Key Courses	Assessment Methods
1	Identify specific ABE problems	Machine Design for AB Production	Written Examinations Laboratory Reports Project Report • each with OBE Assessment Rubric
2	Determine appropriate principles of mathematics, AB science, and/or engineering to solve ABE problems	Calculus 2 Principles of Crop Science Engineering Mechanics	Written Examinations Problem Sets Laboratory Reports • each with OBE Assessment Rubric
3	Formulate strategies to solve specific ABE problem	Engineering Data Analysis Computer Aided	Written Examinations Problem Sets • each with OBE

		Drafting Materials and Processes for ABE	Assessment Rubric
4	Apply appropriate strategies to solve specific ABE problem	Materials and Processes for ABE	Projects • with OBE Assessment Rubric
5	Evaluate the effectiveness of the solution	Machinery Design for AB Production AB Machinery and Mechanization Engineering Economy	Written Examinations Projects Oral Presentation • with OBE Assessment Rubric

For the **Assessment of Program Educational Objectives**, the stakeholders of the program have to be consulted through surveys or focus group discussions to obtain feedback data on the extent of the achievement of the PEOs.

Program Evaluation pertains to one or more processes for interpreting the data and evidence accumulated from the assessment. Evaluation determines the extent at which the Program Outcomes and the Program Educational Objectives are achieved by comparing actual achievement versus set targets and standards **(Table 4)**. Evaluation results in decisions and actions regarding the continuous improvement of the program

Table 4. Sample matrix connecting Assessment Methods with Targets and Standards

Key Courses	Assessment Methods	Targets and Standards
Machinery Design for AB Production	Written Examinations Laboratory Reports Project Report	At least 50% of the students get a rating of 60%
Calculus 2 Principles of Crop Science Engineering Mechanics	Written Examinations Problem Sets Laboratory Reports	At least 50% of the students get a rating of 60%
Engineering Data Analysis Computer Aided Drafting	Written Examinations Problem Sets	At least 50% of the students get a rating of 60%
Materials and Processes for ABE	Projects	At least 50% of the students get a rating of 60%
Machinery Design for AB Production AB Machinery and Mechanization Engineering Economy	Written Examinations Projects Oral Presentation	At least 50% of the students get a rating of 60%

**Note:* The values on the Target and Standards are just examples.

Other Methods of Program Assessment and Evaluation may be found in the **CHED Implementation Handbook for Outcomes-Based Education (OBE) and the Institutional Sustainability Assessment (ISA)** (downloadable from CHED website).

Section 9. Continuous Quality Improvement

Continuous Quality Improvement (CQI) is a periodic feedback process for changing any aspect of a program whereby formal results from assessment and evaluation and other informal observations are utilized in the formulation of the changes, with expected higher degrees of attainment of Program Educational Objectives and Program Outcomes.

The HEI's shall define its CQI plan wherein there must be a documented process for the assessment and evaluation of Program Educational Objectives and Program Outcomes. The comparison of achieved Performance Indicators with declared Targets or Standards of Performance should serve as basis for the priority projects or programs for improving the weak Performance Indicators. Such projects and programs shall be documented as well as the results of its implementation. This regular cycle of documentation of projects or programs for remediation and their successful implementation shall serve as the evidence for Continuous Quality Improvement (CQI).

ARTICLE V
CURRICULUM

Section 10. Curriculum Description

The BSABE curriculum has a well-balanced General Education, AB Science, Basic Engineering and Professional ABE courses aimed at developing students with appropriate knowledge, skills, and attitudes to pursue a career in ABE. A unique feature of the BSABE curriculum is the requirement for the student to complete an undergraduate thesis and industry immersion program (IIP). This considerably enhances the student's competencies for professional practice, entrepreneurship, employment, teaching, research, extension, and graduate study in a specific field of ABE.

The curriculum has a minimum total of 172 credit units, comprising of 122 units of technical courses. These technical courses include 12 units of mathematics, 8 units of natural/physical sciences, **13** units of basic engineering sciences, 9 units of allied courses, **48** units of professional courses, and 10 units for seminar/industry immersion/thesis.

The non-technical courses in accordance with CMO 20 s. 2013 – The New General Education Curriculum consists of 36 units of general education courses distributed as follows: 24 units of core courses, 9 units of GEC electives, and 3 units of Life and Works of Rizal.

The new GEC also includes 8 units of Physical Education (PE), and 6 units of National Service Training Program (NSTP).

Section 11. Minimum Curriculum

11.1 Components

Below is the minimum curriculum of the BSABE program. The institution may enrich the minimum curriculum depending on the needs of the industry and community, provided that all prescribed courses are offered and pre-requisite and co-requisite are observed.

	Minimum No. of Hours		Minimum Credit Units
	Lecture	Laboratory	
I. TECHNICAL COURSES			
A. Mathematics			
Calculus I	3	0	3
Calculus II	3	0	3
Differential Equations	3	0	3
Engineering Data Analysis	3	0	3
Sub-Total	**12**	**0**	**12**
B. Natural and Physical Sciences			
Chemistry for Engineers	3	3	4
Physics for Engineers	3	3	4
Sub-Total	**6**	**6**	**8**
C. Basic Engineering Sciences:			
Computer Aided Drafting	0	3	1
Engineering Mechanics I	3	0	3
Engineering Mechanics II	3	0	3
Engineering Economy	3	0	3
Sub-Total	9	3	10
D. Basic Engineering for ABE			
Introduction to AB Engineering	0	3	1
Strength of Materials	3	0	3
Fluid Mechanics	2	3	3
Surveying	2	3	3
Materials and Processes for ABE	2	3	3
Thermodynamics & Heat Transfer	4	3	5
Computer Applications in AB Engineering	1	6	3
ABE and Related Laws, Specifications, Contracts, and Ethics	1	0	1
Technopreneurship 101	3	0	3
Sub-Total	**18**	**21**	**25**

	Minimum No. of Hours		Minimum Credit Units
	Lecture	Laboratory	
E. Allied Courses:			
Principles of Animal Science	2	3	3
Principles of Crop Science	2	3	3
Principles of Soil Science	2	3	3
Sub-Total	6	9	9
F. Professional Courses			
AB Machinery and Power Engineering			
AB Power Engineering	2	3	3
Renewable Energy for AB Applications	2	3	3
AB Machinery and Mechanization	2	3	3
Machine Design for AB Production	2	3	3
AB Structures & Environment Engineering:			
AB Structures Engineering	2	3	3
Plant and Livestock Systems and Environmental Control Engineering	2	3	3
AB Electrification and Control Systems	2	3	3
AB Waste Management Engineering	2	3	3
AB Land and Water Resources Engineering:			
Hydrometeorology	2	3	3
Irrigation & Drainage Engineering	2	3	3
Land & Water Conservation Engineering	2	3	3
Aquaculture Engineering	2	3	3
AB Process Engineering:			
Properties of AB Materials	2	3	3
AB Products Processing and Storage	2	3	3
Food Process Engineering	2	3	3
Design and Management of AB Processing Systems	2	3	3
Sub-Total	32	48	48
F. Seminar/Industry Immersion/Thesis			
Undergraduate Seminar	1	0	1
Industry Immersion Program (240 hours)	2	3	3
Thesis	1	15	6
Sub-Total	4	18	10
TOTAL TECHNICAL COURSES	87	105	122

	Minimum No. of Hours		Minimum Credit Units
	Lecture	Laboratory	
II. NON-TECHNICAL COURSES			
A. General Education			
Science, Technology, and Society	3	0	3
Contemporary World	3	0	3
Readings in Philippine History	3	0	3
Understanding the Self	3	0	3
Art Appreciation	3	0	3
Purposive Communication	3	0	3
Mathematics in the Modern World	3	0	3
Ethics	3	0	3
Sub-Total	24	0	24
B. General Education (GE) Elective Courses			
GE Elective 1	3	0	3
GE Elective 2	3	0	3
GE Elective 3	3	0	3
Sub-Total:	9	0	9
C. General Education Mandated Course			
Life and Works of Rizal	3	0	3
Sub-Total	3	0	3
D. Physical Education			
Physical Education 1, 2, 3, 4	8	0	8
Sub-Total	8	0	0
E. National Service Training Program (NSTP)			
NSTP 1 and 2	6	0	6
Sub-Total	6	0	6
TOTAL NON-TECHNICAL COURSES	50	0	50
GRAND TOTAL	**137**	**105**	**172**

SUMMARY OF THE BSABE CURRICULUM

Classification/ Field	Total No. of Hours		Total No. of Units
	Lecture	Laboratory	
I. TECHNICAL COURSES			
A. Mathematics	12	0	12
B. Natural/Physical Sciences	6	6	8
C. Basic Engineering Sciences	12	3	13

D. Basic Engineering for ABE	15	21	22
E. Allied Courses	6	9	9
F. Professional Courses	32	48	48
G. Seminar/Industry Immersion/Thesis	4	18	10
Sub- Total	**87**	**105**	**122**
II. NON- TECHNICAL COURSES			
A. General Education Courses	24	0	24
B. General Education Elective Courses	9	**0**	9
C. General Education Mandated Course	3	**0**	**3**
D. Physical Education	8	0	8
E. National Service Training Program	6	0	6
Sub-Total	**50**	**0**	**50**
GRAND TOTAL	**137**	**105**	**172**

11.2 Program of Study

The institution may enrich the sample program of study depending on the needs of the industry, provided that all prescribed courses required in the curriculum outlines are offered and pre-requisites and co-requisites are complied with.

The sample Program of Study listed below is meant for HEIs operating on a Semestral System. HEIs with CHED approved trimester or quarter term systems may adjust their courses and course specifications accordingly to fit their delivery system, as long as the minimum requirements are still satisfied.

The HEIs are also encouraged to include other courses to fulfil their institutional outcomes, as long as the total units for the whole program shall not be less than **172 units**, including P.E., and NSTP.

SAMPLE SEMESTRAL PROGRAM OF STUDY

FIRST YEAR - First Semester				
SUBJECTS	Units	Hours/wk		PREREQUISITE CO-REQUISITE
		Lec	Lab	
Introduction to AB Engineering	1	0	3	NONE
GE-Mathematics in the Modern World	3	3	0	NONE
GE Elective 1	3	3	0	NONE
Chemistry for Engineers	4	3	3	NONE
Physics for Engineers	4	3	3	NONE
PE 1	2	2	0	NONE
NSTP 1	3	3	0	NONE
Total:	**20**	**17**	**9**	

FIRST YEAR - Second Semester				
SUBJECTS	Units	Hours/wk		PREREQUISITE/CO-REQUISITE
		Lec	Lab	
GE-Understanding the Self	3	3	0	NONE
Computer Aided Drafting	1	0	3	NONE
Calculus I	3	3	0	Mathematics in the Modern World
Surveying	3	2	3	Mathematics in the Modern World
Principles of Crop Science	3	2	3	NONE
Principles of Soil Science	3	2	3	NONE
PE 2	2	2	0	PE 1
NSTP 2	3	3	0	NSTP 1
Total:	**21**	**17**	**12**	

SECOND YEAR - First Semester				
SUBJECTS	Units	Hours/wk		PREREQUISITE/CO-REQUISITE
		Lec	Lab	
GE-Ethics	3	3	0	Understanding the Self
Calculus II	3	3	0	Calculus I
Thermodynamics & Heat Transfer	5	4	3	Physics for Engineers, Calculus I
Engineering Mechanics I	3	3	0	Physics for Engineers, Calculus I
Principle of Animal Science	3	2	3	NONE
PE 3	2	2	0	PE 2
Total:	**19**	**17**	**6**	

SECOND YEAR - Second Semester				
SUBJECTS	Units	Hours/wk		PREREQUISITE/CO-REQUISITE
		Lec	Lab	
GE-Readings in Phil. History	3	3	0	NONE
GE-Science, Technology and Society	3	3	0	NONE
Differential Equations	3	3	0	Calculus II
Fluid Mechanics	3	2	3	Engineering Mechanics I
Materials and Processes for ABE	3	2	3	Engineering Mechanics I, Computer-Aided Drawings, Chemistry for Engineers
Engineering Mechanics II	3	3	0	Engineering Mechanics I
ABE and Related Laws, Specifications, Contracts, and Professional Ethics	1	1	0	GE Ethics Introduction to ABE
PE 4	2	2	0	PE 3
Total:	**21**	**19**	**6**	

SECOND YEAR - Midyear Term (Summer)				
SUBJECT	Units	Hours/wk		PREREQUISITE/CO-REQUISITE
		Lec	Lab	
GE- Purposive Communication	3	3	0	NONE
GE-Life and Works of Rizal	3	3	0	NONE
Total:	**6**	**6**	**0**	

THIRD YEAR - First Semester				
SUBJECTS	Units	Hours/wk		PREREQUISITE/CO-REQUISITE
		Lec	Lab	
GE Elective 2	3	3	0	NONE
Strength of Materials	3	3	0	Engineering Mechanics II
Engineering Economy	3	3	0	Third Year Standing
Engineering Data Analysis	3	3	0	Mathematics in the Modern World
Hydrometeorology	3	2	3	Fluid Mechanics, Calculus II
AB Power Engineering	3	2	3	Thermodynamics and Heat Transfer, Calculus II
Properties of AB Materials	3	2	3	Materials and Processes for ABE, Thermodynamics and Heat Transfer
Total:	**21**	**18**	**9**	

THIRD YEAR - Second Semester				
SUBJECTS	Units	Hours/wk		PREREQUISITE/CO-REQUISITE
		Lec	Lab	
Technopreneurship 101	3	3	0	Engineering Economy
Computer Applications in AB Engineering	3	1	6	Third Year Standing
AB Structures Engineering	3	2	3	Strength of Materials
Irrigation and Drainage Engineering	3	2	3	Surveying, Hydrometeorology, Differential Equation, Principles of Crop Science, and Principles of Soil Science
AB Machinery and Mechanization	3	2	3	AB Power Engineering, Prin. of Soil Science, Prin. of Crop Science, and Prin. of Animal Science
AB Products Processing and Storage	3	2	3	Properties of AB Materials, Prin. of Animal Science, and Prin. of Crop Science
AB Electrification and Control Systems	3	2	3	Physics for Engineers and Differential Equations
Thesis 1	1	1	0	Third Year Standing
Total:	**22**	**15**	**21**	

THIRD YEAR - Midyear Term (Summer)				
SUBJECT	Units	Hours/wk		PREREQUISITE/CO-REQUISITE
		Lec	Lab	
Industry Immersion Program (240 hours with at least 160 hours actual industry engagement)	3	2	3	Third Year Standing
Total:	**3**	**2**	**3**	

FOURTH YEAR- First Semester				
SUBJECTS	**Units**	**Hours/wk**		**PREREQUISITE/CO-REQUISITE**
		Lec	**Lab**	
GE-Art Appreciation	3	3	0	NONE
GE-Contemporary World	3	3	0	None
Aquaculture Engineering	3	2	3	Irrigation and Drainage Engineering
Machine Design for AB Production	3	2	3	AB Machinery and Mechanization , Strength of Materials, and Properties of AB Materials
Food Process Engineering	3	2	3	AB Products Processing and storage
Plant and Livestock Systems and Environmental Control Engineering	3	2	3	AB Structures Engineering, Prin. of Soil Science, Prin. of Crop Science, and Prin. Of Animal Science
Undergraduate Seminar	1	1	0	Fourth Year Standing
Thesis 2	2	0	6	Thesis 1
Total:	**21**	**15**	**18**	

FOURTH YEAR- Second Semester				
Second Semester	**Units**	**Hours/wk**		**PREREQUISITE/CO-REQUISITE**
		Lec	**Lab**	
GE Elective 3	3	3	0	None
Land & Water Conservation Engineering	3	2	3	Irrigation and Drainage Engineering
Renewable Energy for AB Applications	3	2	3	AB Power Engineering
Design and Management of AB Processing Systems	3	2	3	AB Products Processing and Storage
AB Waste Management Engineering	3	2	3	Plant and Livestock Systems and Environmental Control Engineering
Thesis 3	3	0	9	Thesis 2
Total:	**18**	**11**	**21**	
GRAND TOTAL:	**172**	**137**	**105**	

Section 12 Sample Curriculum Map

ANNEX II.A and ANNEX II.B present the Sample Curriculum Map and Pre-requisite Map, respectively. The HEI may develop its own Curriculum and Pre-requisite Map.

Section 13. Descriptions of Outcomes Based Teaching and Learning

Outcomes-based Teaching and Learning (OBTL) is an approach where teaching and learning activities are developed to support the Learning Outcomes (University of Hong Kong, 2007). It is a student-centered approach for the delivery of educational programs where the curriculum topics in a program and the courses contained in it are expressed as the intended outcomes for students to learn. It is an approach in which teachers facilitate and students find themselves actively engaged in their learning.

Its primary focus is the clear statement of what students should be able to do after taking a course, known as the Intended Learning Outcomes (ILOs). The ILOs describe what the learners will be able to do when they have completed their course or program. These are statements, written from the students' perspective, indicating the level of understanding and performance they are expected to achieve as a result of engaging in teaching and learning experience (Biggs and Tang, 2007). Once the ILOs have been determined, the next step in OBTL is to design the Teaching/Learning Activities (TLAs) which require students to actively participate in the construction of their new knowledge and abilities. A TLA is any activity which stimulates, encourages or facilitates learning of one or more ILOs. The final OBTL component is the Assessment Tasks (ATs), which measure how well students can use their new abilities to solve real-world problems, design, demonstrate creativity, and communicate effectively, among others. An AT can be any method of assessing how well a set of ILO has been achieved.

A key component of a course design using OBTL is the Constructive Alignment of ILOs, TLAs, and ATs. This design methodology requires the ILOs to be developed first, and then the TLAs, and finally the TAs are developed based on the ILOs (Biggs, 1999).

"Constructive" refers to the idea that students construct meaning through relevant learning activities. "Alignment" refers to the situation when teaching and learning activities, and assessment tasks, are aligned to the Intended Learning Outcomes by using the verbs stipulated in the ILOs. Constructive Alignment provides the "how-to" by stating that the TLAs and the TAs activate the same verbs as in the ILOs (Biggs and Tang, 1999).

The OBTL approach shall be reflected in the Course Syllabus to be implemented by the faculty.

Section 14. Course Syllabus and Course Specifications

Course Syllabus for each subject must be written following a common format to ensure that the course syllabi contain all the necessary information. It shall contain the following:

14.1 Name of the HEI and its Vision and Mission, Program Educational Objectives and relationship to HEI Mission
14.2 General Course Information (course code and title, course description, course pre-requisites and co-requisite, course description`)
14.3 Links between the Program Outcomes (POs) and the PEOs
14.4 Link between Course Outcomes and the POs
14.5 Course Coverage with Unit Learning Outcomes, Teaching and Learning Activities, and Assessment Methods
14.6 Life-long Learning Opportunities
14.7 Contribution of the Course to Meeting Professional Component
14.8 References
14.9 Final Grade Evaluation
14.10 Course Policies and Standards
14.11 Course Materials Made Available
14.12 Effectivity and Revision Information

Course syllabus shall be regularly reviewed and updated to reflect the needed improvements, particularly to provide actions on recommendations that may come out of any evaluation process.

ANNEX III shows the minimum course specifications of mathematics, physical sciences, AB sciences, basic and common engineering courses, and professional courses while ANNEX IV presents the suggested laboratory exercises and laboratory equipment requirements for the BSABE Program.

ANNEX V shows a sample OBE syllabus of one subject. The sample OBE syllabus may be used for the other subjects in the program.

