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

CHED MEMORANDUM ORDER
No. 87
Series of 2017

SUBJECT: POLICIES, STANDARDS AND GUIDELINES FOR THE BACHELOR OF SCIENCE IN COMPUTER ENGINEERING (BSCpE) EFFECTIVE (AY) 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 Computer 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 provide 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 Computer Engineering must first secure proper authority from the Commission in accordance with this PSG. All PHEIs with an existing BS Computer Engineering 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.

ARTICLE III
GENERAL PROVISIONS

Per Section 13 of RA 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 here prescribed as the "minimum unit requirement" under 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. A sample course syllabus is 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 Computer Engineering (BSCpE).

5.2 Nature of the Field of Study

The Bachelor of Science in Computer Engineering (BSCpE) is a program that embodies the science and technology of design, development, implementation, maintenance and integration of software and hardware components in modern computing systems and computer-controlled equipment.

5.3 Characteristics of Computer Engineering Graduates

With the ubiquity of computers, computer-based systems and networks in the world today, computer engineers must be versatile in the knowledge drawn from standard topics in computer science and electrical engineering as well as the foundations in mathematics and sciences. Because of the rapid pace of change in the computing field, computer engineers must be life-long learners to maintain their knowledge and skills within their chosen discipline.

An important distinction should be made between computer engineers, electrical engineers, other computer professionals, and engineering technologists. While such distinctions are sometimes ambiguous, computer engineers generally should satisfy the following three characteristics.

1. Possess the ability to design computers, computer-based systems and networks that include both hardware and software and their integration to solve novel engineering problems, subject to trade-offs involving a set of competing goals and constraints. In this context, “design” refers to a level of ability beyond “assembling” or “configuring” systems.

2. Have a breadth of knowledge in mathematics and engineering sciences, associated with the broader scope of engineering and beyond that narrowly required for the field.

3. Acquire and maintain a preparation for professional practice in engineering.

5.4 Program Educational Objectives

Program Educational Objectives (PEOs) are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve within 3–5 years from graduation. PEOs are based on the needs of the program's constituencies and these shall be determined, articulated, and disseminated to the general public by the unit or department of the HEI offering the BSCpE program. The PEOs should also be assessed and evaluated periodically for continuing improvement.

5.5 Knowledge Areas

The knowledge areas include the following but not limited to:

a) Circuits and Electronics
b) Computing Algorithms
c) Computer Architecture and Organization
d) Digital Design
e) Embedded Systems
f) Computer Networks
g) Professional Practice
h) Information Security
i) Signal Processing
j) Systems and Project Engineering
k) Software Design
l) Occupational Health and Safety
m) Technopreneurship

5.6 Allied Programs

The allied programs of the BSCpE program are the following:

a) Electrical Engineering
b) Electronics Engineering
c) Software Engineering
d) Computer Science
e) Information Technology

These programs are those that may be considered as equivalent to the program for the purpose of determining faculty qualifications to handle allied and related courses to the program.

Section 6. Institutional and Program Outcomes

The minimum standards for the BS Computer Engineering program are expressed in the following minimum set of institutional and BSCpE 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." (RA 7722).
e) Graduates of higher educational institutions must preserve and promote the Filipino historical and cultural heritage.

6.2. BSCpE Program Outcomes

By the time of graduation, the students of the program shall have the ability to:

a) Ability to apply knowledge of mathematics and science to solve complex engineering problems;
b) Ability to design and conduct experiments, as well as to analyze and interpret data;
c) Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability, in accordance with standards;
d) Ability to function on multidisciplinary teams;
e) Ability to identify, formulate, and solve complex engineering problems;
f) Understanding of professional and ethical responsibility;
g) Ability to communicate effectively;
h) Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
i) Recognition of the need for, and an ability to engage in life-long learning
j) Knowledge of contemporary issues;
k) Ability to use techniques, skills, and modern engineering tools necessary for engineering practice; and
l) Knowledge and understanding of engineering and management principles as a member and leader in a team, to manage projects and in multidisciplinary environments.