ARTICLE VI
REQUIRED RESOURCES

This article covers the specific required resources for the BS in Agricultural and Biosystems Engineering program.

All other requirements on administration and support; library, laboratory facilities, and buildings; research; and community involvement for the BS Engineering Program are contained in CMO No.86, s. 2017, known as *Policies, Standards, and Guidelines for Requirements Common to all BS Engineering and Bachelor of Engineering Technology Programs issued by the Commission.*

Section 15. Administration

The administration of the college of engineering must provide academic governance and leadership to engineering programs by exerting efforts to achieve program educational objectives and program outcomes. As such, the college must have a full-time dean and full-time department or program chair who are adept in the principles of outcomes-based education and are trained to implement the elements of OBE and OBTL required by CMO 37 s 2012. The specific qualifications of the Dean of the College of Engineering are specified in CMO 86 s. 2017 under *Article II, Section 5.*

There shall be a full-time Department/Program Chair/Coordinator who will lead the program in curriculum planning, implementation, monitoring, review, and evaluation of BSABE program. The College Dean, who is a Licensed Agricultural or Agricultural and Biosystems Engineer, may serve as concurrent Department/Program Chair/Coordinator in extreme cases of low enrolment.

The Department/Program Chair/Coordinator of BSABE program shall have the following qualifications:

a) shall be holder of baccalaureate degree and Master's degree in Agricultural Engineering or Agricultural and Biosystems Engineering;

b) shall be a registered Agricultural Engineer (AE) or Agricultural and Biosystems Engineer (ABE) with valid PRC license;

c) shall have a minimum teaching experience of not less than three (3) years, preferably with experience in industry practice.

To ensure his/her work effectiveness, the Department/Program Chair/Coordinator shall be given a maximum teaching load of 50% of the regular teaching load.

The College of Engineering shall have a policy on admission, retention, and residency requirements that shall incorporate among others, the eligibility of SHS STEM strand graduates from secondary school recognized by the Department of Education for admission to the 4-year engineering programs. Other requirements stipulated in CMO 86, s. 2017 shall also be satisfied.

It shall also have a Placement Assistance and Monitoring Program and office for its graduates. The college shall conduct continuing tracer studies to monitor the career paths of their graduates and to obtain continuous feedbacks from both the graduates and stakeholders.

Section 16. Faculty

16.1 Requirements

Faculty handling professional courses shall be registered AE or ABE with valid PRC license. In addition, faculty handling professional courses, design in content, shall have industry design experience.

There shall be adequate number of competent and qualified faculty, preferably at least two (2) faculty members for each area of specialization, to teach professional courses of the BSABE program to effectively implement the minimum curricular requirements.

In addition, by AY 2018-2019, all full-time faculty members teaching professional courses in BSABE shall be holder of Master's degree in either Agricultural or Agricultural and Biosystems Engineering or allied engineering programs.

16.2 Additional Policies and Guidelines

Additional policies and guidelines on full-time and part-time faculty qualification, assignment, duties, teaching performance, and hiring are indicated in CMO 86, s. 2017 under *Article II, Section 2.1.*

Section 17. Library and Other Learning Facilities

The requirements for library services and other learning resources are indicated under *Article II, Section 2.3* of CMO No. 86, s. 2017.

Section 18. Laboratory Equipment and Resources

18.1 Facilities

Guidelines on the required facilities are indicated in *Article II, Sections 2.4* and *5.4* of CMO No. 86, s. 2017.

18.2 Laboratories

Guidelines on the required laboratories are indicated in *Article II, Section 2.2* of CMO No. 86, s. 2017.

For the offering of the BSABE program, the institution shall provide laboratories with the corresponding required facilities for the following courses:

1. Chemistry for Engineers
2. Physics for Engineers
3. Fluid Mechanics
4. Surveying
5. Materials and Processes for ABE

6. Thermodynamics and Heat Transfer
7. Principles Animal Science
8. Principles of Crop Science
9. Principles Soil Science
10. AB Power Engineering
11. Renewable Energy for AB Application
12. AB Machinery and Mechanization
13. Machine Design for AB Production
14. AB structures Engineering
15. Plant and Livestock Systems and Environmental Control Engineering
16. AB Electrification and Control
17. AB Waste Management Engineering
18. Hydrometeorology
19. Irrigation and Drainage Engineering
20. Land and Water Conservation Engineering
21. Aquaculture Engineering
22. Properties of AB Materials
23. AB Products Processing and Storage
24. Food Process Engineering
25. Design and Management of AB Processing Systems

Annex IV shows the Laboratory equipment and resources required for the BSABE Program.

18.3 Modern Tools in ABE

The institution must provide access to modern tools in ABE. Examples of these tools are spreadsheet software, graphing software, mathematical software, programming language environment, open or commercial simulation tools in ABE, and design and analysis software. These modern tools shall be sufficient so that students can achieve the course outcomes.

18.4 Modernization of Equipment

Each ABE Department of the College of Engineering shall have a program for the continuing modernization and upgrading of its instructional laboratories, facilities, and equipment. The said program shall have an adequate annual allocation in accordance with the financial capability of the school.

18.5 Calibration of Equipment

Each school/college of engineering shall ensure that the measuring instruments in its laboratories are recalibrated regularly. The date of the last calibration of a measuring instrument shall be indicated on each instrument.

ARTICLE VII
COMPLIANCE OF HEIs

Section 19. Full Compliance with CMO 37, s. 2012

Before the start of AY 2018-2019, all HEIs planning to offer the BS in Agricultural and Biosystems Engineering must show evidence of full compliance with CMO 37, s. 2012 on the (Establishment of an Outcomes-Based Education System) by complying the following:

19.1 Monitoring Workbook and Self-Assessment Rubric

The Commission, through its Regional offices or the TPET Website shall make available to all HEIs currently offering or applying to offer BSABE program a Monitoring Workbook (CMO 37-MW-2017-HEI-BSABE) and Self-Assessment Rubric (SAR) (CMO-37-HEI-SAR-2017-BSABE).

The five-year BSABE Curriculum shall be the basis of the monitoring. The completed Monitoring Workbook with a List of Supporting Evidences and Self-Assessment Rubric must be submitted to CHED or online through the CHED TPET website (*www.ched-tpet.org*) within 30 working days after the effectivity of this CMO. Failure to submit these documents will disqualify the concerned HEIs from continuing or starting their BSABE program in AY 2018-2019.

19.2 Review of Submitted Forms by CHED

CHED shall review the submitted Monitoring Workbooks and Self-Assessment Rubrics and may schedule monitoring visits to the HEI thereafter. These visits shall determine the extent of compliance of the concerned HEI with CMO 37, s. 2012. HEIs with BSABE program with low SAR total scores may be asked to submit a one- or two-year development plan to CHED-CHEDRO before they shall be allowed to apply to continue their BSABE program for AY 2018-2019.

19.3 Exemptions

HEIs with BSABE programs that have applied as COEs/CODs during AY 2015-2016 and whose applications have been approved as COE or COD shall not be required to comply with Section 19.1 and 19.2. Instead, these HEIs must submit only their proposed four-year curriculum, corresponding curriculum map, and program of study using the Application Workbook for AY 2018-2019 (AW-2018-HEI-BSIE). See Section 20. Those HEIs whose COD/COE applications were disapproved for AY 2018-2019 must still comply with Sections 19.1 and 19.2.

Section 20 Application Workbook for AY 2018-2019

All HEIs currently offering the BSABE program for AY 2018-2019 shall be required to submit the new Application Workbook. The New Application Workbook (AW-2018- HEI-BSABE) shall be make available through the CHEDRO or downloadable from the CHED-TPET website. The Application Workbook shall be completed and submitted to CHED or uploaded to the CHED-TPET website not later than end of December AY 2017.

Section 21 Approval of Application

All HEIs with BSABE programs with COE or COD status submitting their completed Application Workbooks shall automatically receive certifications from CHED and shall be given approval to implement their programs beginning AY 2018-2019.

Other concerned HEIs which have submitted their CMO Monitoring Workbooks, Self-Assessment Rubrics, and Application Workbook before the end of AY 2017 shall be given conditional approval by their **CHED** to start offering their new BSABE Curriculum following this PSG effective AY 2018-2019. The Technical Committee for AB Engineering and CHED Regional Offices shall however conduct monitoring of HEIs to assure complete compliance of this CMO within the transitory period, during which the HEI with BSABE program of weak implementation may be asked to submit developmental plans, which shall be subject to constant monitoring.

ARTICLE VIII
TRANSITORY, REPEALING and EFFECTIVITY PROVISIONS

Section 22 Transitory Provision

All private HEIs, state universities and colleges (SUCs) and local universities and colleges (LUCs) with existing authorization to operate the Bachelor of Science in Agricultural Engineering or Bachelor of Science in Agricultural and Biosystems Engineering program are hereby given a period of **three (3) years** from the effectivity thereof to fully comply with all the requirements in this CMO. However, the prescribed minimum curricular requirements in this CMO shall be implemented starting AY 2018-2019.

Section 23 Repealing Clause

Any provision of this Order, which may thereafter be held invalid, shall not affect the remaining provisions.

All CHED issuances or part thereof inconsistent with the provision in this CMO shall be deemed modified or repealed.

Section 24 Effectivity Clause

This CMO shall take effect fifteen (15) days after its publication in the Official Gazette or in a newspaper of general circulation. This CMO shall be implemented beginning **AY 2018-2019**.

Quezon City, Philippines December 4, 2017

For the Commission:

PATRICIA B. LICUANAN, Ph.D.
Chairperson

ATTACHMENTS:

Annex I - Competency Standard Attributes and Competencies of an Agricultural and Biosystems Engineer (ABE)
Annex II.A - Sample Curriculum Map
Annex II.B - Pre-requisite Map
Annex III - Course Specifications
Annex IV - Laboratory Requirements
Annex V - Sample Outcomes-Based Syllabus

ANNEX I - COMPETENCY STANDARD ATTRIBUTES AND COMPETENCIES
Bachelor of Science in Agricultural and Biosystems Engineering

Agricultural and Biosystems Engineer (n) - is a professional who applies engineering science and designs to the processes and systems involved in the sustainable production, post production, and processing of safe food, feed, fiber, timber, and other agricultural and biological materials and the efficient utilization, conservation, and management of natural and renewable resources in order to enhance human health in harmony with the environment.

Competency Standards
Attributes and Competencies of an Agricultural and Biosystems Engineer

Attributes		Competency Levels		
		New Graduate	1 - 7 Years Engineering Experience	Globally Qualified Engineer (APEC/ASEAN)
1	Apply knowledge of mathematics, chemistry, physics, biology, Information Technology and other engineering principles	Understand the principles of mathematics, chemistry, physics, biology, natural and applied sciences including information technology. Determine relevant and appropriate applied science, engineering principles and techniques that can be used to address engineering concerns related to process design and operations.	Use relevant and appropriate applied science, engineering principles and techniques in formulating process design and operations improvement and optimization. Develop simple computer programs to solve Agricultural and Biosystems engineering problems.	Use relevant and appropriate applied science, engineering principles and techniques in formulating process design and operations improvement and optimization. Develop simple computer programs to solve Agricultural and Biosystems engineering problems.
2	Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	Use relevant information gathered from research literature and other available technological information sources in coming out with solutions to complex engineering problems.	Apply results research literature and other technological advances in process design and operations improvement and optimization. Propose changes in parameter settings used in manufacturing processes or lab-scale set-ups to achieve the desired outputs.	Propose changes in parameter settings used in manufacturing processes or lab-scale set-ups to achieve the desired outputs.
3	Design solutions for complex engineering	Study, investigate, and gather data related to complex	Study, investigate, and gather data related to problems in agri-	Consolidate studies made on problems in agri-industrial processes

	problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.	engineering problems and propose solutions based on the fundamentals of engineering principles while incorporating ethics, safety, and environmental considerations.	industrial processes and operations and prepare proposals to implement solutions while incorporating ethics, safety, and environmental considerations. Conduct test runs and prepare final recommendations based on results gathered.	and operations and propose changes in operational parameters. Prepare project proposals, budget and reports related to improvements and optimization of agri-industrial processes and operations. Impart learnings to peers.
4	Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.	Conceptualize, formulate, and implement design of experiments in a standard scientific manner in conducting investigations of complex engineering problems with consideration of cost, quality, security, and environmental impact. Recommend valid conclusions based on gathered information and results of investigation.	Organize teams of experts, plan, and design experiments in conducting investigations of complex engineering problems. Conduct laboratory scale and plant scale trials as may be deemed necessary to validate conclusions. Prepare feasibility, optimization reports, implementation plans, and make presentations to the concerned entities on the proposed solutions to the complex engineering problems.	Use available database information; coordinate with other technical experts, plan, and design experiments in conducting investigations of complex engineering problems. Conduct laboratory scale and plant scale trials as may be deemed necessary to validate conclusions. Prepare reports and make presentations to concerned entities on the proposed solutions to the complex engineering problems.
5	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to solve complex engineering problems, with an understanding of the limitations.	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to solve complex engineering problems, with an understanding of the limitations.	Be familiar with the appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations. Consolidate applicable techniques and modern tools that can be used to solve complex engineering problems.	Be familiarized with process operations and applicable modern tools and techniques to solve operational problems taking into consideration process limitations. Use industrial experience in conjunction with technical expertise and appropriate modern tools in solving complex engineering problems.

			Prepare recommendations based on results considering optimization, practical applications, and limitations of process parameters and equipment.	Prepare reports and recommendations and present these to the concerned entities.
6	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems.	Be familiar with relevant policies, laws, regulations, and technical standards locally in conjunction with the Agricultural and Biosystems Engineering Professional Practice. Make a personal commitment to societal, health, safety, legal, and cultural issues recognising obligations to society, subordinates, and the environment.	Be familiar with relevant policies, laws, regulations and technical standards both locally and internationally in conjunction with the Agricultural and Biosystems Engineering Professional Practice. Be familiar with specific country regulations on professional engineering practice in implementing solutions to complex engineering problems. Prepare plans and designs to address industrial process problems while taking into consideration moral, ethical and environmental concerns. Impart learning to peers.	Be familiar with relevant policies, laws, regulations, and technical standards both locally and internationally in conjunction with the Agricultural and Biosystems Engineering Professional Practice. Be familiar with specific country regulations on professional engineering practice in implementing solutions to complex engineering problems. Prepare plans and designs to address industrial process problems while taking into consideration moral, ethical and environmental concerns. Impart learning to peers.
7	Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts.	Be familiar with relevant applicable technical and engineering standards that can be applied in professional engineering practice. Assess the effects of professional engineering work on process operational problems. Gather relevant data in relation to the professional engineering work.	Be familiar with relevant applicable technical and engineering standards that can be applied in professional engineering practice.	Be familiar with relevant applicable technical and engineering standards that can be applied in professional engineering practice. Use gained experience in industrial professional practice to measure impacts on society and environment. Be familiar with carbon footprint calculations, life cycle assessment, green technologies and other upcoming standards.

				Do research, develop projects and prepare implementation plans to implement and assess professional engineering works in relation to complex engineering problems. Impart learning to peers.
8	Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.	Be familiar with the Philippine Code of Ethical Standards of Engineers and apply and behave according to this code in professional practice. Apply ethical principles in conjunction with engineering practice.	Be familiar with the Philippine Code of Ethical Standards of Engineers and apply and behave according to this code in professional practice. Be familiar with corporate and industrial policies. Apply ethical principles in conjunction with engineering practice incorporating public safety as a priority. Be an example to upcoming engineers in terms of integrity, morality and ethics.	Be familiar with the Philippine Code of Ethical Standards of Engineers and apply and behave according to this code in professional practice. Be familiar with corporate and industrial policies. Apply ethical principles in conjunction with engineering practice incorporating public safety as a priority. Be an example to upcoming engineers in terms of integrity, morality and ethics. Exemplify ethical and moral values through participation in socially relevant projects that contribute to national development. Impart learning to peers.
9	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.	Perform functions required in the completion of a task as part of a project or endeavour, or as an employee of a company. Interact with peers and higher levels in a professional manner. Participate in activities either as a team leader or member and perform designated tasks.	Perform functions required in the completion of a task as part of a project or endeavour, or as an employee of a company. Interact with peers and higher levels in a professional manner. Participate in activities either as a team leader or member and perform designated tasks.	Plan, lead, coordinate, and implement designated tasks either as a team leader or member. Interact with a network of professionals and participate in projects or activities. Handle small to medium-sized projects.
10	Communicate effectively on complex engineering	Prepare reports, presentations, and other engineering documents	Prepare reports, presentations, and other engineering documents	Consolidate reports and make presentations to peers and superiors

	activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	in an organized way and relay information related to these effectively. Communicate clearly both verbally and in written form all instructions to peers, subordinates and superiors as may be deemed necessary. Organize, coordinate and implement activities or projects in a clear way.	in an organized way and relay information related to these effectively. Prepare policies, procedures and other documents related to an activity or project and cascade to subordinates, peers and superiors effectively. Conduct trainings to subordinates and peers. Communicate clearly with legal entities/ authorities regarding engineering activities.	on projects or on assigned endeavors. Conduct trainings to subordinates, peers and superiors. Communicate and coordinate clearly and act as liaison officer on matters concerning legal or regulatory issues. Prepare policies, rules, regulations, instructions, procedures, and implements them.
11	Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	Plan, lead, organize and control small projects or tasks as may be deemed necessary in the practice of engineering.	Plan, lead, organize and control small to medium-sized projects or tasks as may be deemed necessary in the practice of engineering. Manage financial aspects of the project. Supervise subordinates and peers when needed. Prepare reports related to projects.	Manage and implement medium-sized to major projects or tasks as may be deemed necessary in the practice of engineering. Manage financial aspects of the project. Manage supervisors and peers. Prepare reports related to projects.
12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	Attend trainings, seminars, conferences or participate in projects that encourage continued learning in the engineering profession. Pursue graduate studies.	Attend trainings, seminars, conferences or participate in projects that encourage continued learning in the engineering profession. Pursue graduate studies.	Attend trainings, seminars, conferences, and participate in professional organizations that encourage continued learning in the engineering profession. Pursue graduate studies Comply with CPD units required annually. Conduct research studies and impart results to peers.

ANNEX II.A. – SAMPLE CURRICULUM MAP
Bachelor of Science in Agricultural and Biosystems Engineering

LEGEND

Code	PROGRAM OUTCOMES:
a	Apply knowledge of mathematics and science to solve complex AB engineering problems
b	Design and conduct experiments, as well as to analyze and interpret data
c	Design a system, component, or process to meet desired needs within realistic constraints in accordance with standards
d	Function on multidisciplinary teams
e	Identify, formulate, and solve complex AB engineering problems
f	Understand professional and ethical responsibility
g	Communicate effectively complex AB engineering activities
h	Understand the impact of engineering solutions in a global, economic, environmental, and societal context
i	Recognize the need for, and an ability to engage in life-long learning
j	Know contemporary issues
k	Use techniques, skills, and modern engineering tools necessary for engineering practice
l	Know and understand engineering and management principles as a member and leader in a team, to manage projects and in multidisciplinary environments
m	understand at least one specialized field of ABE practice
Code	**COURSE DESCRIPTOR**
I	An **introductory** course to an outcome
E	An **enhancing** course to an outcome
D	A **demonstrating** course to an outcome

SAMPLE BSABE CURRICULUM MAP

A. GENERAL EDUCATION COURSES:	STUDENT OUTCOMES												
	a	b	c	d	e	F	g	h	i	j	k	l	m
Science, Technology, and Society								I	I	I			
The Contemporary World								I	I	I			
Readings in Philippine History						I				I			
Understanding the Self							I		I	I			
Art Appreciation									I	I			
Purposive Communication							I		I		I		
Mathematics in the Modern World	I				I				I				
Ethics						I			I	I			
GE Elective Courses													
GE Elective 1								I	I	I			
GE Elective 2			I	I				I				I	
GE Elective 3				I				I		I			
GE Mandated Course													
Life and Works of Rizal (Mandated0									I	I			
Mathematics													
Calculus I	I						E				I		

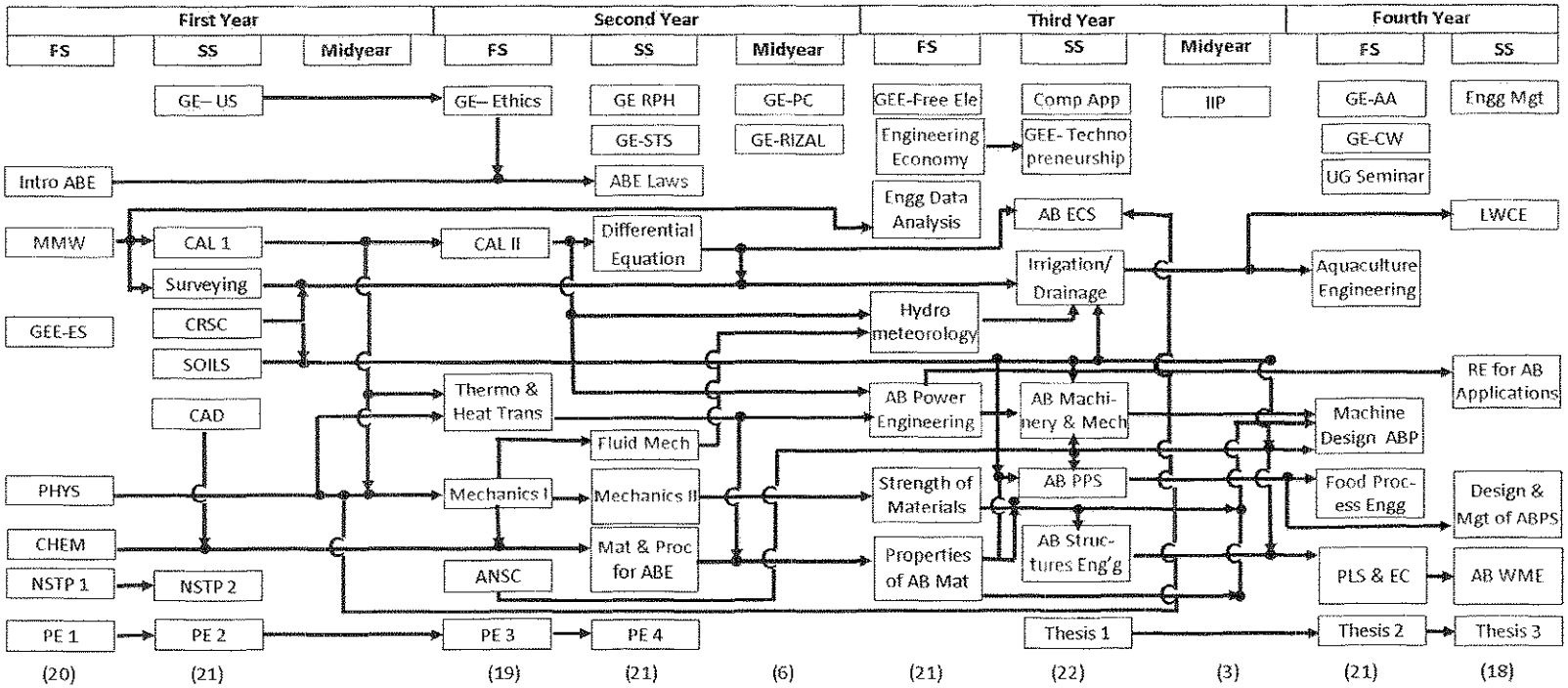
Calculus II	E						E				E		
Differential Equations	E						E				E		
Engineering Data Analysis	E	I			E						E		
Natural and Physical Sciences													
Chemistry for Engineers	I	I									E		
Physics for Engineers	I	I									E		
Physical Education and NSTP													
PE 1				I			I						
PE 2				I			I						
PE 3				I			I						
PE 4				I			I						
NSTP 1				I			I	I					
NSTP 2				I			I	I					
B. AB SCIENCES:													
Principles of Animal Science		E		E			E				E		
Principles of Crop Science		E		E			E				E		
Principles of Soil Science		E		E			E				E		
Technopreneurship			i	i				i				i	
C. BASIC ENGINEERING COURSES:	**a**	**b**	**c**	**d**	**e**	**F**	**g**	**h**	**i**	**j**	**k**	**l**	**m**
Common Basic Engineering													
Computer Aided Drafting					E		E				E		
Engineering Mechanics I	E	E					E				E		
Engineering Mechanics II	E	E					E				E		
Engineering Economy	E		E				E	I			E	E	
Engineering Management				E		E					E	E	
Basic Engineering Courses for ABE	**a**	**b**	**c**	**d**	**e**	**F**	**g**	**h**	**i**	**j**	**k**	**l**	**m**
Introduction to ABE						E		E		E			E
Strength of Materials	E				E						E		
Fluid Mechanics	E				E						E		
Surveying	E	E			E						E		E
Materials and Processes for ABE	E				E						E		E
Thermodynamics and Heat Transfer	E				E						E		
Computer Applications in ABE	E				E						E		E
ABE and Related Laws, Specifications, Contracts, and Professional Ethics						D		D	D	D			D
D. PROFESSIONAL COURSES:													
AB Machinery & Power Engineering													
AB Power Engineering	D				D		D				D		D
Renewable Energy for ABE Applications	D		D	D	D		D	D			D		D
AB Machinery and Mechanization	D		D	D	D		D	D			D	D	D
Machine Design for AB Production	D		D		D		D	D			D		D

AB Structures & Environment Engineering	a	b	c	d	e	F	g	h	i	j	k	l	m
AB Structures Engineering	D		D	D	D		D	D			D		D
Plant and Livestock Systems and Environmental Control Engineering	D		D	D	D		D	D			D		D
AB Electrification and Control System	D		D		D		D				D		D
AB Waste Management Engineering	D		D	D	D		D	D		D	D		D
AB Land and Water Resources Engineering													
Hydrometeorology	D						D			D	D		D
Irrigation and Drainage Engineering	D		D	D	D		D	D			D		D
Aquaculture Engineering	D		D	D	D		D	D			D	D	D
Land and Water Conservation Engineering	D		D	D	D		D	D		D	D		D
AB Process Engineering													
Properties of AB Materials	D						D				D		D
AB Products Processing and Storage	D		D	D	D		D	D			D		D
Food Process Engineering	D		D	D	D		D	D			D		D
Design and Management of AB Processing Systems	D		D	D	D		D	D		D	D	D	D
Undergraduate Seminar	D	D					D			D			
Industry Immersion Program (IIP)			D	D			D			D	D	D	
Thesis/ Field Practice	D	D	D		D		D			D	D	D	D

ANNEX II.B. – PRE-REQUISITE MAP

Bachelor of Science in Agricultural and Biosystems Engineering

FLOWCHART OF THE BS AGRICULTURAL AND BIOSYSTEMS ENGINEERING CURRICULUM



Total Units: 172

All students are required to undergo NSTP (6 units) for one year with an option of ROTC, CWTS, or LTS as a requirement for graduation.

All students are required to take PE 1 (2 units) and PE 2, PE 3, PE 4 (6 units).

TCAE-RMCA-BSABE-v4

III.1. MATHEMATICS AND PHYSICAL SCIENCES COURSES

1. Calculus I

Course Contents

Course Name	Calculus I
Course Description	An introductory course covering the core concepts of limit, continuity and differentiability of functions involving one or more variables. This also includes the application of differential calculations in solving problems on optimization, rates of change, related rates, tangents and normals, and approximations; partial differentiation and transcendental curve tracing.
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours per week
Prerequisites	Mathematics in the Modern World
Program Outcomes addressed by the Course	a, g, k
Course Outcomes	At the end of the course, the students must be able to: 1. Differentiate algebraic and transcendental functions 2. Apply the concept of differentiation in solving word problems 3. Analyze and trace transcendental curves
Course Outline	1. Functions 2. Continuity and Limits 3. The Derivative 4. The Slope 5. Rate of Change 6. The Chain Rule and the General Power Rule 7. Implicit Differentiation 8. Higher – Order derivatives 9. Polynomial curves 10. Applications of the Derivative 11. The Differential 12. Derivatives of Trigonometric Functions 13. Derivative of Inverse Trigonometric Functions 14. Derivative of Logarithmic and Exponential Functions 15. Derivative of the Hyperbolic Functions 16. Solutions of Equations 17. Transcendental Curve Tracing 18. Parametric Equations 19. Partial differentiation

2. Calculus II

Course Contents

Course Name	Calculus II
Course Description	The course introduces the concept of integration and its application to some physical problems such as evaluation of areas, volumes of

	revolution, force, and work. The fundamental formulas and various techniques of integration are taken up and applied to both single variable and multi-variable functions. The course also includes tracing of functions of two variables for a better appreciation of the interpretation of the double and triple integral as volume of a three-dimensional region bounded by two or more surfaces.
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours per week
Prerequisites	Calculus I
Program Outcomes addressed by the Course	a, g, k
Course Outcomes	After completing this course, the student must be able to: 1. Apply integration to the evaluation of areas, volume of revolution, force and work 2. Use integration techniques on single and multi-variable functions 3. Explain the physical interpretation of the double and triple integral
Course Outline	1. Integration Concepts/Formulas 1.1. Anti-differentiation 1.2. Indefinite Integrals 1.3 Simple Power Formula 1.4 Simple Trigonometric Functions 1.5 Logarithmic Function 1.6 Exponential Function 1.7 Inverse Trigonometric Functions 1.8 Hyperbolic Functions (sinh u & cosh u only) 1.9 General Power formula (include Substitution Rule) 1.10 Constant of Integration 1.11 Definite Integral (include absolute, odd & even functions) 2 Integration Techniques 2.1 Integration by Parts 2.2 Trigonometric Integrals 2.3 Trigonometric Substitution 2.4 Rational Functions 2.5 Rationalizing Substitution 3 Improper Integrals 4 Application of Definite Integral 4.1 Plane Area 4.2 Areas between Curves 5 Other Applications 5.1 Volumes 5.2 Work 5.3 Hydrostatic Pressure 6 Multiple Integrals (Inversion of order/ change of coordinates) 6.1 Double Integral 6.2 Triple Integral 7 Surface Tracing 7.1 Planes 7.2 Spheres

	7.3 Cylinders 7.4 Quadratic Surfaces 7.5 Intersection of Surfaces 8 Multiple Integrals as Volume 8.1 Double Integrals 8.2 Triple Integrals

3. Differential Equations

Course Contents

Course Name	**Differential Equations**
Course Description	This course is intended for all engineering students to have a firm foundation on differential equations in preparation for their degree-specific advanced mathematics courses. It covers first order differential equations, nth order linear differential equations and systems of first order linear differential equations. It also introduces the concept of Laplace Transforms in solving differential equations. The students are expected to be able to recognize different kinds of differential equations, determine the existence and uniqueness of solution, select the appropriate methods of solution and interpret the obtained solution. Students are also expected to relate differential equations to various practical engineering and scientific problems as well as employ computer technology in solving and verifying solutions
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours per week
Prerequisites	Calculus II
Program Outcomes addressed by the Course	a, g, k
Course Outcomes	After completing this course, the student must be able to: 1. Apply integration for the evaluation of areas, volumes of revolution, force and work 2. Use integration techniques on single and multi-variable functions 3. Explain the physical interpretation of the double and triple integral
Course Outline	1. Introduction 1.1. Definition and Classifications of Differential Equations (DE) 1.2. Solution of a DE 2. Solution of some 1st order DE 2.1. Variable Separable 2.2. Exact Equation 2.3. Linear Equation 2.4. Substitution Methods 2.5. Mixed Problems (method not pre-identified) 2.6. Introduction to Use of Computer in Solving Differential Equations 3. Application of 1st Order Differential Equations 3.1. Decomposition /Growth 3.2. Newton's Law of Cooling

	3.3. Mixing (non-reacting fluids) 3.4. Electric Circuits 4. Linear Differential Equation of Order n 4.1. Introduction 4.2. Homogeneous Linear Differential Equation with Constant Coefficients 4.3. Non-homogeneous Differential Equation with Constant Coefficients 4.4. Solution of Higher Order Differential Equations using Computer 5. Laplace Transforms of Functions 5.1. Definition 5.2. Transform of Elementary Functions 5.3. Transform of $e^{at}f(t)$ – Theorem 5.4. Transform of $t^n f(t)$ – Derivatives of Transforms 5.5. Inverse Transforms 5.6. Laplace and Inverse Laplace Transforms using a Computer 5.7. Transforms of Derivatives 5.8. Initial Value Problems

4. Engineering Data analysis

Course Contents

Course Name	**Engineering Data Analysis**
Course Description	This course is designed for undergraduate engineering students with emphasis on problem solving related to societal issues that engineers and scientists are called upon to solve. It introduces different methods of data collection and the suitability of using a particular method for a given situation. The relationship of probability to statistics is also discussed, providing students with the tools they need to understand how "chance" plays a role in statistical analysis. Probability distributions of random variables and their uses are also considered, along with a discussion of linear functions of random variables within the context of their application to data analysis and inference. The course also includes estimation techniques for unknown parameters; and hypothesis testing used in making inferences from sample to population; inference for regression parameters and build models for estimating means and predicting future values of key variables under study. Finally, statistically based experimental design techniques and analysis of outcomes of experiments are discussed with the aid of statistical software.
Number of Units for Lecture and Laboratory	3 units lecture (2 lec, 1 lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	Mathematics in the Modern World
Program Outcomes addressed by the Course	a, b, e, k
Course Outcomes	After completing this course, the student must be able to: 1. Apply statistical methods in the analysis of data 2. Design experiments involving several factors

Course Outline	1. Obtaining Data 1.1. Methods of Data Collection 1.2. Planning and Conducting Surveys 1.3. Planning and Conducting Experiments: Introduction to Design of Experiments 2. Probability 2.1. Sample Space and Relationships among Events 2.2. Counting Rules Useful in Probability 2.3. Rules of Probability 3. Discreet Probability Distributions 3.1. Random Variables and their Probability Distributions 3.2. Cumulative Distribution Functions 3.3. Expected Values of Random Variables 3.4. The Binomial Distribution 3.5. The Poisson Distribution 4. Continuous Probability Distribution 4.1. Continuous Random Variables and their Probability Distribution 4.2. Expected Values of Continuous Random Variables 4.3. Normal Distribution 4.4. Normal Approximation to the Binomial and Poisson Distribution 4.5. Exponential Distribution 5. Joint Probability Distribution 5.1. Two or Random Variables 5.2. Linear Functions of Random Variables 5.3. General Functions of Random Variables 6. Sampling Distributions and Point Estimation of Parameters 6.1. Point Estimation 6.2. Sampling Distribution and the Central Limit Theorem 6.3. General Concept of Point Estimation 7. Statistical Intervals 7.1. Confidence Intervals: Single Sample 7.2. Confidence Intervals: Multiple Samples 7.3. Prediction Intervals 7.4. Tolerance Intervals 8. Test of Hypothesis for a Single Sample 8.1. Hypothesis Testing 8.2. Test on the Mean of a Normal Distribution, Variance Known 8.3. Test on the Mean of a Normal Distribution, Variance Unknown 8.4. Test on the Variance and Statistical Deviation of a Normal Distribution 8.5. Test on a Population Proportion 9. Statistical Inference of Two Samples 9.1. Inference on the Difference in Means of Two Normal Distributions, Variances Known 9.2. Inference on the Difference in Means of Two Normal Distributions, Variances Unknown 9.3. Inference on the Variance of Two Normal Distributions 9.4. Inference on Two Population Proportions 10. Simple Linear Regression and Correlation

	10.1. Empirical Models 10.2. Regression: Modelling Linear Relationships – The Least-Squares Approach 10.3. Correlation: Estimating the Strength of Linear Relation 10.4. Hypothesis Tests in Simple Linear Regression 10.5. Prediction of New Observations 10.6. Adequacy of the Regression Model 10.7. Correlation 11. Multiple Linear Regression 11.1. Multiple Linear Regression Model 11.2. Hypothesis Test in Multiple Linear Regression 11.3. Prediction of New Observations 11.4. Model Adequacy Checking 12. Design and Analysis of Single Factor Experiments 12.1. Completely Randomized Single Factor Experiments 12.2. The Random-Effects Model 12.3. Randomized Complete Block Design 13. Design of Experiments with Several Factors 13.1. Factorial Experiments 13.2. Two-Factor Factorial Experiments 13.3. 2^k Factorial Design 13.4. Blocking and Confounding in the 2^k Design 13.5. Fractional Replication of the 2^k Design 13.6. Response Surface Methods

5. Chemistry for Engineers

Course Contents

Course Name	**Chemistry for Engineers**
Course Description	This course provides students with core concepts of chemistry that are important in the practice of engineering profession.
Number of Units for Lecture and Laboratory	4 units (3 lec, 1 lab)
Number of Contact Hours per Week	6 hours (3 lec, 3 lab)
Prerequisites	None
Co-requisites	None
Program Outcomes Addressed by the Course	a, b, k
Course Outcomes	At the end of the course, the students must be able to: 1. Discuss the application of chemistry in relation to the generation of energy 2. Explain the chemical principles and concepts of structures and bonding of common materials

	3. Discuss the chemical processes that takes place in the environment 4. Identify key chemistry concepts related to the specific field of engineering
Course Outline	1. Energy 1.1. Electrochemical energy 1.2. Nuclear chemistry and energy 1.3. Fuels 2. The Chemistry of Engineering Materials 1.1. Basic Concepts of Crystal Structure 1.2. Metals 1.3. Polymers 1.4. Engineered Nanomaterials 3. The Chemistry of the Environment 1.1. The Chemistry of the atmosphere 1.2. The Chemistry of Water 1.3. Soil chemistry 4. Chemical Safety 5. Special Topics specific to field of expertise
Laboratory Equipment	See Annex IV

6. Physics for Engineers

Course Contents

Course Name	**Physics for Engineers**
Course Description	Vectors; kinematics; dynamics; work, energy, and power; impulse and momentum; rotation; dynamics of rotation; elasticity; and oscillation. Fluids; thermal expansion, thermal stress; heat transfer; calorimetry; waves; electrostatics; electricity; magnetism; optics; image formation by plane and curved mirrors; and image formation by thin lenses.
Number of Units for Lecture and Laboratory	4 units (3 lec, 1 lab)
Number of Contact Hours per Week	6 hours (3 lec, 3 lab)
Prerequisites	None
Program Outcomes Addressed by the Course	a, b, k
Course Outcomes	After completing this course, the student must be able to: 1. Use calculus to solve problems in force statics and kinematics; 2. Apply the Newton's Laws of Motion; 3. Use calculus to solve work and energy problems; 4. Apply the law of conservation of energy to problems; 5. Solve problems on impulse and momentum and collisions; 6. Determine the stress and strain on a body;