A PHEI, SUC, or LUC, at its option, may adopt mission-related program outcomes that are not included in the minimum set

Annex I presents the Competency Standards, Attributes and competencies of a Computer Engineer which should result from the program outcomes stated above.

Section 7. Sample Performance Indicators

Performance Indicators (PIs) are specific, measurable statements identifying the performance(s) required to meet the outcome; confirmable through evidence.

Table 1. Sample Performance Indicators of a Program Outcome

Performance Outcomes		Performance Indicators	
f	Understanding of professional and ethical responsibility	1	Demonstrate knowledge of professional code of ethics
		2	Evaluate the ethical and societal implications of a design solution to a problem in CpE

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.

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. Evaluation results in decisions and actions regarding the continuous improvement of the program.

All HEIs are encouraged to form a Consultative Body to be part of the assessment and evaluation processes to be represented by the stakeholders.

8.1 Assessments and Evaluation of PEOs

The Assessment of Program Educational Objectives may include the following: the stakeholders of the program have to be contacted through surveys or focus group discussion to obtain feedback data on the extent of the achievement of the PEOs.

8.2. Assessment and Evaluation of POs

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 Methods (AM) may be applied. 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. Refer to Table 2.

Table 2. Sample Matrix Linking Performance Indicators with Key Courses, Assessment Methods, Set Targets and Standards

Performance Indicators		Key Courses	Assessment Tools	Targets and Standards
1	Demonstrate knowledge of professional code of ethics	OJT	Employer Assessment Form (EAF)	60% of students enrolled in the course shall get at least a rating of 70%
2	Evaluate the ethical and societal implications of a design solution to a problem in CpE	Design Project 2 (Project Implementation)	Rubric for Design Presentation (RDP)	60% of students enrolled in the course shall get at least a rating of 70%

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

Section 9. Continuous Quality Improvement

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, programs for remediation and their successful implementation shall serve as the evidence for Continuous Quality Improvement.

ARTICLE V
CURRICULUM

Section 10. Curriculum Description

The BSCpE curriculum is designed to meet the SOs/POs stated in Article IV Section 6. This is articulated in a curriculum map discussed in Section 12 to develop graduates of the program to have a strong background in mathematics, natural, physical and allied sciences. Also, it contains complementary courses such as general education courses to ensure that the graduates are articulate and understands the nature of their role and impact of their work in the society and environment.

The BSCpE curriculum is designed to guarantee breadth of knowledge of the discipline through a set of professional courses and to ensure depth and focus in certain disciplines through cognates/tracks. Also, it develops student's ability to use modern tools necessary to solve problems in the field of computer engineering.

The curriculum has a minimum total of 166 credit units, comprising of 115 units of technical courses. These technical courses include 12 units of mathematics, 8 units of natural/physical sciences, 6 units of basic engineering sciences, 8 units of allied courses, 72 units of professional courses, and 9 units of elective/cognate courses.

The general education courses in accordance with CMO 20 s. 2013 - The New General Education Curriculum consists of 24 units of general education courses, 12 units of GEC electives/mandated courses, 8 units of Physical Education (PE), and 6 units of National Service Training Program (NSTP).

Section 11. Sample Curriculum

11.1. Components:

Below is a sample curriculum of the BSCpE program. The institution may enrich the sample 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.

Classification/Field/Course	Minimum no. of hours / week		Minimum Credit Units
	Lecture	L/F/D	
I. TECHNICAL COURSES			
A. Mathematics			
Calculus 1	3	0	3
Calculus 2	3	0	3
Engineering Data Analysis	3	0	3
Differential Equations	3	0	3
Subtotal	**12**	**0**	**12**
B. Natural/Physical Sciences			
Chemistry for Engineers	3	3	4
Physics for Engineers	3	3	4
Subtotal	**6**	**6**	**8**
C. Basic Engineering Sciences			
Computer-Aided Drafting	0	3	1
Engineering Economics	3	0	3
Technopreneurship101	3	0	3
Subtotal	**6**	**3**	**7**