	7. Solve simple harmonic motion applications; 8. Describe the characteristics of fluids at rest and in motion; 9. Solve basic problems in fluid statics and kinematics 10. Describe the three methods of heat transfer; 11. Solve basic problems in heat transfer; 12. Discuss the properties of waves, modes of vibration of strings and air columns; 13. Define electric current, electric resistance and voltage; 14. Compute the electric force between electric charges; 15. Solve problems on resistance and cells in series and parallel; 16. State Kirchhoff's rules and apply them in a given circuit; 17. Describe electromagnetism and apply its principles to problem on magnetic field and torque. 18. Describe image formation by mirrors and lenses and solve basic optics problems
Course Outline	1. Work, Energy and Power 2. Impulse and Momentum 3. Kinematics 4. Dynamics 5. Rotation 6. Dynamics of Rotation 7. Elasticity 8. Oscillations 9. Fluids 10. Heat Transfer 11. Waves 12. Electrostatics 13. Electricity 14. Magnetism 15. Optics
Laboratory Equipment	See Annex IV

III.2 AB SCIENCE COURSES

1. Principles of Animal Science

Course Contents

Course Name	**Principles of Animal Science**
Course Description	Introduction to animal science, economic importance of animals; contribution of livestock and poultry animals to climate change; anatomy and physiology; mechanism of growth; methods of genetic improvement; identification of feed sources and nutrition needed by animals
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)

Prerequisites	None
Co-requisites	None
Program Outcomes Addressed by the Course	b, d, g, k
Course Outcomes	After the completion of the course, the student must be able to: 1. Describe the whole animal industry, its role in the society, the ecology of animals and its relationship with the changing climate; 2. Identify anatomical parts of the animals as well as discuss its physiology; 3. Explain the principles governing the study of animal science; 4. Explain the factors affecting the growth and maturity of the bones, muscles and other parts of the animal's body with consideration on the endocrinology and the genetics of the animal; 5. Trace the flow of blood from the heart to the different parts of the body; 6. Explain the physiology of blood formation; 7. Trace the diffusion of gases from the external environment to the cell; 8. Distinguish the type of hormones released based on the physiological action of the different parts of the animal; including its body processes; 9. Compare and state the difference between avians and mammals in terms of their urinary system 10. Differentiate the function of the reproductive organs in both avians and mammals; 11. Explain the guiding principles of animal breeding; 12. Describe the biotechnologies common in the improvement of farm animals; and 13. Explain the importance of nutrients to the growth and maintenance of the animals
Course Outline	1. Introduction 1.1. Introduction to animal science 1.2. Ecology of animals 1.3. Livestock and climate change 2. Anatomy and Physiology of Farm Animals: External anatomy 2.1. Directional terms 2.2. Main body divisions 2.3. Integumentary systems 3. Internal Anatomy of Farm Animals: Skeletal System 3.1. General composition of bones 3.2. Main skeletal divisions 3.3. Main classification of bones 3.4. Joint and articulations 3.5. Fracture of the bones 4. Musculatory and Circulatory Systems 4.1. Musculatory System

	4.2. Types of muscle tissues 4.3. Functional grouping of muscles 4.4. Microscopic anatomy of muscles 4.5. Cardiovascular system 4.6. Comparative anatomy and physiology of the heart 4.7. Circulatory system 4.8. Blood formation and physiology 5. Nervous System 5.1. Structure of the nervous system 5.2. Classification of neurons according to direction of impulse 6. Digestive System 6.1. Functions of the digestive system 6.2. Types of digestive systems of different farm animals 6.3. Parts of the digestive system and their physiology 7. Respiratory System 7.1. Major and secondary functions of respiratory system 7.2. Respiratory organs and their functions 7.3. Physiology and respiration process 7.4. Mechanics and diffusion of gases 8. Endocrinology 8.1. Definition of hormones and its action 8.2. The importance of hormones 8.3. Types of hormones 9. Urinary system 9.1. Differences between avian and mammalian urinary system 9.2. Major parts comprising the urinary system including its anatomy and physiology 9.3. Concentration and dilution of urine 10. Mammalian and Avian Reproductive System 10.1. Gametogenesis, fertilization, and pregnancy 10.2. Female reproductive organs and the physiology of the formation of the egg cells 10.3. Mammalian and avian male reproductive system 10.4. Testes abnormality and classification 11. Genetics and Animal Breeding 11.1. Animal breeding 11.2. Basic terms in animal genetics 11.3. Kinds of selection 11.4. Methods of selection 11.5. Systems of breeding 12. Animal Biotechnology 12.1. Artificial Insemination 12.2. Embryo transfer 12.3. Cloning 13. Animal Nutrition 13.1. Nutrients required by animal 13.2. Classifications of carbohydrates 13.3. Importance of nutrients to the growth and maintenance of animals
Laboratory Exercises	To be formulated by the concerned HEI

2. Principles of Crop Science

Course Contents

Course Name	**Principles of Crop Science**
Course Description	Physiological processes affecting crop production; factors affecting crop production; crop production system; sustainable crop production; issues, policies, and trade agreement concerning crop production
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	None
Co-requisites	None
Program Outcomes Addressed by the Course	b, d, g, k
Course Outcomes	After the completion of the course, the student must be able to: 1. Categorize crops according to agronomic and horticultural classification, importance, and climatic requirements; 2. Discuss the basic physiological processes in crop production; 3. Describe the principles and practices of crop production and management; and 4. Explain the socio-economic, cultural, and political issues in crop production in relation to agricultural sustainability
Course Outline	1. Physiological Processes Affecting Crop Production 1.1. Photosynthesis 1.2. Respiration 1.3. Transpiration 1.4. Translocation 1.5. Mineral nutrition 1.6. Growth and development 1.7. Seed Dormancy 2. Factors Affecting Crop Production 2.1. Genetic factors 2.2. Biotic factors 2.3. Abiotic factors 3. Crop Production System 3.1. Classification of crops 3.2. Seed production and certification 3.3. Crop management practices 3.4. Cropping systems 3.5. Harvesting and postharvest management 4. Sustainable Production 4.1. Goals of agriculture 4.2. Practices in sustainable crop production 4.3. Organic farming 4.4. Nutrition Cycle

	5. Issues, Policies, and Trade Agreement Governing Crop Production
Laboratory Exercises	To be formulated by the concerned HEI

3. Principle of Soil Science

Course Contents

Course Name	**Principles of Soil Science**
Course Description	Genesis and classification, nature and properties, management and conservation of soils
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	None
Co-requisites	None
Program Outcomes Addressed by the Course	b, d, g, k
Course Outcomes	After the completion of the course, the student must be able to: 1. Describe the mechanisms involved in soil formation and development 2. Explain the different kinds of soils and their nature and properties 3. Explain the soil physical, chemical and biological properties and relate their importance to agriculture, environmental concerns, and engineering 4. Identify recommended soil management practices to rehabilitate, conserve and/or improve performance of the soil for various purposes 5. Develop awareness of the importance of the soil to other disciplines
Course Outline	**1. Fundamental Concepts and Definitions:** 1.1. Components of the global ecosystem 1.2. The pedosphere 1.3. Definition of soil 1.4. Hierarchy of study of soil, dimensions and boundaries 1.5. Importance and functions of soils 1.6. Concepts of the study of soil 1.7. History of Soil Science 1.8. Divisions of Soil Science **2. The Earth** 2.1. Origin, Composition and Structure 2.2. Geology History of the Earth and its Major Sphere 2.3. Rocks and Minerals **3. Soil Formation and Development** 3.1. Definitions: formation vs. development

	3.2. Factors of soil formation 3.3. Weathering 3.4. Soil Development 3.5. Soil Profile vs. Soil Horizon 3.6. Master horizons and common diagnostic horizons 3.7. Interpreting soil properties from horizon depth and letter designations **4. Soil as a three-phase system** 4.1. Three-phase composition of the soil 4.2. Soil air and soil water 4.3. Soil Solids such as mineral soils, rocks, rock cycle, and organic fraction **5. Soil Physical Properties** 5.1. Types of physical properties 5.2. Important physical properties examined in profile description and land use decision such soil texture, structure, color, consistency, density, and hydraulic conductivity 5.3. Soil water and its properties with respect to moisture content, energy state, porous media, Darcy's law, and infiltration and estimation of depth to welting front **6. Soil Chemical Properties** 6.1. Importance of chemical properties 6.2. Review of basic chemistry concepts 6.3. Soil Colloid (inorganic and organic) 6.4. Clay mineralogy 6.5. Ion exchange 6.6. Base saturation 6.7. Soil reaction and liming 6.8. Redox reaction **7. Soil Biological properties and soil organic matters** 7.1. Macrofauna 7.2. Microorganisms both microfauna and macroflora 7.3. Distribution of microorganisms in a soil profile 7.4. Environmental conditions affecting soil microbial populations 7.5. Beneficial activities of microorganisms – N – Cycle 7.6. Metabolic classification of soil microorganisms 7.7. Soil organic matter, its definitions, composition, decomposition, and functions of soil organic matter **8. Soil Nutrition** 8.1. Criteria of essentiality 8.2. Essential nutrients 8.3. Nutrient uptake mechanisms 8.4. Plant-available forms of essential elements 8.5. Sources of essential elements 8.6. Nutrient in Focus such as nitrogen and phosphorous, their importance cycles, and as pollutant 8.7. Methods of assessing soil fertility status 8.8. Management or improvement of soil fertility **9. Erosion and soil protection/conservation** 9.1. Types of erosion 9.2. Erosion and its types 9.3. Mechanisms involved in water-induced erosion

	9.4. Principles of soil protection/conservation 9.5. Methods of soil protection/conservation erosion control **10. Systematic and Geography of Soils** 10.1. Hierarchy in soil classification 10.2. Soil orders and their formative elements 10.3. Geography of soils in the world
Laboratory Exercises	To be formulated by the concerned HEI

III.3. BASIC ENGINEERING COURSES

1. Computer Aided Drafting

Course Contents

Course Name	**Computer-Aided Drafting**
Course Description	The course covers the concepts of computer-aided drafting with introduction on CAD terminologies and environment with the application of techniques in inputting and executing CAD commands and other related software.
Number of Units for Lecture and Laboratory	1 unit (Lab)
Number of Contact Hours per Week	3 laboratory hours
Prerequisites	None
Co-requisites	None
Program Outcomes Addressed by the Course	e, g, k
Course Outcomes	After the completion of the course, the student must be able to: 1. Define the terms related to computer-aided drafting; 2. Identify the important tools used to create technical drawings in CAD; 3. Create electronic drawings using the CAD/related software
Course Outline	1. Introduction to CAD/related Software and its environment 2. Snapping and construction elements 3. Dimensioning 4. Plotting and inputting of images 5. 3D and Navigating in 3D 6. Rendering
Laboratory Equipment	1. 25 Personal computers with operating system and installed CAD/related software for a laboratory class of 25 students 2. Printer or plotter
Laboratory Exercises	To be formulated by the concerned HEI

2. Engineering Mechanics I

Course Contents

Course Name	**Engineering Mechanics I**
Course Description	Principles of statics; resultant of force systems; equilibrium force; analysis of structures, and friction
Number of Units for Lecture and Laboratory	3 units
Number of Contact Hours per Week	3 lecture hours
Prerequisites	Physics for Engineers, Calculus I
Co-requisites	None
Program Outcome/s Addressed by the Course	a, b, g, k
Course Outcomes	After the completion of the course, the student must be able to: 1. Explain the principles of statics 2. Compute resultant of force system 3. Compute equilibrium of force system 4. Analyze and compute structures 5. Apply the concept of friction in solving wedges, screws, belt friction and rolling resistance
Course Outline	1. Principles of Statics 2. Resultants of Force Systems 2.1 Forces and Components 2.2 Resultant of Three or More Concurrent Forces 2.3 Moment of a Force 2.4 Resultant of Parallel Forces 2.5 Couples 2.6 Resolution of a Force into a Force and a Couple 2.7 Resultant of Non-Concurrent Force Systems 3. Equilibrium of Force Systems 3.1 Free-Body Diagrams 3.2 Equilibrium of Concurrent Force Systems 3.3 Conditions of Equilibrium from Moments 3.4 Three Coplanar Forces in Equilibrium are Concurrent 3.5 Equilibrium of Parallel Forces 3.6 Equilibrium of Non-Concurrent Force Systems 4. Analysis of Structures 4.1 Method of Joints 4.2 Method of Sections 4.3 Frames and Machines 5. Friction 5.1 Theory of Friction 5.2 Angle of Friction 5.3 Problems in Friction 5.4 Wedges 5.5 Square-Threaded Screws

	5.6 Belt Friction 5.7 Rolling Resistance
Supplemental Activities	Computational exercises

3. Engineering Mechanics II

Course Contents

Course Name	**Engineering Mechanics II**
Course Description	Principles of dynamics; rectilinear translation; curvilinear translation; rotation; and work and energy;
Number of Units for Lecture and Laboratory	3 units
Number of Contact Hours per Week	3 lecture hours
Prerequisites	Engineering Mechanics I
Co-requisites	None
Program Outcomes Addressed by the Course	a, b, g, k
Course Outcomes	After the completion of the course, the student must be able to: 1. Describe the principles of dynamics and its importance in the field of engineering; 2. Explain the concepts of rectilinear and curvilinear translation, rotation, and work and energy 3. Compute problems involving rectilinear and curvilinear translations at varying conditions; 4. Analyze and compute problems related to rotation, work, and energy; and 5. Apply the principles of dynamics in designing basic machine and building structures in actual field situation
Course Outline	1. Principles of Dynamics 2. Rectilinear Translation 2.1. Rectilinear Motion with Constant Acceleration 2.2. Freely Falling Bodies, Air Resistance Neglected 2.3. Rectilinear Motion with Variable Acceleration 2.4. Dynamic Equilibrium in Translation 3. Curvilinear Translation 3.1. Flight of Projectiles. Air Resistance Neglected 3.2. Tangential and Normal Components of Acceleration 3.3. Kinetics of Curvilinear Translation. Dynamic Equilibrium 4. Rotation 4.1. Rotation with Constant Angular Acceleration 4.2. Rotation with Variable Angular Acceleration 5. Work and Energy 5.1. Application of Work-Energy Method. Constant Forces 5.2. Resultant Work. Variable Forces

	5.3. Power. Efficiency 5.4. Work-Energy Applied to Plane Motion
Supplemental Activities	Computational exercises

4. Engineering Economy

Course Contents

Course Name	**Engineering Economy**
Course Description	Time value of money; money discounting; effect of inflation; International Accounting Standards (IAS); International Financial Reporting Standards (IFRS) under the IAS; use of feasibility analysis software adopting the IAS standards; future value and present worth; investments, operating costs, financial and economic benefits; annual projection of material quantities, costs and benefits; annual cash flow; feasibility indicators - Net Present Value (NPV), Internal Rate of Return (IRR), Benefit-Cost Ratio (BCR), Return on Investment (ROI) and Payback Period; financial and economic feasibility analyses with risk/sensitivity analysis; break-even analysis, financial ratios and the financial statements based on International Financial Reporting Standards (IFRS) - Income Statement, Cash Flow Statement, Balance Sheet; preparation of international standard feasibility studies complete with Project Summary, Market, Technical, Financial, Socio-Economic and Management Feasibilities.
Number of Units	3 units
Contact Hrs/Wk	3 hours lecture
Prerequisites	Third Year Standing
Co-requisites	None
Program Outcomes Addressed by the Course	a, c, g, h, k, l
Course Outcomes	At the end of the semester the students must be able to: 1. Explain the time value of money and money discounting at normal and inflationary conditions; 2. Determine the future value of an investment and the present worth of a targeted future amount; 3. Prepare using manual computations and computer the detailed investments, operating costs, financial and economic benefits of any engineering projects; 4. Do annual projection of material quantities, costs and benefits for any engineering projects manually and using the computer; 5. Prepare annual cash flows for any engineering project using the International Accounting Standards (IAS); 6. Quantify and explain the implications of the following project feasibility indicators: Net Present Value (NPV), Internal Rate of Return (IRR), Benefit-Cost Ratio (BCR), Return on Investment (ROI) and Payback Period;

	7. Do financial and economic feasibility analyses with risk/sensitivity analysis using the life cycle cash flow accounting method and all applicable International Accounting Standards (IAS); 8. Interpret the implications of break-even analysis, financial ratios and the financial statements based on International Financial Reporting Standards (IFRS) – Income Statement, Cash Flow Statement, Balance Sheet 9. Prepare manually and using a software an international standard feasibility studies complete with Project Summary, Market, Technical, Financial, Socio-Economic and Management Feasibilities.
Course Outline	1. Introduction 1.1. Time value of money 1.2. Money discounting at normal and inflationary 1.3. Conditions 1.4. International Accounting Standards (IAS) 1.5. International Financial Reporting Standards (IFRS) of IAS 1.6. Use of feasibility analysis software adopting IAS standards 2. Future value and present worth 2.1. Future value of an investment 2.2. Present worth of a targeted future amount 3. Estimation of detailed costs and benefits of any engineering projects 3.1. Assumptions 3.2. Investments 3.3. Operating costs 3.4. Financial benefits 3.5. Economic benefits 4. Annual projection of project data manually and using computer 4.1. Material quantities 4.2. Costs 4.3. Financial benefits 4.4. Economic benefits 5. Preparation of annual cash flows manually and using computer 5.1. Applying the International Accounting Standards (IAS) 5.2. Cash flow preparation 6. Quantification and interpretation of project feasibility indicators manually and using computer: 6.1. Net Present Value (NPV) 6.2. Internal Rate of Return (IRR) 6.3. Benefit-Cost Ratio (BCR) 6.4. Return on Investment (ROI) 6.5. Payback Period 7. Financial and economic feasibility analyses using the life cycle cash flow accounting method and considering risks 7.1. Applicable provisions of International Accounting Standards 7.2. Financial feasibility analysis

	7.3. Economic feasibility analysis 7.4. Inflation and other risk factors 7.5. Sensitivity analysis 8. Introduction to financial statements, break-even analysis and financial ratios and their interpretations 8.1. Applying International Financial Reporting Standards (IFRS) 8.2. Income statement 8.3. Cash flow statement 8.4. Balance sheet 8.5. break-even analysis 8.6. financial ratios 9. Preparation of international standard feasibility studies manually and using a software adopting the IAS standards 9.1. Project summary 9.2. Market feasibility 9.3. Technical feasibility 9.4. Financial feasibility 9.5. Socio-economic feasibility 9.6. Management feasibility 9.7. Appendices 10. Engineering Management 10.1 Management and its functions 10.2 Planning 10.3 Leading 10.4 Organizing 10.5 Controlling 10.6 Managing Product and Service Operations 10.7 Managing the Marketing and Finance Functions
Lecture Equipment	At least 25 computers with any standard feasibility analysis software

III.4 BASIC ENGINEERING COURSES FOR ABE

1. Introduction to Agricultural and Biosystems Engineering

Course Contents

Course Name	**Introduction to Agricultural and Biosystems Engineering**
Course Description	Introduction to the field of Agricultural and Biosystems Engineering, the profession as a tool for sustainable development in global and local frontiers; AB engineering projects; success stories; best practices and approaches; innovations; challenges and opportunities.
Number of Units for Lecture and Laboratory	1 unit
Number of Contact Hours per Week	3 hours laboratory (industry visits, observation visits, study tour)
Prerequisites	None

Co-requisites	None
Program Outcomes Addressed by the Course	f, h, j
Course outcomes	At the end of the semester the students must be able to: 1. explain the ABE program and basic sub-disciplines; 2. describe the opportunities of graduates of the ABE program and its contribution to food security and sustainable development in local and global frontiers; 3. develop a clear appreciation of the various ABE projects, success stories, best practices and approaches, innovations and challenges; 4. explain the importance of technical communication and teamwork in the ABE profession
Course Outline	1. Introduction 1.1. Vision, mission, goals of the university/college 1.2. BSABE program educational objectives and program outcomes 1.3. BSABE program and the basic sub-disciplines of the ABE 2. Opportunities of graduates of the ABE program and its contribution to food security and sustainable development in local and global frontiers 3. ABE projects, success stories, best practices and approaches, innovations and challenges 4. Technical communication and teamwork in the ABE profession
Laboratory Equipment	See Annex IV

2. Strength of Materials

Course Contents

Course Name	**Strength of Materials**
Course Description	Axial shear force and bending moments, stress-strain relationships; torsion, bending and shear stresses; combined stresses; beam deflection; continuous and restrained beam buckling; and plastic behaviour of structures.
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	Engineering Mechanics II
Co-requisites	None
Program Outcomes Addressed by the Course	a, e, k
Course Outcomes	At the end of the semester the students must be able to: 1. Identify the different types of stresses due to external forces;

	2. Explain the effects of the stresses due to applied forces and their direct and indirect contributions to the structural integrity of the bodies; 3. Apply the knowledge of fundamental engineering and mathematical information to the advanced structural, mechanical, and other vital engineering theories.
Course Outline	1. Different types stresses due to external forces. 1.1. Normal stress, shearing stress, bearing stress 1.2. Stress in thin-walled cylinders, spherical stress 1.3. Strain, thermal stress, and torsion 1.4. Flanged Bolt Couplings, Helical Spring 2. Stresses due to applied forces and their direct and indirect contributions to the structural integrity of the bodies. 2.1. Shear and Moment in Beams 2.2. Moving Loads 2.3. Flexure Formula 2.4. Economic Sections 2.5. Floor Framing 2.6. Unsymmetrical Beams 2.7. Horizontal Shearing Stress 2.8. Spacing of Rivets or Bolts in Built-Up Members 3. Fundamental engineering and mathematical information to the advanced structural, mechanical, and other vital engineering theories. 3.1. Double Integration Method 3.2. Area Moment Method and Moment Diagram by parts 3.3. Restrained Beams 3.4. Three-Moment Equation 3.5. Combined Stresses 3.6. Mohr's Circle

3. Fluid Mechanics

Course Contents

Course Name	**Fluid Mechanics**
Course Description	Properties of fluids; fluid statics, kinematics and dynamics; flow in pressure conduits and open channels; fluid measurements and turbo-machinery.
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	Engineering Mechanics II
Co-requisites	None
Program Outcomes Addressed by the Course	a, e, k
Course Outcomes	At the end of the course, the students should be able to: 1. Discuss the principles of fluid mechanics; and, 2. Compute fluid flows; 3. Apply the principles of fluid mechanics to the analysis and solution of engineering problems.

Course Outline	1. Introduction to Fluid Mechanics 1.1. Fluid Classification, Fluid Properties 1.2. Units and Scales of Pressure Measurement 2. Pressure 2.1. Pressure-Measuring Device and Pressure at a Point 2.2. Pressure Variation in a Static Fluid 2.3. Manometers 3. Hydrostatic Forces and Buoyancy 3.1. Hydrostatic Forces on Plane Surfaces 3.2. Hydrostatic Forces on Curved Surfaces 3.3. Hydrostatic Forces in Layered Fluids 3.4. Buoyancy and Stability 4. Relative Equilibrium 1. Relative Equilibrium: Rectilinear Acceleration 2. Relative Equilibrium: Rotation 5. Fluid Flow 5.1. Classification 5.2. Reynolds' Transport Theorem 5.3. Conservation of Mass and Linear Momentum 5.4. Conservation of Angular Momentum 5.5. Conservation of Energy 5.6. Pipe Flow Equations and Friction Losses 5.7. Simple Pipe Problems and Minor Losses 5.8. Multiple Pipe Systems 5.9. Open-Channel Flow and Uniform Flow 5.10. Geometric Elements of an Open Channel 5.11. Multiple Reservoir Problems
Laboratory Exercises	Computation exercises

4. Surveying

Course Content

Course Name	**Surveying**
Course Description	Surveying principles and applications; theory and measurements of error; measurements of distances, elevations, and directions; profile and topographic surveying; earthwork calculations; and land grading.
Number of Units for Lecture and Laboratory	3 units (2 lec; 1 lab)
Number of Contact Hours per Week	5 hours (2 lec; 3 lab)
Prerequisites	Mathematics in the Modern World
Co-requisites	None
Program Outcomes Addressed by the Course	a, b, e, k
Course Outcomes	1. Explain the principles of surveying. 2. Perform precise measurement and analyze the accuracy of results obtained in engineering surveys. 3. Conduct topographic survey and analyze it to solve engineering problems, particularly those in land and water management. 4. Produce topographic map

Course Outline	1. Principles of surveying 1.1. Introduction to surveying 1.2. Theory and Measurement of error 2. Linear Measurements 2.1. Pacing 2.2. Taping over even/uneven ground surfaces 2.3. Sources and types of errors 2.4. Special taping problems 3. Leveling 3.1. Theory of leveling 3.2. Earth's curvature and refraction 3.3. Methods of determining difference in elevation 3.4. Instruments for direct leveling 3.5. Differential leveling 3.6. Profile leveling 3.7. Sources of errors 4. Angles and Direction 4.1. Engineer's transit operations 4.2. Sources of errors 5. Stadia Measurements 6. Traversing 7. Area Computations 8. Mapping 9. Volume of Earthwork 9.1. Types of cross-section 9.2. Setting of slope stakes 9.3. Earthwork volumes 10. Land Grading
Laboratory Equipment	See Annex IV

5. Materials and Processes for ABE

Course Contents

Course Name	**Materials and Processes for ABE**
Course Description	Practical mensuration; proper selection and safe use of hand and power tools; common engineering shop materials and processes, basic machining, welding and foundry
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	Chemistry for Engineers, Computer-Aided Drafting, Engineering Mechanics I
Co-requisites	None
Program Outcomes Addressed by the Course	a, e, k
Course Outcomes	At the end of the course, the students should be able to:

	1. Identify common materials used in ABE applications 2. Perform basic wood and metal bench work operations, 3. Perform/ Observe basic operation that can be done with drill press, lathe machine, milling machine, electric arc welding and an oxyacetylene welder. 4. Describe basic forging and foundry operations 5. Prescribe appropriate materials in the fabrication of various ABE projects 6. Select appropriate construction materials for farm structures
Course Outline	1. Review of related concepts 1.1. Occupational Safety and Health Standards (OSHS) 2. Construction Materials 2.1. Metals 2.2. Wood 2.3. Ceramics 2.4. Polymers 2.5. Composites 3. Material Processes 3.1. Metals 3.2. Wood 3.3. Ceramics 4. Polymers 5. Composites 6. Material Selection for AB Structures 7. Design and Computation of Requirements for AB Structures
Laboratory Equipment	See Annex IV

6. Thermodynamics and Heat Transfer

Course Contents

Course Name	**Thermodynamics and Heat Transfer**
Course Description	Basic laws of thermodynamics; characteristics of gases, vapor and mixtures; laws governing heat transfer and their applications to insulators and heat exchangers such as condensers, cooling coils and evaporators
Number of Units for Lecture and Laboratory	5 units (5 lec, 0 lab)
Number of Contact Hours per Week	5 hours (5 lec, 0 lab)
Prerequisites	Physics for Engineers, Calculus 1
Co-requisites	None
Program Outcomes Addressed by the Course	a, e, k

Course Outcomes	At the end of the course, the students should be able to: 1. Explain the basic concepts of thermodynamics and heat transfer 2. Compute problems related to the different laws of Thermodynamics, pure substances, vapour and gas power cycles, and reactive systems 3. Compute problems related to heat transfer by conduction, convection, radiation and/or combination of the three modes of heat transfer 4. Apply the principles of thermodynamics and heat transfer in actual working models.
Course Outline	1. Basic Concepts and Definitions 2. The First Law of Thermodynamics 3. The Second Law and Entropy 4. The Ideal Gas and the Corresponding States and Incompressible Models 5. Properties of Pure Substance 6. Vapor Power Cycles 7. Gas Power Cycles 8. Reactive Systems 9. Overview of Heat Transfer 10. Heat Transfer by 1-D Steady-state and Transient Conduction 11. Heat Transfer by Convection 12. Combined Conduction and Convection Heat Transfer 13. Heat Transfer by Radiation
Laboratory Exercises	None but with computational exercises

7. Computer Applications in AB Engineering

Course Contents

Course Name	**Computer Applications in AB Engineering**
Course Description	Basic concepts of computer programming; computer-generated solutions to problems in Agricultural and Biosystems Engineering Applications
Number of Units for Lecture and Laboratory	3 units (1 lec, 2 lab)
Number of Contact Hours per Week	7 hrs (1 lec, 6 lab)
Prerequisites	Junior Standing
Co-requisites	None
Program Outcomes Addressed by the Course	a, e, k
Course Outcomes	At the end of the course, the students should be able to: 1. Explain the basics of computer programming

	2. Develop computer algorithms for agricultural and biosystems engineering applications using spreadsheet 3. Develop computer algorithms for agricultural and biosystems engineering applications using text-based programming 4. Develop computer algorithms for agricultural and biosystems engineering applications using graphical programming 5. Solve problems in Agricultural and Biosystems Engineering using computer-aided solutions
Course Outline	1. Introduction to Computer-Aided Solutions to Solving Problems 1.1. Basic Programming Language Elements 1.2. Software for Computer-Aided Solutions including Spreadsheet, Text-based programming, and Graphical programming 2. Spreadsheet- Based Computing 2.1. Basic Operations and Functions 2.2. Spreadsheet Applications 3. Text-Based Programming for Control Systems 3.1. Introduction to Text-based Programming 3.2. Basic Operations and Functions 3.3. Data Acquisition and Handling 3.4. Simple Control System Simulation 4. Graphical Programming 4.1. Introduction to Graphical Programming 4.2. Basic Operations and Functions 4.3. Data Acquisition and Handling 4.4. Simple Control System Simulation
Laboratory Equipment	See Annex IV

8. ABE and Related Laws, Specifications, Contracts, and Professional Ethics

Course Contents

Course Name	ABE and Related Laws, Specifications, Contracts, and Professional Ethics
Course Description	Agricultural and biosystems engineering laws, preparation of ABE contracts and specifications, engineering ethics, intellectual property rights, Relevant laws for the practice of ABE profession.
Number of Units for Lecture and Laboratory	1 unit (1 lec)
Number of Contact Hours per Week	1 hour lecture
Prerequisites	Intro to ABE, GE-Ethics
Co-requisites	None

Program Outcomes Addressed by the Course	f, h, l, j
Course Outcomes	At the end of the course, the students should be able to: 1. Explain the salient provisions of the RA 10915 (Agricultural and Biosystems Engineering Law of 2016) and other laws related to the agricultural and biosystems engineering profession. 2. Discuss the basic concepts of intellectual property and its significance to the ABE profession. 3. Discuss ethical issues involving engineering decisions.
Course Outline	1. Introduction 2. Laws and policies that relate to the practice of agricultural and biosystems engineering. 2.1. ABE Law of 2016 (RA 10915) 2.2. AFMA Law of 1997 (RA 8435) 2.3. AFMech Law of 2013 (RA 10601) 2.4. Government Procurement Reform Act (RA 9184) 2.5. Standards and PAES 2.6. Intellectual Property Law (RA 8293) 2.7. Ethics, engineering ethics. (RA 6713 and AE Code of Conduct) 2.8. Issuances of BoAE-PRC 3. Other related laws
Laboratory Equipment	None

III.5. PROFESSIONAL COURSES

III.5.1. AB Machinery and Power Engineering

1. AB Power Engineering

Course Contents

Course Name	**AB Power Engineering**
Course Description	Conventional and non-conventional sources of power and their measurements for agricultural and biosystems applications
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	Thermodynamics and Heat Transfer, Calculus II
Co-requisites	None
Program Outcomes Addressed by the Course	a, e, g, k
Course Outcomes	At the end of the course, the students should be able to:

	1. Identify the conventional and renewable power sources, their applications and limitations 2. Demonstrate proper operation and performance test of small engine, farm tractor and electric motor 3. Estimate the power available from renewable energy sources
Course Outline	1. Introduction 1.1. Concept of energy and power 1.2. Sources of power in the farm 2. External Combustion Engine 3. Internal Combustion Engine 3.1. Thermodynamic principles 3.2. Engine components 3.3. Engine cycles and timing 3.4. Power efficiencies and measurements 3.5. Fuels and combustion 3.6. Engine auxiliary system 3.7. Engine operation and maintenance 4. Tractors 4.1. Two- and four-wheel tractors 4.2. Clutches and brakes 4.3. Transmission, differential and final drive 4.4. Hitches and stability 4.5. Tractor performance tests 4.6. Tractor operation and maintenance 5. Solar Power 5.1. Thermodynamic pathways for solar energy conversion 5.2. Geometric relationships of the sun and the receiving solar collector 5.3. Available solar energy resource 5.4. Solar PV and solar collectors 5.5. Applications of solar power in agriculture 6. Wind Power 6.1. Estimation of available wind power 6.2. Wind generators 6.3. Applications of wind power in agriculture 7. Water Power 7.1. Power available in moving water 7.2. Water wheels, turbines, and rams 7.3. Applications 8. Biomass 8.1. Sources of biomass resource 8.2. Thermal conversion process 8.3. Biological conversion process 8.4. Chemical conversion process 8.5. e. Uses of biomass converted products
Laboratory Equipment	See Annex IV

2. Renewable Energy for AB Applications

Course Contents

Course Name	**Renewable Energy for AB Applications**
Course Description	Principles and design criteria of solar energy collection; Wind and micro-hydro energy resource calculations; Biomass energy resource calculations
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	AB Power Engineering
Co-requisites	None
Program Outcomes Addressed by the Course	a, c, d, e, g, h, k
Course Outcomes	At the end of the course, the students should be able to: 1. compute the theoretical and actual solar energy resource in a given location 2. estimate the theoretical and actual wind energy resource in a given location 3. estimate the theoretical and actual micro-hydro energy resource in a given location 4. estimate the available biomass resource in a given location 5. design at least one renewable energy systems
Course Outline	1. Introduction 1.1. Forms of renewable energy 1.2. Sources of renewable energy 2. Solar Energy 2.1. Types of solar power 2.2. Solar energy resource 2.3. Estimation of available solar power 2.4. Design of solar energy collectors 3. Wind Energy 3.1. Windmill types 3.2. Wind energy resource 3.3. Estimation of Wind power 3.4. Design wind energy conversion systems 4. Hydro Power 4.1. Micro-hydro system 4.2. Water resource 4.3. Theoretical power 4.4. Design of micro-hydro system 5. Biomass 5.1. Sources of biomass for energy conversion 5.2. Overview of biomass conversion processes 5.3. Biomass characterization for thermal conversion 5.4. Biomass characterization for biological conversion 5.5. Design of biomass conversion system 6. AB application of renewable energy systems

Laboratory Equipment	See Annex IV

3. AB Machinery and Mechanization

Course Contents

Course Name	**AB Machinery and Mechanization**
Course Description	Principles of agricultural and bio-production mechanization; specifications, construction, operation, testing, selection and economics of agricultural and bio-production machinery; farm machinery management
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	AB Power Engineering Principles of Soil Science Principles of Crop Science Principles of Animal Science
Co-requisites	None
Program Outcomes Addressed by the Course	a, c, d, e, g, h, k
Course Outcomes	At the end of the course, the students should be able to: 1. Discuss the Philippine Agricultural Engineering Standards 2. Identify the construction of agricultural and bio-production machinery 3. Operate agricultural and bio-production machinery; 4. Evaluate the economics of use of agricultural and bio-production machinery
Course Outline	1. Philippine Agricultural Engineering Standards (PAES) 1.1. Introduction and History 1.2. Standard specifications and methods of test of Bio production machinery (PAES 109:2000 and PAES 111:2000) 1.3. Performance rating of bio production machinery (Catalogue of AMTEC-tested machine- prime movers and hand tractors) 1.4. Guidelines on after-sales service of crop production machinery (PAES 138: 2004) 2. Prime movers in the agricultural and bio-production systems 2.1. Sources of Power in the farm 2.2. Human and Animal Power 2.3. Electric Motors 2.4. Internal Combustion Engines 2.5. Tractors and their Transmission Systems 3. Tillage Machinery

	3.1. Primary Tillage operation 3.2. Secondary Tillage Operation 3.3. General Purpose Tillage Operation 4. Crop Establishment Machinery 4.1. Row crop planter 4.2. Grain planter 4.3. Transplanter 5. Crop Protection Machinery 5.1. Mechanical weeders and cultivators 5.2. Chemical Applicators (Sprayers) 6. Water Pumping Machinery 6.1. Positive Displacement Pump 6.2. Variable Displacement pump 7. Harvesting and Threshing Machinery 7.1. Harvesting Machinery 7.2. Threshing Machinery 8. Economics of use of bio production machinery 8.1. Selection of bio-production machinery 8.2. Measures of project worth
Laboratory Equipment	See Annex IV

4. Machine Design for AB Production

Course Contents

Course Name	**Machine Design for AB Production**
Course Description	Fundamentals of machine design as applied to bio-production systems
Number of Units for Lecture and Laboratory	3 units (2 lec, 1lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	AB Machinery and Mechanization Strength of Materials Properties of AB Materials
Co-requisites	None
Program Outcomes Addressed by the Course	a, c, e, g, h, k, l
Course Outcomes	At the end of the course, the students should be able to: 1. Identify machine elements 2. analyze kinematic and dynamic characteristics of machine elements 3. Analyze and evaluate the strength of mechanical components 4. Design and evaluate machine components
Course Outline	1. Introduction to Design of Machine Elements 1.1. Definition of Terms

	1.2. Machine Design Process 1.3. Creativity and Idea Development 1.4. Design Considerations and Criteria 2. Kinematics of Machine Components 2.1. Kinematics Fundamentals 2.2. Kinematic Synthesis and Analysis 2.3. Joints and Mobility 2.4. Four-Bar and Common Linkages 2.5. Position Analysis 3. Velocity Analysis of Machine Components 3.1. Definition of Velocity 3.2. Graphical Velocity Analysis 3.3. Instant Centers of Velocity 3.4. Centroids 3.5. Velocity of Slips 4. Acceleration Analysis of Machine Components 4.1. Graphical Method of Acceleration Analysis 4.2. Acceleration of Points in Four-Bar Linkages 5. Material in Mechanical Design 5.1. Mechanical Properties of Materials 5.2. Classification of Metals and Alloys 5.3. Review of Basic Manufacturing Processes 5.4. Standard Sizes of Materials 5.5. Material Selection and Specifications 6. Load and Stress Analysis 6.1. Review of Fundamental Stresses 6.2. Design Factor and Factor of Safety Mohr Circle 6.3. Combined Stresses 6.4. Stress Concentration 7. Failure Resulting from Static Loading 7.1. Maximum Shear Stress Theory for Ductile Materials 7.2. Distortion Energy Theory 7.3. Coulomb Mohr Theory for Ductile Material 7.4. Maximum Normal Stress Theory for Brittle Materials 7.5. Modifications of the Mohr Theory for Brittle Materials 8. Fatigue Failure Resulting from Variable Loading 8.1. Approach to Fatigue Failure in Analysis and Design 8.2. Endurance Limit 8.3. Fatigue Strength 8.4. Endurance Limit Modifying Factors 8.5. Stress Concentration and Notch Sensitivity 8.6. Characterizing Fluctuating Stress 8.7. Fatigue Failure Criteria for Fluctuating Stress 8.8. Combined Loading Modes 9. Shaft Design and Analysis 9.1. Shaft Material and Layout 9.2. Design for Stress 9.3. ASME Code and PAES Procedure on Designing Shaft 9.4. Miscellaneous Shaft Components 10. Belt Drives 10.1. Design Considerations 10.2. Standards for Pulleys and Belts