Classification/Field/Course	Minimum no. of hours / week		Minimum Credit Units
	Lecture	L/F/D	
D. Allied Courses			
Fundamentals of Electrical Circuits	3	3	4
Fundamentals of Electronic Circuits	3	3	4
Subtotal	**6**	**6**	**8**
E. Professional Courses			
Discrete Mathematics	3	0	3
Numerical Methods	3	0	3
Computer Engineering as a Discipline	1	0	1
Fundamentals of Mixed Signals and Sensors	3	0	3
Computer Engineering Drafting and Design	0	3	1
Programming Logic and Design	0	6	2
Data Structures and Algorithms	0	6	2
Object Oriented Programming	0	6	2
Software Design	3	3	4
Microprocessors	3	3	4
Logic Circuits and Design	3	3	4
Methods of Research	2	0	2
Operating Systems	3	0	3
Computer Architecture and Organization	3	3	4
Data and Digital Communications	3	0	3
Computer Networks and Security	3	3	4
Embedded Systems	3	3	4
Digital Signal Processing	3	3	4
Feedback and Control Systems	3	0	3
Introduction to HDL	0	3	1
Seminars and Fieldtrips	0	3	1
Basic Occupational Health and Safety	3	0	3
CpE Laws and Professional Practice	2	0	2
Emerging Technologies in CpE	3	0	3
CpE Practice and Design 1	0	3	1
CpE Practice and Design 2	0	6	2
On the Job Training	3	240	3
Subtotal	**53**	**297**	**72**
F. Cognates/Electives (Please refer to Suggested Electives)			
Cognate/Track Course 1			3
Cognate/Track Course 2			3
Cognate/Track Course 3			3
Subtotal			**9**
II. NON - TECHNICAL COURSES			
A. General Education Courses			
Science, Technology, and Society	3	0	3
The Contemporary World	3	0	3

Classification/Field/Course	Minimum no. of hours / week		Minimum Credit Units
	Lecture	L/F/D	
Readings in Philippine History	3	0	3
Understanding the Self	3	0	3
Art Appreciation	3	0	3
Purposive Communication	3	0	3
Mathematics for the Modern World	3	0	3
Ethics	3	0	3
Subtotal	**24**	**0**	**24**
B. GEC Electives/Mandated Courses			
GEC Elective 1	3	0	3
GEC Elective 2	3	0	3
GEC Elective 3	3	0	3
Life and Works of Rizal	3	0	3
Subtotal	**12**	**0**	**12**
C. Physical Education			
PE 1	2	0	2
PE 2	2	0	2
PE 3	2	0	2
PE 4	2	0	2
Subtotal	**8**	**0**	**8**
D. National Service Training Program			
NSTP 1	3	0	3
NSTP 2	3	0	3
Subtotal	**6**	**0**	**6**
GRAND TOTAL	**133**	**312**	**166**

SUMMARY OF THE BSCpE CURRICULUM

Classification/Field/Course	Total No. of Hours / Week		Minimum Credit Units
	Lecture	Lab	
I. TECHNICAL COURSES			
A. Mathematics	12	0	12
B. Natural/Physical Sciences	6	6	8
C. Basic Engineering Sciences	6	3	7
D. Allied Courses	6	6	8
E. Professional Courses	53	297	72
F. Cognates/Electives			9
Subtotal	**83**	**312**	**116**
II. NON-TECHNICAL COURSES			
A. General Education Courses	24	0	24
B. GEC Electives/Mandated Courses	12	0	12
C. Physical Education	8	0	8
D. NSTP	6	0	6
Subtotal	**50**	**0**	**50**
GRAND TOTAL (including PE and NSTP)	**133**	**312**	**166**

11.2. Program of Study

The institution may enrich the sample/model 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 fulfill their institutional outcomes, as long as the total units for the whole program shall not be less than **166 units**, including P.E., and NSTP.