	10.3. Tension Ratio 10.4. Belt Slip 10.5. Speed Ratio 11. Chain Drives 11.1. Design Considerations 11.2. Standards for Chains and Sprockets 12. Gears 12.1. Gear Types 12.2. Spur Gear Nomenclature 12.3. Gear Trains 12.4. Designing Gear Trains 13. Power Screw 13.1. Thread Standards 13.2. Mechanics of Power Screw 14. Threaded Fasteners 14.1. Thread Standards 14.2. Screw and Bolt Grades 14.3. Axially Loaded Fasteners 14.4. Bolts in Shear
Laboratory Equipment	See Annex IV

III.5.2. AB Structure and Environment Engineering

1. AB Structures Engineering

Course Contents

Course Name	**AB Structures Engineering**
Course Description	Engineering principles of AB structures design; design criteria for construction structures; concepts of materials of engineering; material selection; cost estimates and specifications; application of the Philippine Building Code and other related laws, regulations and standards; preparation of 7-sheet building plan for permit application
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	Strength of Materials
Co-requisites	None
Program Outcome/s Addressed by the Course	a, c, d, e, g, h, k

Course Outcomes	At the end of the semester the students must be able to: 1. Apply engineering principles to the design of AB structures; 2. Design AB structures like farm house, animal housing, greenhouse, farm-to-market roads and bridges and other AB structures; 3. Prepare material estimates, specifications and cost analysis; 4. Apply the Philippine Building Code and other related laws, regulations and standards 5. Prepare Building Plan for Permit Application
Course Outline	1. Introduction 1.1. Objectives/Scope 1.2. Review of related concepts 1.3. The Philippine Building Code and other related laws, regulations and standards 2. Engineering principles of AB structures design 2.1. Estimating structural loads 2.2. Beam 2.3. Column 2.4. Floor system 2.5. Roof system 2.6. Combined loadings 2.7. Soil test and excavation 2.8. Footings 3. Design criteria for AB structures 3.1. Farm house 3.2. Animal housing 3.3. Greenhouse 3.4. Farm-to-market roads and bridges 3.5. Other AB structures 4. Concepts of materials of engineering 4.1. Defects 4.2. Strengthening of metals 4.3. Analytical techniques in materials engineering 4.4. Materials under service conditions 4.5. Material selection 5. Materials of construction 5.1. Wood 5.2. Concrete 5.3. Concrete hollow blocks 5.4. Steel 5.5. GI sheets 5.6. Glued-laminated structures 5.7. Other construction materials 6. Cost estimates and specifications 6.1. Material estimates and specifications 6.2. Cost analysis 7. Design of AB Buildings and Preparation of Engineering Drawings
Laboratory Equipment	See Annex IV

2. Plant and Livestock Systems and Environmental Control Engineering

Course Contents

Course Name	**Plant and Livestock Systems and Environmental Control Engineering**
Course Description	Environmental parameters and their interrelationships in a plant and livestock production system; microclimate modification for plants and livestock; principles of environmental control engineering; analysis and design of environmentally controlled AB structures
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	AB Structures Engineering, Prin. of Soil Science, Prin. of Crop Science, and Prin. of Animal Science
Co-requisites	None
Program Outcomes Addressed by the Course	a, c, d, e, g, h, k
Course Outcomes	At the end of the course, students must be able to: 1. Explain the significant environmental parameters and techniques for microclimate modification for plants and livestock production systems; 2. Describe the principles of environmental control; 3. Design environmental control systems for AB structures
Course Outline:	1. Introduction 2. Plant and livestock microclimate 2.1. Physical factors which make up the environment 2.2. Important parameters in agricultural and bio-production systems 2.3. Plant and livestock weather relationships 3. Physiological responses to the environment 3.1. Plant physiological response 3.2. Livestock physiological responses 4. Microclimate modification 4.1. Techniques of microclimate modification for plants 4.2. Techniques of microclimate modification for livestock 5. Principles of environmental control 5.1. Psychrometry and air conditioning 5.2. Use of insulation and vapor barriers 5.3. Energy considerations 5.4. Ventilation systems 5.5. Manipulation of light and radiation 5.6. Dust collectors and odor manual 6. Analysis and design of controlled environment systems 6.1. Plant production system 6.2. Livestock production systems 6.3. Other biological organisms
Laboratory Equipment	See Annex IV

3. AB Electrification and Control Systems

Course Contents

Course Name	AB Electrification and Control Systems
Course Description	Review of basic electrical engineering concepts and design of residential and farmstead wiring systems
Number of Units for Lecture and Laboratory	3 units (2 lec, 3 lab)
Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	Physics for Engineers, Differential Equations
Co-requisites	None
Program Outcomes Addressed by the Course	a, c, e, g, k
Course Outcomes	At the end of the course, the students are expected to: 1. Explain the concepts in DC and AC 2. Demonstrate proper electrical measurement and wiring installations 3. Design residential electrical systems 4. Design farmstead distribution systems
Course Outline	1. Review of Basic Electrical Engineering Concepts 1.1. Direct Current 1.2. Alternating Current 1.3. Inductance and Capacitance 1.4. RLC Circuits 1.5. Apparent Power, Reactive Power and Real Power 1.6. Power Factor and Power Factor Correction 2. Generation of Electrical Power 2.1. Conventional Energy – Generating set 2.2. Renewable Energy – using Hydro, Solar, Wind, 2.3. Biofuel, Biogas, New Renewable Fuels 3. Power Transmission and Distribution 3.1. Power Grid Extension 3.2. Transformer 3.3. Service System (Single-Phase and Three-Phase) 3.4. Electrical Grounding 4. Wiring for Agricultural and Biosystems Structures 4.1. Type of wire and insulation needed to meet the 4.2. requirements of its surroundings 4.3. Size of wire and insulation type necessary to safely carry 4.4. the current 4.5. Size of wire necessary to prevent excessive voltage drops 4.6. in the lines 5. Lighting System for Farm and Agricultural and Biosystems Structures 5.1. Light Sources

	5.2. Lighting Requirements 5.3. Methods of Computing Illumination 5.4. Lighting System Design Computation 6. Electrical Controls for Agricultural and Biosystems Structures 6.1. Manually Operated Controls 6.2. Automatically Operated Controls 6.3. Commonly Used Sensing Elements 7. Electric Motor for Farm Application 7.1. Types and Characteristics 7.2. Selection of Motors 7.3. Sizing of Conductor of Motors 8. Residential Electrical Distribution System in the Farm 8.1. Kinds of Outlets 8.2. Branch Circuit 8.3. Sizing the Service Entrance 9. Farmstead Electrical Distribution System 9.1. Wiring of Agricultural Buildings 9.2. Demand Load for Farm Buildings 9.3. Central Metering and Distribution 9.4. Capacity of Main Service for Farmstead 9.5. Selecting Service Conductors 10. Standby Generator for Farm Applications 10.1. Standby Generator Types 10.2. Sizing a Standby Generator Manually Operated Generator 10.3. Automatically Operated Generator
Laboratory Equipment	See Annex IV

4. Agricultural and Biosystems Waste Management Engineering

Course Contents

Course Name	**Agricultural and Biosystems Waste Management Engineering**
Course Description	Characterization of agricultural and bio-product wastes; processes and systems; analysis and design of agricultural waste utilization, treatment and management systems, economics, entrepreneurial, environmental, institutional and legal aspects of waste utilization.
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	Plant and Livestock Systems and Environmental Control Engineering
Co-requisites	None
Program Outcomes Addressed by the Course	a, c, d, e, g, h, j, k

Course Outcomes	At the end of the semester the students must be able to: 1. explain the principles of waste management engineering; 2. characterize AB wastes, processes, and systems; 3. design AB wastes treatment and management systems; 4. analyze the economics, entrepreneurial possibilities, and the environment, institutional and legal aspects of waste utilization
Course Outline	1. Introduction 1.1. Overview of AB waste management engineering 1.2. State of the art technologies on AB waste management 1.3. Existing laws and regulations, policy and water quality standards with emphasis on Philippine Clean Water Act, and Philippine Clean Air Act 2. Characterization of AB wastes 2.1. Agricultural and Biosystems wastes and its characteristics 2.2. Role of soils in AB wastes management 2.3. Role of plants in AB wastes management 2.4. Geologic and groundwater considerations in AB wastes management 3. Design of AB wastes treatment and management systems 3.1. Siting AB wastes management system 3.2. Types and functions of AB wastes management systems 3.3. Design of AB waste treatment and management systems e.g., biogas systems, treatment lagoons, composting and other similar technologies 4. Economics, entrepreneurial possibilities, and the environmental, institutional and legal aspects of waste utilization 4.1. AB wastes processing and utilization – waste recycling and energy conversion 4.2. Waste management equipment, operation and safety 4.3. Economic analysis of AB waste processing and utilization 5. Environmental, institutional, and legal aspects of AB waste utilization
Laboratory Equipment	See Annex IV

III.5.3. AB Land and Water Resources Engineering

1. Hydrometeorology

Course Contents

Course Name	**Hydrometeorology**
Course Description	The hydrologic cycle; climatic elements; streamflow hydrographs; evaporation and evapotranspiration; groundwater; hydrograph and runoff analysis; statistical treatment of hydrologic data; study and use of hydrometeorological instruments.
Number of Units for Lecture and Laboratory	3 units (2 lec; 1 lab)

Number of Contact Hours per Week	5 hours (2 lec; 3 lab)
Prerequisites	Fluid Mechanics, Calculus II
Co-requisites	None
Program Outcomes Addressed by the Course	a, g, h, i
Course Outcomes	At the end of the course, the students should be able to: 1. Explain the various hydrologic processes and their relationships; 2. Operate weather instruments in collecting hydrologic data; 3. Analyze hydrologic data using statistical software; 4. Produce hydrologic map using available software.
Course Outline	1. Introduction 1.1. Hydrologic Cycle 1.2. Importance of Hydrology in Engineering 2. Weather and Hydrology 2.1. Solar and earth 2.2. Heat balance at earth's surface 2.3. General atmospheric circulation 2.4. Temperature, humidity and wind 2.5. Patterns affecting Philippine weather and climate 3. Precipitation: Spatial Distribution 3.1. Types, form and variation 3.2. Measurement of precipitation 3.3. Analysis and Interpretation 4. Elements of hydrology 4.1. Rainfall Data Analysis 4.2. Stream flow and Stream Flow Hydrographs 4.3. Evaporation and Evapotranspiration 4.4. Groundwater 5. Hydro meteorological Instrument 5.1. Statistical Treatment of Hydrologic Data 5.2. Concepts of Probability 5.3. Probability Distributions of Hydrometer Logical Data 5.4. Frequency Analysis
Laboratory Equipment	See Annex IV

2. Irrigation and Drainage Engineering

Course Contents

Course Name	**IRRIGATION AND DRAINAGE ENGINEERING**
Course Description	Soil-plant-water relationships; flow measurement; use and selection of pumps; survey of irrigation and drainage systems; system planning and design
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	Surveying, Hydrometeorology, Differential Equation, Principles of Soil Science, Principles of Crop Science
Co-requisites	None

Program Outcomes Addressed by the Course	a, c, d, e, g, h, k
Course Outcomes	At the end of the course, the students should be able to: 1. discuss the importance and purposes of irrigation and drainage engineering for sustainable agriculture; 2. interpret the field data for designing irrigation and drainage systems; 3. design of irrigation and drainage systems; 4. evaluate irrigation and drainage systems
Course Outline	1. Introduction to Irrigation and Drainage Systems 1.1. Basic soil-plant-water relations 1.2. Mechanical and Physical Properties of Soil 1.3. Measurement of Soil Moisture Content 2. Flow of water into and thru the soil 2.1. Infiltration and hydraulic conductivity of soil 2.2. Crop water requirements for Irrigation 2.3. Methods of Estimating Evapotranspiration 2.4. Consumptive Use 3. Crop responses to flooding and water logging 4. Water flow measurement 5. Methods of irrigation application and systems application 5.1. Surface Irrigation Method 5.2. Subsurface Irrigation Method 5.3. Overhead Irrigation Systems 6. Estimation of farm drainage requirements 6.1. Surface Drainage Systems 6.2. Subsurface Drainage Systems 6.3. Pumps Wells 6.4. Planning, design, operation and maintenance of irrigation and drainage systems 7. Computer applications in irrigation and drainage
Laboratory Equipment	See Annex IV

3. Land and Water Conservation Engineering

Course Contents

Course Name	**Land and Water Conservation Engineering**
Course Description	Planning, design, construction and maintenance of water conservation systems; soil erosion control systems.
Number of Units for Lecture and Laboratory	3 units (2 lec; 1 lab)
Number of Contact Hours per Week	5 hours (2 lec; 3 lab)
Prerequisites	Irrigation and Drainage Engineering
Co-requisites	None
Program Outcomes Addressed by the Course	a, c, d, e, g, h, k
Course Outcomes	At the end of the course, the students should be able to: 1. Explain the principles of Land and Water Engineering; 2. Discuss the soil and water conservation practices; 3. Discuss the soil erosion process and the applications of various soil erosion control practices;

	4. Design structures for soil and water conservation; 5. Design vegetated waterways; and 6. Evaluate land water conservation systems.
Course Outline	1. Importance of soil and water conservation; 2. Sustainable Water Resources Development and Management 2.1. Sources of Water 2.2. Water resources assessment/characterization 2.3. Water Resources Development 3. Soil erosion and its control 3.1. Mechanics of Soil Erosion 3.2. Measurement of Soil Erosion 3.3. Soil erosion control 3.4. Sediment transport and sedimentation 3.5. Transported materials/sediments 3.6. Vertical distribution of sediment flow 3.7. Measurement/prediction of sediment transport and sediment yields 4. Flood-Damage Control 5. Principles for the planning, design and construction methods for water conservation structures; 5.1. Small Farm Reservoirs (SFRs) 5.2. Small Water Impounding Projects (SWIPs) 6. Rainfall harvesting Techniques 6.1. Storage system 6.2. Distribution system 6.3. Groundwater recharge 7. Computer applications in soil and water conservation
Laboratory Equipment	See Annex IV

4. Aquaculture Engineering

Course Contents

Course Name	**Aquaculture Engineering**
Course Description	Principles of planning aquaculture systems; layout of farm facilities.
Number of Units for Lecture and Laboratory	3 units (2 lec; 1 lab)
Number of Contact Hours per Week	5 hours (2 lec; 3 lab)
Prerequisites	Irrigation and Drainage Engineering
Co-requisites	None
Program Outcomes Addressed by the Course	a, c, d, e, h, k, l
Course Outcomes	At the end of the course, the students should be able to: 1. Explain the fundamentals of aquaculture operations and their requirements; 2. Describe the basic biological characteristics and; requirements of important aquaculture species common in the ASEAN countries; 3. Apply engineering principles in the planning, design, and operation of aquaculture systems;

	4. Design an aquaculture system.
Course Outline	1. Introduction to Aquaculture 1.1. Definitions 1.2. General Overview 2. Importance of aquaculture systems 3. Survey of aquaculture systems in the Philippines 4. Review of basic biological characteristics and requirements of important aquaculture species (tilapia, milkfish, prawn, catfish, mudfish and eel) 4.1. Selection criteria and characteristics of important aquaculture species 4.2. Production cycles of selected aquaculture species 4.3. Environmental and water quality requirements 4.4. Culture practices and other considerations 5. Aquaculture production systems, design and requirements 5.1. Aquaculture site selection criteria 5.2. Aquaculture processes 5.3. Pond System 5.4. Pen and Cage System 5.5. Tank and recirculating system 5.6. Flow-through systems 5.7. Recirculating aquaculture systems (RAS) 5.8. Integrated systems 5.9. Hatchery Design and Construction 6. Technical and economic feasibility considerations
Laboratory Equipment	See Annex IV

III.5.4. AB Process Engineering

1. Properties of AB Material

Course Contents

Course Name	**Properties of AB Materials**
Course Description	Physical characteristics, electrical, mechanical, thermal and optical properties of AB materials
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	Materials and Processes of AB, Thermodynamics and Heat Transfer
Co-requisites	None
Program Outcomes Addressed by the Course	a, e, k
Course Outcomes	At the end of the course, the students should be able to: 1. Define the different engineering properties of agricultural and biological materials;

	2. Explain the importance of engineering properties of agricultural and biological materials to agricultural processing; and 3. Identify different methods in determining or measuring these properties.
Course Outline	1. Introduction to Engineering Properties of AB Materials 1.1. Importance and Significance 1.2. Properties of AB Materials 2. Physical Characteristics 2.1. Size of AB Materials 2.2. Shape of AB Materials 2.3. Surface Area of AB Materials 2.4. Porosity of AB Materials 3. Electrical Properties 3.1. Dielectric Properties 4. Mechanical Properties 4.1. Introduction 4.2. Compressive and Tensile Resistance 4.3. Impact Resistance 4.4. Vibration 5. Thermal Properties 5.1. Thermal Conductivity 5.2. Specific Heat 5.3. Enthalpy and Latent Heat 5.4. Thermal Diffusivity 5.5. Mass Diffusivity 6. Optical properties 6.1. Color Theory and Models
Laboratory Equipment	See Annex IV

2. AB Products Processing and Storage

Course Contents

Course Name	**AB Products Processing and Storage**
Course Description	Principles and practices in the primary processing, handling, and storage of agricultural crops including refrigeration and cold storage systems
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	Properties of AB Materials, Prin. of Animal Science, and Prin. of Crop Science
Co-requisites	None
Program Outcomes Addressed by the Course	a, c, d, e, g, h, k

Course Outcomes	At the end of the course, the students should be able to: 1. Explain the principles underlying agricultural processing, handling and storage operations; 2. Apply knowledge to practical problems in processing, handling and storage of agricultural crops; 3. Operate agricultural process equipment including laboratory systems; and 4. Design the components of cold storage systems for agricultural crops.
Course Outline	1. Introduction to AB Processing 1.1. Definition, Activities 1.2. Importance 1.3. Trends in Agricultural Processing 2. Postharvest Operations and Losses 2.1. Basic Postharvest operations 2.2. Crop Spoilage and Postharvest Losses 3. Moisture and Moisture Content 3.1. Moisture in dried products 3.2. Methods of Determining MC 3.3. EMC, water activity, sorption isotherms, glass transition 4. Psychrometry 4.1. Composition of dry/moist air 4.2. Thermodynamic Properties of Moist Air 4.3. Thermodynamic Properties of Saturated Water 4.4. Psychrometric charts 4.5. Typical air-conditioning processes 4.6. Case Study: Drying capacity of moist air 5. Drying 5.1. Theories and Principles of Drying 5.2. Trends in Drying of AB Materials 6. Milling 6.1. Principles 6.2. Operations of Milling 6.3. Milling of some AB Materials 7. Storage and Handling 7.1. Basic Storage and Handling Principles 7.2. Requirements of Storage and Handling AB Materials 8. Refrigeration and Cold Storage 8.1. Vapor- compression refrigeration system 8.2. Main components of a typical refrigeration system 8.3. Refrigerants 8.4. Estimating the refrigeration load 8.5. Commodity Storage requirements and compatibility 8.6. Cold Chain Systems
Laboratory Equipment	See Annex IV

3. Food Process Engineering

Course Contents

Course Name	**Food Process Engineering**
Course Description	Unit operations in agricultural process engineering including dehydration, freezing, size reduction and enlargement, evaporation for fluid concentration, mechanical separation, and mixing.
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Number of Contact Hours per Week	5 hours (2 lec, 3 lab)
Prerequisites	AB Products Processing and Storage
Co-requisites	None
Program Outcomes Addressed by the Course	a, c, d, e, g, h, k
Course Outcomes	At the end of the course, the students should be able to: 1. Explain the principles unit operations underlying agricultural processing 2. Compute material and energy balances for various unit operations 3. Analyze thermo-physical properties of processed products 4. Develop the proper combination of unit operations for a specific product
Course Outline	1. Introduction to Unit Operations 1.1. Overview of Agricultural Process Engineering 1.2. Postharvest Losses for Grains and other AB Materials 1.3. Unit Operations 2. Mass and Energy Balances 2.1. Introduction to mass/ Energy balances 2.2. Analysis and Computation 3. Application of Fluid Flows in AB Materials 3.1. Fluid Statics and Dynamics 3.2. Viscosity and Flow 3.3. Losses 4. Application of Heat Transfer in AB Materials 4.1. Modes of Heat Transfer 4.2. Overall heat Transfer Coefficient 4.3. Applications 5. Drying of AB Materials 5.1. Introduction 5.2. Moisture of Dried products 5.3. Development of sorption isotherms 5.4. Trends in Drying AB Materials 6. Size Alteration of AB Materials 6.1. Size Reduction 6.2. Size Enlargement 7. Evaporation 7.1. Principles and Importance

	7.2. Applications 8. Mechanical-Physical Separation of AB Materials 8.1. Theory 8.2. Techniques or Methods of Separation 9. Mixing of AB Materials 9.1. Principles 9.2. Mixing of Solid AB Materials 9.3. Mixing of Liquid AB Materials
Laboratory Equipment	See Annex IV

4. Design and Management of AB Processing Systems

Course Contents

Course Name	**Design and Management of AB Processing Systems**
Course Description	Principles and practices in plant design; process and economic analysis; agricultural plant operation and management.
Number of Units for Lecture and Laboratory	3 units (2 lec, 1 lab)
Number of Contact Hours per Week	5 units (2 lec, 3 lab)
Prerequisites	AB Products Processing and Storage
Co-requisites	None
Program Outcomes Addressed by the Course	a, c, d, e, g, h, k
Course Outcomes	At the end of the course, the students will be able to: 1. Identify the principles and practices of the plant design 2. Determine the principles and characteristics of different material handling equipment for agricultural processing operations 3. Perform a process analysis of the plant 4. Design a processing plant for a particular agricultural product
Course Outline	1. Overview of Process analysis and plant design 1.1. Economic and Technical Aspects of Agricultural Processing Plant Design 2. Process and Material Flow 2.1. Activity symbols 2.2. Types of process charts 2.3. Chart design and construction 2.4. Layout Diagram and Layout Procedures 2.5. Mass and Energy Balances 3. Design and Selection of Plant Equipment 3.1. Materials Handling Equipment 3.2. Performance Analysis 3.3. Power requirements of Plant Equipment

	4. Agricultural Processing Plant Safety 4.1. Hazard Analysis and Critical Control Point (HACCP) 4.2. Good Manufacturing Practices (GMP) 4.3. Other Standards 5. Environmental Laws and Assessment 6. Organization Structure 6.1. Definition of Organizational Structure 6.2. Elements of Structure 6.3. Common Role 7. Plant Financial Analysis 7.1. Cash Flow 7.2. Feasibility 7.3. Financing Options
Laboratory Equipment	See Annex IV

ANNEX IV – BS ABE LABORATORY REQUIREMENTS

A. Natural/Physical Science Laboratory

1. Chemistry for Engineers
Laboratory Exercises and Equipment Requirement

Exercise	Equipment Required	Minimum Quantity
1. Calorimetry	Analytical balance	2 units
2. Heat of Combustion	Combustion and Emission analyser	1 unit
3. Metals and Some Aspects of Corrosion	Spectrophotometer	1 unit
4. Mechanical Properties of Materials	Adiabatic Oxygen Bomb Calorimeter	1 unit
5. Water: Its Properties and Purification	Dissolved oxygen analyzer	5 units
6. Determination of the Dissolved Oxygen Content of Water	Digital balance	2 units
7. Cigarette Smoking and Air Pollution	Digital thermometers	5 units
Other Possible Exercises	Erlenmeyer Flasks	15 units
1. Nuclear Reactions, Binding Energy and Rate of Decay	Volumetric Flasks	15 units
2. Crystal Lattices and Unit Cells	Burets	10 units
3. Community Immersion: Care for the Environment	Graduated Cylinders	15 units
	Water Condenser	2 units
	Bunsen Burner	10 units
	Iron Clamp	5 units
	Iron Ring	5 units
	Iron Stand	5 units

2. Physics for Engineers
Laboratory Exercises and Equipment Requirement

Exercise	Suggested Equipment	Minimum Quantity
1. An exercise to illustrate the principles, use, and precision of the vernier caliper and micrometer caliper	Ruler	5 units
	Vernier caliper	5 units
	Micrometer caliper	5 units
	Objects for measuring	5 sets
2. An exercise to verify the graphical and analytical methods of determining resultant forces.	Force table	5 units
	Weight holder	20 units
	Masses	5 sets
	Meter stick	5 units
	Protractor	5 units
	Alternate apparatus:	
	Force frame	5 units
	Spring balance	15 units
	Weight holder	15 units

	Masses Ruler	5 sets 5 units
3. An exercise to observe and verify the elements of motion along the straight line	Linear air track with blower and trolley Timer/stopwatch Meter stick Free fall apparatus Metal balls of different sizes Clamp Support rod **Alternate apparatus:** Spark timer/ticker timer Paper tape Stopwatch Plane board with stand Clamp Wooden cart Scissors Carbon paper Masking tape Meter stick	5 units 5 units 5 units 5 units 12 units 5 units 5 units 5 units 5 units 5 units 5 units 5 units 5 units 5 units 5 units 1 set 5 units
	Blackwood ballistic pendulum Metal ball Meter stick Carbon paper Inclined plane Protractor **Alternate apparatus:** Projectile apparatus Metal ball/plastic solid ball Photogate Timer/stopwatch Time of flight receptor pad Carbon paper White paper Meter-stick	5 units 5 units 5 units 5 units 5 units 5 units 5 units 5 units 5 units 5 units 5 units 5 units 5 units 5 units
4. An exercise to verify the laws of motion	Atwood's machine Masses Stopwatch String **Alternate apparatus:** Frictionless dynamic track Smart pulley Stopwatch Weight holder String Clamp	5 units 5 sets 5 units 5 units 5 units 5 units 5 units 5 units 5 units 5 units

5. An exercise to determine the coefficients of static and kinetic friction of various surfaces	Friction board with pulley Friction block with different surfaces Glass plate of size similar to friction board Platform/triple beam balance Weight holder Meter stick Slotted masses, 5-500g	5 units 5 units 5 units 5 units 5 units 5 units 5 sets
6. An exercise to verify the work-energy theorem	Dynamic cart Frictionless dynamic track Masses Weight holder Clamp String Timer/stopwatch Platform/triple beam balance Support rod	5 units 5 units 5 sets 5 units 5 units 5 units 5 units 5 units 5 units
7. An exercise to verify the principles of conservation of mechanical energy	Metal stand Clamp Metal ball String Meter stick Cutter blade Hanging mass Carbon paper White paper Masking tape	5 units 5 units 5 units 5 units 5 units 5 units 5 units 10 units 10 units 1 set
8. An exercise to verify the principles of conservation of momentum	Ramp/launcher Metal stand Clamp Metal balls of different sizes Meter stick Carbon paper White paper Masking tape	5 units 5 units 5 units 10 units 5 units 10 units 10 units 1 set
9. An exercise to verify the condition of the body in rotational equilibrium	Demonstration balance Vernier caliper Platform/triple beam balance Masses Meter stick	5 units 5 units 5 units 5 sets 5 units
10. An exercise to verify the forces involved in uniform circular motion	Centripetal force apparatus Meter stick Mass with hook Platform/triple beam balance Stopwatch	5 units 5 units 5 units 5 units 5 units
11. An exercise to verify the principle of simple harmonic motion	Clamp Masses Weight holder Meter stick	5 units 5 sets 5 units 5 units

	Support rod Spring **Alternate apparatus:** Hooke's Law apparatus	5 units 5 units 5 units
12. An exercise to measure specific gravity	**Liquids:** Hydrometer jar U-tube Inverted U-tube Beaker Masses Meter stick Vernier caliper Specimen of liquids **Solids:** Beam balance Hydrometer jar Beaker Thread Thermometer Specimen of solids **Alternate apparatus:** Mohr-Westpal Balance	 5 units 5 units 5 units 5 units 5 units 5 sets 5 units 5 units 5 units 5 units 5 units 5 units 5 units 5 sets 5 units
13. An exercise to determine the specific heats of solids by the methods of mixture	Calorimeter Stirrer for shot Specimen for shot Thermometer Platform/triple beam balance Beaker Ice Water	5 units 5 units 5 sets 5 units 5 units 5 units 5 sets
14 An exercise to observe and verify the elements of transverse wave motion	Sonometer Weight holder Set of masses Tuning forks of three different frequencies Rubber hammer Meter stick	5 units 5 units 5 units 5 sets 5 units 5 units
15. An exercise to observe and verify the elements of electric charge	Van de Graff generator Tissue paper Aluminum foil Metal conductor with insulated handle Fluorescent lamp Masking Tape Power Source Galvanometer Conducting paper Field mapper kit/mapping Apparatus	2 sets 2 sets 2 sets 2 sets 2 sets 1 set 5 units 5 units 5 units 5 units 5 sets

	Connectors	
16. An exercise to illustrate Ohm's Law	Panel board/circuit board VOM or multi-tester DC power supply Bridging plugs/connecting wires Fixed resistor SPST switch SPDT switch Alternate apparatus: Bread board Jumper	5 units 5 units 5 units 5 sets 15 units 5 units 5 units 5 units 5 sets
17. An exercise to observe the principle of magnetic field	Natural magnets Horseshoe magnets Bar magnets Ring Glass plate Iron fillings Frame for bar magnets Compass Mounted straight wire Coil Solenoid Battery Reversing switch Alternate apparatus: Tesla meter / tangent galvanometer	5 units 5 units 10 units 5 units 5 units 5 sets 5 units 5 units 5 units 5 units 5 units 5 units 5 units 2 sets
18. An exercise to investigate and study the image formation in mirror and lenses	Optic bench Light source Ray table and base Component holder Parallel ray lens Slit plate Ray optics mirror 5 cm focal length spherical mirror -15cm focal length concave lens 10cm/7.5 cm focal length convex lens 15 cm focal length convex lens Viewing screen Crossed arrow target	5 units 5 units 5 units 15 units 5 units 5 units 5 units 5 units 5 units 5 units 5 units 5 units 5 units

B. Basic ABE Courses

1. Introduction to Agricultural and Biosystems Engineering
Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Minimum Quantity
1. Film showing, orientation on the BSABE program, MVGO, infrastructure	Laptop LCD	1 unit 1 unit
2. Campus tour, visit academic buildings, administration, laboratory rooms, research facilities, etc.	Camera	1 unit
3. Filed trip to industry	Camera	1 unit
4. Film showing of success stories, , best practices and approaches, innovations and challenges	Laptop LCD	1 unit 1 unit
5. Group discussion on the technical communication and teamwork in the ABE profession	Laptop LCD	1 unit 1 unit

2. Surveying
Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Minimum Quantity
1. Laboratory Orientation	Computer Projector	1 unit 1 unit
2. Measurement of distance by pacing.	Measuring Instrument	5 units
3. Taping over Even and Uneven Ground Surfaces	Measuring Instrument	5 units
4. Differential Leveling	Surveying Instrument	5 sets
5. Determining direction of a Given Line using Engineer's Transit	Surveying Instrument	5 sets
6. Measurement of Horizontal and Vertical Angles by Repetition	Surveying Instrument	5 sets
7. Determining Stadia Interval Factor	Surveying Instrument	5 sets
8. Azimuth Stadia Traverse, Adjustment of a Traverse, Area Determination of a Closed Traverse	Surveying Instrument	5 sets
9. Topographic Survey	Surveying Instrument	5 sets
10. Topographic Mapping and Map Interpretation	Surveying Instrument	5 sets
11. Volumes of Earthwork	Surveying Instrument	5 sets

3. Materials and Processes for ABE
Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Required Quantity
1. Lab Safety and the use Personal Protective Equipment	Laptop LCD	1 unit 1 unit
2. Practical Mensuration	Steel Tape/ Measuring Tape	3 units
3. Wood Works	Cutting machine Drilling machine Lathe machine Planer Grooving equipment	1 unit 1 unit 1 unit 1 unit 1 unit
4. Metal Works	Cutting machine Bending Shearing Drilling machine Lathe machine Grooving Metal Grinder Arc Welding Machine Acetylene Welding machine Forging Equipment	1 unit 1 unit 1 unit 1 unit 1 unit 1 unit 1 unit 1 unit 1 unit
5. Mechanical Testing of structural materials	Universal Testing Machine (UTM)* *UTM at DPWH may be used	1 unit
6. Casting	Casting system	1 unit
7. Design Project		

4. Computer Application in AB Engineering
Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Quantity
1. Development of Flow Charts for Engineering Solutions	Computer Units Data Acquisition Unit and its Accessories	15 units 2 units
2. Spreadsheet Functions		
3. Macro Development for Spreadsheets		
4. Numerical Integration Using Spreadsheets		
5. Finite Difference Method for Simple Heat Transfer		
6. Basic Operations and Functions in Graphical Programming		

7. Drying of Agricultural Products: Monitoring, Data Acquisition and Processing using Graphical Programming		
8. Greenhouse Control Systems Simulation using Graphical Programming		
9. Basic Operations and Functions in Text-Based Programming		
11. Greenhouse Control Systems Simulation using Text-Based Programming		

C. Professional Courses

AB Machinery and Power Engineering

1. AB Power Engineering
Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Minimum Quantity
1. Gasoline Engine Parts: disassembly and assembly	Single cylinder gasoline engine set of mechanic tools	5 units 5 sets
2. Engine operation	Single cylinder gasoline and diesel engine, tachometer	5 units 5 unit
3. Diesel Engine Parts: disassembly and assembly	Single cylinder diesel engine set of mechanic tools	5 units 5 sets
4. Auxiliary Engine System: Fuel, Ignition, Cooling, and Lubrication System	Non-functional gasoline and diesel engine set of mechanic tools	5 units 5 sets
5. Farm tractor drive train	Two-wheel tractor, Four-wheel tractor	1 unit
6. Two- and four-wheel tractor operation	Two-wheel tractor, Four-wheel tractor	1 unit
7. Induction Motor: Parts, operation and maintenance	Electric motors, set of mechanic tools	5 sets
8. Estimation of available renewable energy resources		

2. **Renewable energy for AB Applications**
Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Minimum Quantity
1. Estimation of Solar Energy Resource	Solar meter	2 units
. Determination of Solar Constant		
3. Calculations of Theoretical Wind Power	Digital Anemometer	2 units
4. Power Coefficient	Scientific Calculators/ Personal Computers	5 units
5. Weibull Distribution		
6. The Power Curve of a Windmill Machine		
7. Hydro Power Calculations		
8. Biomass Resource Calculations		
9. Heating Value Calculation	Bomb Calorimeter	1 unit
10. Design of simple bioethanol production system – Fermentation	20L capacity container Graduated cylinder Digital weighing scale (1kg)	5 units 5 units 1 unit
11. Project Making		

3. **AB Machinery and Mechanization**
Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Minimum Quantity
1. Internal Combustion Engines	Single cylinder gasoline engine, Single cylinder diesel engine mechanic's tool, graduated cylinder, tachometer, sound level meter	5 units 5 sets 5 unit
2. Tractors and their Transmission Systems- Tractor Specifications	cut-away transmission system 2-wheel tractor 4-wheel tractor	1 unit
3. Tractors and their Transmission Systems-Tractor Operation	2-wheel tractor, 4-wheel tractor, tachometer, sound level meter	1 unit 5 units
4. Tillage Machinery-Specification	Plow, harrow, rotavator	1 unit
5. Tillage Machinery-Operation	2-wheel tractor 4-wheel tractor Plow, harrow, rotavator Oven, digital weighing scale (1kg), drying cans	1 unit 5 sets

6. Planting Equipment	corn planter, rice seeder/ transplanter, digital weighing scale (1kg)	1 unit
7. Crop Protection Equipment	Knapsack sprayer Mechanical weeder	5 units
8. Water pumping equipment	Centrifugal pump Pitcher pump Pump test rig	1 set

4. Machine Design for AB Production
Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Minimum Quantity
1. Formulation of Project Proposal	Drawing Tables Personal Computers Woodworking and Metal Workshop	15 units 15 units 1 area
2. Position and Displacement Analysis of Common Mechanisms		
3. Graphical Solution of Velocity and Acceleration Analysis		
4. Combined Stress and Mohr Circle Application		
5. Failure Resulting from Static Loading: *Ductile Material*		
6. Failure Resulting from Static Loading: *Brittle Materials*		
7. Endurance Limit		
8. Fatigue Failure		
9. Design of Shaft and its Components		
10. Belt and Chain Drives		
11. Gear Train		
12. Power Screw		
13. Project Making		

C.2 AB Structure and Environment Engineering

1. AB Structures Engineering
Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Required Quantity
1. Estimation of structural load		
2. Design of farm house		
3. Design of animal housing		

4. Design of greenhouse	Personal computer Digital camera LCD projector	15 units 1 unit 1 unit
5. Design of farm to market roads and bridges		
6. Design of one AB Building		
7. Material estimates and cost analysis		
8. Project study and presentation (Group or individual work)		

2. Plant and Livestock Systems and Environmental Control Engineering Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Minimum Quantity
1. Analysis of plant and livestock weather relationships	Personal computer Digital camera LCD projector	15 units 1 unit 1 unit
2. Microclimate modification for plants and livestock		
3. Psychrometry and Heat and vapor transmission		
4. Energy and mass balance in agricultural and bio-productions structures		
5. Aeration systems for plant and livestock		
6. Design of controlled environment systems - swine; dairy; poultry; greenhouse		
7. Project study and presentation (Group or individual work)		

3. AB Electrification and Control Systems Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Minimum Quantity
1. DC Circuit Analysis	Personal Computers/ Calculators	15 unis
2. Electrical Measurement		
3. RLC Circuit Analysis		
4. Power Factor Correction		
5. Lighting Load Calculation		
6. Wire size Calculation		
6. Lighting System Design Calculation		

7. Measurement of Electrical Inputs and Mechanical Outputs of Motor	Electric motor Multi-tester Clamp-on ammeter kWh-meter Tachometer	3 units 3 units 3 units 3 units 3 units
9. Farm Residential Wiring Plan	Personal Computers	15 units
10. Farmstead Wiring Plan		
11. Sizing of Standby Power Generator		