SAMPLE SEMESTRAL PROGRAM OF STUDY

FIRST YEAR

1st year – 1st semester

Courses	No. of Hours		Units	Prerequisites
	Lec	Lab/Field/Drafting		
Calculus 1	3	0	3	
Chemistry for Engineers	3	3	4	
Computer Engineering as a Discipline	1	0	1	
Programming Logic and Design	0	6	2	
Mathematics for the Modern World	3	0	3	
Science, Technology, and Society	3	0	3	
Understanding the Self	3	0	3	
Physical Education 1	2	0	2	
NSTP 1	3	0	3	
TOTAL	**21**	**9**	**24**	

1st year – 2nd semester

Courses	No. of Hours		Units	Prerequisites
	Lec	Lab/Field/Drafting		
Calculus 2	3	0	3	Calculus 1
Physics for Engineers	3	3	4	Calculus 1
Object Oriented Programming	0	6	2	Programming Logic and Design
Engineering Data Analysis	3	0	3	Calculus 1
Discrete Mathematics	3	0	3	Calculus 1
Readings in Philippine History	3	0	3	
Physical Education 2	2	0	2	Physical Education 1
NSTP 2	3	0	3	NSTP 1
TOTAL	**20**	**9**	**23**	

SECOND YEAR

2nd year – 1st Semester

Courses	No. of Hours		Units	Prerequisites
	Lec	Lab/Field/Drafting		
Differential Equations	3	0	3	Calculus 2
Art Appreciation	3	0	3	
Data Structures and Algorithms	0	6	2	Object Oriented Programming
Engineering Economics	3	0	3	2nd Year Standing*
Fundamentals of Electrical Circuits	3	3	4	Physics for Engineers
GEC Elective 1	3	0	3	
Computer-Aided Drafting	0	3	1	2nd Year Standing*
Physical Education 3	2	0	2	Physical Education 2
TOTAL	**17**	**12**	**21**	

2nd year – 2nd semester

Courses	No. of Hours		Units	Prerequisites
	Lec	Lab/Field/Drafting		
Numerical Methods	3	0	3	Differential Equations
Software Design	3	3	4	Data Structures and Algorithms
Purposive Communication	3	0	3	
Fundamentals of Electronic Circuits	3	3	4	Fundamentals of Electrical Circuits
Life and Works of Rizal	3	0	3	
Physical Education 4	2	0	2	
The Contemporary World	3	0	3	
TOTAL	**20**	**6**	**22**	

THIRD YEAR

3rd year – 1st Semester

Courses	No. of Hours		Units	Prerequisites
	Lec	Lab/Field/Drafting		
Logic Circuits and Design	3	3	4	Fundamentals of Electronic Circuits
Operating Systems	3	0	3	Data Structures and Algorithms
Data and Digital Communications	3	0	3	Fundamentals of Electronic Circuits
Introduction to HDL	0	3	1	Programming Logic and Design; Fundamentals of Electronic Circuits
Feedback and Control Systems	3	0	3	Numerical Methods; Fundamentals of Electrical Circuits
Fundamentals of Mixed Signals and Sensors	3	0	3	Fundamentals of Electronic Circuits
Computer Engineering Drafting and Design	0	3	1	Fundamentals of Electronic Circuits
Cognate / Elective Course 1**			3	3rd Year Standing*
TOTAL	**15**	**9**	**21**	

3rd year – 2nd semester

Courses	No. of Hours		Units	Prerequisites
	Lec	Lab/Field/Drafting		
Basic Occupational Health and Safety	3	0	3	3rd Year Standing*
Computer Networks and Security	3	3	4	Data and Digital Communications
Microprocessors	3	3	4	Logic Circuits and Design
Methods of Research	2	0	2	Engineering Data Analysis; Purposive Communication; Logic Circuits and Design
Technopreneurship	3	0	3	3rd Year Standing*
Ethics	3	0	3	
CpE Laws and Professional Practice	2	0	2	3rd Year Standing*
Cognate/Elective Course 2**			3	Cognate/Track Course 1
TOTAL	19	6	24	

FOURTH YEAR

4th year – 1st semester

Courses	No. of Hours		Units	Prerequisites
	Lec	Lab/Field/Drafting		
Embedded Systems	3	3	4	Microprocessors
Computer Architecture and Organization	3	3	4	Microprocessors
Emerging Technologies in CpE	3	0	3	4th Year Standing*
CpE Practice and Design 1	0	3	1	Microprocessors; Methods of Research
Digital Signal Processing	3	3	4	Feedback and Control Systems
GEC Elective 2	3	0	3	
Cognate/Elective Course 3**			3	Cognate/Track Course 2
TOTAL	15	12	22	

4th year – 2nd semester

Courses	No. of Hours		Units	Prerequisites
	Lec	Lab/Field/Drafting		
CpE Practice and Design 2	0	6	2	CpE Practice and Design 1
Seminars and Fieldtrips	0	3	1	4th Year Standing*
On the Job Training	3	240***	3	4th Year Standing*
GEC Elective 3	3	0	3	
TOTAL	**6**	**246**	**9**	

Suggested Cognates/Electives
(The program has an option to include additional cognates/electives.)

Embedded Systems	**No. of Hours**		**No. of Hours**
	Lab	**Lab/Field/Drafting**	
Embedded Systems 1			3
Embedded Systems 2			3
Embedded Systems 3			3
Microelectronics	**Lab**	**Lab/Field/Drafting**	
Microelectronics 1			3
Microelectronics 2			3
Microelectronics 3			3
Software Development	**Lab**	**Lab/Field/Drafting**	
Software Development 1			3
Software Development 2			3
Software Development 3			3
System and Network Administration	**Lab**	**Lab/Field/Drafting**	
System and Network Administration 1			3
System and Network Administration 2			3
System and Network Administration 3			3
Machine Learning	**Lab**	**Lab/Field/Drafting**	
Machine Learning 1			3
Machine Learning 2			3
Machine Learning 3			3
Big Data Analytics	**Lab**	**Lab/Field/Drafting**	
Big Data Analytics 1			3
Big Data Analytics 2			3
Big Data Analytics 3			3
Augmented Reality	**Lab**	**Lab/Field/Drafting**	
Augmented Reality 1			3
Augmented Reality 2			3
Augmented Reality 3			3

Technopreneurship

Courses	No. of Hours		No. of Hours
	Lab	Lab/Field/Drafting	
Technopreneurship 1			3
Technopreneurship 2			3
Technopreneurship 3			3

* The n^{th} year standing means that the student must have completed at least 75% of the load requirements of the previous year level.

** The courses in track specializations should be related.

*** 80 hours per unit of field work.

Section 12. Sample Curriculum Map

Refer to **Annex II** for the Minimum Program Outcomes and a Sample Curriculum Map. The HEI may develop own Curriculum Map.

Section 13. Description 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 intended learning outcome. 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 Intended Learning Outcomes to be developed first, and then the Teaching / Learning Activities and Assessment Tasks 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 assessment tasks 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

The Course Syllabus must contain at least the following components:

14.1. General Course Information (Title, Description, Code, Credit Units, Prerequisites)
14.2 Links to Program Outcomes
14.3 Course Outcomes
14.4 Course Outline (Including Unit Outcomes)
14.5 Teaching and Learning Activities
14.6 Assessment Methods
14.7 Final Grade Evaluation
14.8 Learning Resources
14.9 Course Policies and Standards
14.10 Effectivity and Revision Information

See Annex III for Sample Course Specifications for the courses listed in the suggested Curriculum Map.

ARTICLE VI
REQUIRED RESOURCES

This article covers the specific required resources for the BS Computer Engineering program.

All other requirements on Administration, Library and Laboratory facilities, and buildings for the BS Engineering Program are contained in CMO No. 86, s. 2017, 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 s2012.

There shall be a full-time Department/Program Chair/Coordinator who will lead the program in curriculum planning, implementation, monitoring, review, and evaluation of BSCpE program. The College Dean may serve as concurrent Department or Program Chair when appropriate.

The qualifications of the Department/Program Chair/Coordinator of BSCpE program:

a) Shall be a Professional Computer Engineer, if applicable;
b) Shall be holder of any of the following Master's degree
    (1) Master of Science in Computer Engineering
    (2) Master of Engineering in Computer Engineering
    (3) Master of Engineering Education in Computer Engineering
    (4) Master of Engineering Program Major in Computer Engineering
    (5) Master of Science in Engineering Major in Computer Engineering; and
c) Shall have a minimum teaching experience of not less than three (3) years preferably with industry practice

The Department/Program Chair to carry out his/her administrative function must be given a teaching load of not more than 50% of regular teaching load.

Section 16. Faculty

16.1 Requirements

There shall be adequate number of competent and qualified faculty to teach professional courses of BSCpE program and appropriate student-faculty ratio to effectively implement the minimum curricular requirements. The program shall not be dependent on single faculty handling professional courses.

In addition, by AY 2018-2019, thirty-five percent (35%) of the total full-time faculty members teaching professional courses in BSCpE must be holder of Master's degree in CpE or allied programs and preferably Doctoral degree in CpE or allied programs. Faculty members teaching professional courses must be a Certified Computer Engineer, if applicable.

All other full-time faculty of the program, including those teaching Mathematics, Sciences, Computing, and General Education courses, must also possess at least Master's degrees relevant to their courses being taught and research specializations by AY 2018-2019.

Faculty members teaching professional courses that require industry certification shall have valid industry certification.

Faculty members teaching CpE Design preferably shall have relevant industry immersion or experience.

All faculty members must undergo training in the principles of OBE and the practice of OBTL using various modes of teaching and learning activities and appropriate outcomes-based assessment.

16.2 Duties

The faculty shall be actively involved in the following areas of implementation of CpE program:

(1) curriculum review, decision-making, and implementation of the academic program
(2) program assessment and evaluation, and implementation of continuous improvement of the program
(3) development, improvement, and achievement of course outcomes (COs)
(4) enrichment of teaching and learning activities(TLAs)
(5) development and improvement of assessment tasks, constructively aligned with COs and TLAs
(6) student advising activities of the program
(7) research and scholarly work
(8) professional services offered by the program
(9) linkage and extension work

Section 17. Library and other Learning Resources

The library services and other learning resources are covered by CMO No. 86, s. 2017, Policies, Standards and Guidelines for Requirements Common to all BS Engineering and Bachelor of Engineering Technology Programs.

Section 18. Laboratory Equipment and Resources

18.1 Facilities

Facilities are covered by CMO No. 86, s. 2017, Policies, Standards and Guidelines for Requirements Common to all BS Engineering Programs

18.2 Laboratories for the BSCpE Program

1. Chemistry for Engineers
2. Physics for Engineers
3. Fundamentals of Electrical Circuits
4. Fundamentals of Electronic Circuits
5. Microprocessors
6. Logic Circuits and Design
7. Computer Architecture and Organization
8. Computer Networks and Security
9. Embedded Systems

10. Computer Engineering Drafting and Design
11. Programming Logic and Design
12. Data Structures and Algorithms
13. Object Oriented Programming
14. Software Design
15. Digital Signal Processing
16. Introduction to HDL

18.3 Modernization of Facilities

Each school/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.

18.4 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 the 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 offering BS in Computer Engineering programs must show evidence of full compliance with CMO 37, s. 2012 (Establishment of an Outcomes-Based Education System) by the following actions:

19.1 CMO 37 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 BS Computer Engineering programs a Monitoring Workbook (CMO 37-MW-2017-HEI-BSCpE) and Self-Assessment Rubric (SAR) (CMO-37-HEI-SAR-2017-BSCpE).

The five-year BCpE 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 BSAeE programs 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 BCpE programs with low SAR total scores may be asked to submit a one- or two-year development plan to CHED.

19.3 Exemptions

HEIs with BSCpE 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-BSCpE). 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

HEIs currently offering the BSCpE program for AY 2018-2019 shall be made to complete a new Application Workbook (AW-2018-HEI-BSCpE) which shall be made available through CHED or downloadable from the CHED-TPET website. The Application Workbook shall be completed and submitted to CHED or uploaded to the CHED-TPET website before the start of AY 2018-2019.

Section 21 Approval of Application

All HEIs with BSCpE 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 shall be given conditional approval by CHED to start offering their new BSIE Curriculum following this CMO effective AY 2018-2019. CHED shall, however, conduct monitoring of HEIs to assure complete compliance of this PSG within the transitory period, during which HEIs with BSCpE programs with 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, and local universities and colleges with existing authorization to operate the Bachelor of Science in Computer 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 Standards