4. Agricultural and Biosystems Waste Management Engineering Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Minimum Quantity
1. Water quality standard for agricultural production	Personal computer Camera LCD	15 units 1 unit 1 unit
2. Agricultural and Biosystems wastes and its impact	None	None
3. Wastes characterization	None	None
4. Analysis of physical and chemical properties of AB wastes	pH meter, dissolved oxygen meter, colorimeter, UV VIS spectrophotometer (optional)	1 each
5. Design of biogas system, physical treatment facility (lagoon, compost pit, and other systems appropriate in the locality)	Personal computer Camera LCD	15 units 1 unit 1 units
6. AB waste processing and utilization	None	None
7. Project study and presentation (Group or individual work)	None	None

C.3 AB Land and Water Resources Engineering

1. Hydrometeorology Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Minimum Quantity
1. Catchment Delineation and Determination of Watershed Characteristics	Personal Computer Planimeter	15 units 5 units
2. Collection and Spatial Analysis of Precipitation Data	Automatic Weather Station or the corresponding basic weather instruments	1 set

3. The Hydrologic Cycle and Hydrologic Budget Equation	Personal Computer	15 units
4. Field Visit: Weather Station	None	None
5. Rainfall Analyses: Double Mass Analysis and Areal Precipitation Determination	Personal Computer	15 units
6. Discharge Measurement	Flow meter Current meter Weirs Parshall flumes	1 set
7. Unit Hydrograph Evaluation	Personal Computer	15 units
8. Evapotranspiration	Evaporation pan Rain gage Measuring instrument	1 unit 1 unit 5 unit
9. Hydrometeorological Instrument	Automatic Weather Station or the corresponding basic weather instruments	1 set
10. Frequency Analysis of Hydrological data	Personal Computer	15 units

2. Irrigation and Drainage Engineering
Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Minimum Quantity
1. Moisture Content and Porosity Determination of the Soil	Soil Moisture Meter Soil Oven Weighing Scale Beakers	3 units 1 unit 5 units 5 units
2. Design of Pumping Irrigation System	Personal Computers	15 units
3. Design of Surface/Canal Irrigation	Personal Computers	15 units
4. Design of Drip and Sprinkler Irrigation	Personal Computers	15 units
5. Design of Subsurface Drainage System	Personal Computers	15 units
6. Crop Water Requirement (actual experiment)	Personal Computers	15 units
7. Irrigation Scheduling	Personal Computers	15 units
8. Water Balance Calculations	Personal Computers	15 units
9. Cropping Pattern	Personal Computers	15 units
10. Water flow 11. Pumps 12. Open Channel	Centrifugal pump set Weirs Parshall flumes Current meter	1 set 1 unit 1 unit 5 units

3. Land and Water Conservation Engineering
Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Minimum Quantity
1. Watershed Physiography	None	None
2. Development of Hypsometric Curve and Soil Map	None	None
3. Rainfall Erosivity Computations	Recording rain gage Sediment load samplers	5 units
4. Peak Runoff Estimations	Personal Computers	15 units
5. Estimation of Sheet Erosion	None	None
6. Design of Vegetated Waterways	Personal Computers	15 units
7. Design of Terraces	None	None
8. Design of Conservation Structures	None	None
9. Estimation of Small Reservoir Sedimentation	Recording rain gage	5 units

4. Aquaculture Engineering
Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Minimum Quantity
Water Quality Determination	DO meter pH meter BOD/COD meters Turbidimeter	1 unit 1 unit 1 unit 1 unit
Design of a Pond System	Computer	10 units
Design of a Pen and Cage System	Computer	10 units
Design a Tank and Recirculating System	Computer	10 units
Recirculating Aquaculture System Evaluation	Pump set	1 set
Recirculating Aquaponics System	Pump set	1 set
Pumps, Aerators and Aeration Systems for Aquaculture	Pond aerators Pump set Surveying Instruments	1 set
Field Visit		
Operation and Management of Local Fish Farms		
Materials and Equipment for Aquaculture Production and Harvesting		
Transport and Transport Facilities for Aquaculture		

C.4. AB Process Engineering

1. Properties of AB Material

Exercise	Required Equipment	Required Quantity*
1. Lab Safety and the use Personal Protective Equipment	None	
2. Physical Characteristics of Fruits and Vegetables	Moisture meter/oven Weighing Scale Vernier caliper	1 unit 1 unit 1 unit
3. Physical Characteristics of Grains	Moisture meter/ oven Weighing Scale Bulk Density apparatus Vernier caliper	1 unit 2 units 1 unit 1 unit
4. Quality Evaluation of AB materials	Near Infrared Spectroscopy Weighing scale	1 unit 2 unit
5. Electrical Properties of AB materials	Infrared thermometer Multimeter Moisture meter/ oven	1 unit 1 unit 1 unit
6. Mechanical Properties of AB materials	UTM	1 unit
7. Thermal Properties of AB materials	Thermocouple data logger Infrared thermometer Calorimeter Oven Weighing scale	1 unit 1 unit 1 unit 1 unit 2 units
8. Optical properties of AB materials	Colorimeter/ Near Infrared Spectroscopy	1 unit

2. AB Products Processing and Storage

Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Minimum Quantity
1. Lab Safety and the use Personal Protective Equipment	NA	
2. Grain Cleaning and Dockage Determination	Sieves Aspirator Indented trays Weighing Scale	2 units 1 unit 2 units 2 units
3. Psychrometry	Sling Psychrometer	2 units
4. Moisture Content Determination	Weighing Scale Moisture meter Oven	2 units 1 unit 1 unit

5. Sample Drying and Calculation	Weighing Scale Moisture meter/ Oven Laboratory Dryer Sling Psychrometer Air flow meter Manometer	2 units 1 unit 1 unit 1 unit 1 unit 1 unit
6. Sample Milling and Grading	Weighing Scale Milling Equipment Sieves Indented trays	2 units 1 unit 2 units 2 units
7. Vapor Compression Refrigeration Cycle (Mechanical and Electrical Components)	Basic Refrigeration System with pressure gauges Power meter Multimeter	1 unit 1 unit 1 unit
8. Refrigeration Load Calculation	NA	
9. Cold Storage Design	NA	

3. Food Process Engineering
Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Minimum Quantity
1. Lab Safety and the use Personal Protective Equipment	NA	
2. Mass and Energy Balances	NA	
3. Fluid Flows in AB Materials	Flow meter Manometer Tachometer Thermocouple data logger Thermocouple wires Thermometer/ Infrared Viscometer Weighing Scale	1 unit 1 unit 1 unit 1 unit 10 units 10 units 10 units 1 unit
4. Heat Transfer in AB Materials	Thermocouple data logger Infrared thermometer/ Dial Thermometer Weighing Scale Oven	1 unit 1 unit 5 units 2 units 1 unit
5. Equilibrium Moisture Content Determination of AB Materials	Infrared thermometer/ Glass Thermometer Weighing Scale RH meter/ Sling Psychrometer Mechanical Oven Desiccator Incubator	1 unit 2 units 1 unit 1 unit 3 units 3 units

6. Drying Curves and Drying Time Determination	Thermocouple data logger/Glass Thermometer/ Infrared thermometer Weighing Scale Oven/ Moisture meter RH meter/ Sling Psychrometer Laboratory Dryer	1 unit 2 units 1 unit 1 unit 1 unit
7. Particle Size Distribution and analysis	Set of 7 Sieves Weighing Scale, hammer mill	2 unit 1 unit

4. Design and Management of AB Processing Systems
Laboratory Exercises and Equipment Requirement

Exercise	Required Equipment	Required Quantity*
1. Chart symbols and procedures	NA	
2. Development of an operation process chart	Personal Computers	15 units
3. Development of a flow process chart		
4. Issues in evaluating an operation process chart		
5. Revision of an operation process chart		
6. Revision of a flow process chart		
7. Construction of an activity relationship diagram		
8. Case study of AB plant		
9. Plant Design Project		

ANNEX V – SAMPLE OUTCOMES-BASED SYLLABUS
Bachelor of Science in Agricultural and Biosystems Engineering

Name of Institution: _____
Vision: _____
Mission:
a. _____
b. _____
c. _____
d. _____

Program Educational Objectives and Relationship to Institution Mission

Program Educational Objectives	Mission			
	a	b	c	d
PEO 1				
PEO 2				
PEO 3				
PEO 4				
PEO 5				

*Place a check mark in the boxes if the institution mission vs program educational objectives are attained

COURSE SYLLABUS

1. **Course Code:** ABE *51
2. **Course Title:** AB Power Engineering
3. Pre-requisite: Thermodynamics and Heat Transfer
4. **Co-requisite:** None
5. **Credit:** 3 units
6. **Semester Offered:** 1st Semester
7. **Number of hours:** 5 hour a week (2 lec, 3 lab)
8. **Course Description:** Conventional and renewable sources of power for agriculture; power measurement and alternative fuels
9. **Program Outcomes and Relationship to Program Educational Objectives:**
(Note: depends on the subject)

Program Outcomes		Program Educational Objectives				
		1	2	3	4	5
a	Apply knowledge of mathematics and science to solve Agricultural and Biosystems (AB) engineering problems	√		√	√	√
b	Design and conduct experiments, as well as to analyze and interpret data					
c	Design a system, component, or process to meet desired needs within realistic constraints, in accordance with standards	√	√		√	√
d	Function in multidisciplinary and multi-cultural teams;					
e	Identify, formulate, and solve complex problems;					
f	Understand professional and ethical responsibility;					
g	Communicate effectively complex AB engineering activities with the engineering community and with society at large;					
h	Understand the impact of AB engineering solutions in a global, economic, environmental, and societal context;	√		√		√

i	Recognize the need for, and engage in life-long learning;					
j	Know contemporary issues;					
k	Use techniques, skills, and modern engineering tools necessary for AB engineering practice; and	√	√	√		√
l	Know and understand engineering and management principles as a member and leader of a team, and to manage projects in a multidisciplinary environment.					
m	Preserve and promote Filipino historical and cultural heritage					

10. Course Outcomes (COs) and Relationship to Program Outcomes
(Note: limit the program outcomes of each subject to the most relevant ones only)

Program Outcomes addressed by the course	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
	D	D						D	D		D	
Program Outcomes addressed by the Course Outcomes: After completing this course, the student must be able to:	Program Code											
	a	b	c	d	e	f	g	h	i	j	k	l
1. Explain the conventional sources of power, their application and availability in agriculture								D	D		D	
2. Relate the renewable sources of energy, its application, availability and environmental impacts in agriculture	D	D						D			D	
3. Differentiate alternative fuels that can be derived from agricultural products and by-products.	D	D						D	D		D	
4. Apply specific PAES standards and other standards relative to methods of test of conventional and renewable energy sources as applied to agriculture	D	D						D			D	

***Level:** I – Introductory, E – Enabling, D – Demonstrative

11. Course Coverage

Week	Course Outcomes	Topics	Unit Learning Outcomes	Teaching and Learning Activities		Assessment Tasks
	At the end of the course, the student must be able to:		**At the end of the unit, the student must be able to**	**Teaching Activities**	**Learning Activities**	
1	CO 1: Explain the conventional sources of power, their application and availability in agriculture	Sources of energy and power in the farm - Human and Animal Power - Water, Wind and Electricity - Electric Motors	Discuss the different sources of power and energy in the farm including their applications and limitations Define electric motors Identify external and internal parts of the electric motor and give their functions	Lecture/Working through sample problems	Pre-reading, group discussion Perform Lab Ex 1 –Electric Motors Disassemble & assemble EM Group Discussion	Quiz 1 Recitation Laboratory Exercise 1 Report
2		-Internal Combustion Engines - Parts of internal combustion engines;	Define ICE Identify external and internal parts of ICE and give their functions	Lecture/Working through sample problems	Perform Lab Ex 2 – ICEs Disassemble and assemble ICE Group Discussion	Laboratory Exercise 2 (ICEs) Quiz 2 Lecture written Examination
	CO 2: Relate the renewable sources of energy, its application, availability and environmental impacts in agriculture	Renewable energy sources	Identify the different renewable energy sources Compute the available energy/power Relate the different renewable energy	Lecture/Working through sample problems	Environmental Scanning Research Paper Oral Presentation	Quiz Case study reports Lecture written Examination

			sources as to it application and environmental impacts			
Week No _.	CO 3: Differentiate alternative fuels that can be derived from agricultural products and by-products.	Biomass fuels Bioethanols	Identify the types of fuels that can be derived from agricultural products and by-products Discuss the applicability and limitations of the alternative fuels as sources of energy	Lecture	Assignments	Quiz Assignment Written Exam
Week no._	CO 4: Apply specific standards in the PAES relative to methods of test of conventional and renewable energy sources as applied to agriculture	Philippine Agricultural Engineering Standards	Explain the different parts of PAES Write Machine Specifications Discuss Machine Methods of Tests	Lecture/Working through sample standards (The faculty will relate the concepts and its relevance to the practice of AE profession)	Peer/Group Discussion Research Paper	Quiz Recitation Research Paper Written Exam

12. Life-long Learning Opportunities

(Note: learning activities for the student to continuously apply the subject even after graduation)

Students will be encouraged to learn on their own the provisions stated in other available Philippine Agricultural Engineering Standards related to agricultural and bio production systems and be updated on other PAES/PNS of agricultural and bio production machinery to be formulated in the future. They can further enhance their knowledge on new technologies on agricultural and bio-production machinery to be developed.

13. Contribution of Course to Meeting the Professional Component

General Education: 0 %
Basic Engineering: 0%
Professional Engineering: 100%

14. References

Liljedahl, J. B. W. M. Carleton, P. K. Turnquist, and D. M. Smith. 1979. Tractors and Their Power Units.

Jones, F. P. 1963. Farm Gas Engines and Tractors.

Report of an Ad Hoc Panel. 1976. Energy for Rural Development. National Academy of Sciences.

Internet-based references

PAES Volumes 1-VIII

15. Course Evaluation

In OBTL, grading criteria are based on the ILOs. Conversion to final grade depends on the performance achievement of the ILOs. The following is an example of course evaluation assuming a minimum average for satisfactory performance is 60%.

Assessment Tasks		Weight	Minimum Average for Satisfactory Performance
CO 1	AT1	AT1%	50.00 %
	AT2	AT2%	
	AT3	AT3 %	
	...ATi	ATi%	
CO 2	AT1	AT1%	50.00 %
	AT2	AT2%	
	AT3	AT3 %	
	...ATi	ATi%	
CO 3	AT1	AT1%	50.00 %
	AT2	AT2%	
	AT3	AT3 %	
	...ATi	ATi%	
CO 4	ATi	ATi%	50.00%
Summative Assessment: Final Exam		FE %	50.00 %
	TOTAL:	**100.00 %**	**50.00 %**

The final grades will correspond to the weighted average scores shown below:
(Note: grading system of the university)

Range	Grade	Range	Grade
100 – 96	1.00	71.9 – 68	2.50
95.9 – 92	1.25	67.9 – 64	2.75
91.9 – 87	1.50	63.9 – 60	3.00

86.9 – 82	1.75	59.9 – 55	TAKE REMOVALS
81.9 – 77	2.00	Below 55	5.00
76.9 – 72	2.25		

15.1. Other Course Policies

(Note: depends on the subject)

a. Laboratory exercises and computations should be hand written in LETTER SIZE bond paper. Use only black or blue ink pen. The deadline for the laboratory reports will be one week after performing the exercises except for the computations that will be done during laboratory hours.
b. Laboratory exercises will be performed by groups however, reports should be submitted individually. For laboratory reports, include the members present during the exercise, date performed, and date submitted. Late submission is equivalent to 5% (of the perfect score) deduction per day and another 1% per page for not following instructions. Laboratory reports are required to submit even if your score reaches zero (0) because of deductions.
c. Exams should be written in a clean LETTER SIZE bond paper and only one side of the paper should be used. Use the questionnaire for multiple choice problems. Solutions to each problem in the problem solving part should always start on a new page. A deduction of 1% (of the perfect score) per page for not following instructions will be imposed.
d. Excuse from the classes will only be honoured if a VALID EXCUSE SLIP coming from the College Secretary's Office is presented. No other form of excuses will be entertained. An excused absence is still considered as absence.
e. University rules on attendance and specially on cheating will be strictly implemented.
f. Absence in the laboratory class without valid excuse slip will automatically get a zero (0) on that particular exercise. Otherwise, if valid excuse slip is presented, the student must perform the missed exercise and submit the report a week after.
g. Examination will be scheduled at least two weeks before the exam. Early examination is allowed provided that the student will not leave the classroom until all the examinees arrived. Late examination, on the other hand, is not allowed. No ifs, no buts. In case the student fails to take an examination on the scheduled date, a valid excuse slip should be presented. In this case, the student is required to take the final examination and the student's score in the final examination will also be his/her score in the missed examination. In case the student fails to present a valid excuse slip, the student will automatically get a grade of zero (0) in the missed examination.
h. Quizzes can be either announced or unannounced. Answer sheet (quiz notebook) will be provided.
i. Deadline of submission of late reports will be on our scheduled Final Examination. Non-submission on the said date will get a grade of INC if the student's final standing is passing.
j. Unsatisfactory project will not be accepted. However, the student/group will be given a chance to improve their project. Non-submission of the project on the set deadline means an automatic final grade of 5.
k. Exemptions from taking final examination are as follows: (1) no exam below 60%, (2) late laboratory reports are submitted on the specified date, (3) at least

first draft of the project is submitted on the specified date, (4) absences do not exceed the maximum allowed, and (5) no missed exam. No ifs, no buts.

l. This class policy serves as our written agreement for the whole semester.

16. Other References

(can also include journals, website, etc.; must include references that was published within 10 years)

16.1. Books

Agricultural Machinery Testing and Evaluation Center. 2004. Catalogue of AMTEC-tested Agricultural Machines for Prime Movers and Hand Tractors. AMTEC, CEAT, UPLB.

Agricultural Machinery Testing and Evaluation Center. 2005. Philippine Agricultural Engineering Standards. 2nd Edition. CD version 2005. AMTEC, CEAT, UPLB.

International Commission of Agricultural Engineering. 1999. CIGR Handbook of Agricultural Engineering. Plant Production Engineering. Volume III. American Society of Agricultural

Jones, Fred R. and William H. Aldred. 1980. Farm Power and Tractors.5th Edition. McGraw-Hill Book Company.

Kepner, R.A, Roy Bainer and E.L. Barger. 1978. Principles of Farm Machinery. 3rd Edition. Avi Publishing Company, Inc. Westport Connecticut. USA

Resurreccion, A. N. 2006. AENG 62 Agricultural Machinery Lecture Notes. AMD, IAE, CEAT, UPLB.

Smith Harris Pearson and Lambert Henry Wilkes. 1976. **Farm machinery and equipment**. 6th ed. McGraw-Hill, New York .

Srivastava, Ajit K., Carroll E. Goering, Roger P. Rohrbach and Dennis R. Buckmaster. 2006. Engineering Principles of Agricultural Machines. 2nd Ed. American Society of Agricultural and Biological Engineers.

17. Course Materials Made Available

(Note: may also include laboratory and lecture manuals)

Course syllabus, Lecture Notes, and Slide Presentations

18. Revision history

Revision No.	Date of revision	Date of implementation	Highlights of revision
1	June 26, 2015	1st Sem. 2015-16	Followed OBTL Format as per CMO # s. 2015

19. Preparation, Review, and Approval

Prepared by:	Reviewed by:	Recommending Approval:
		<Department Chair>
		APPROVED:
		<Dean>
		Date: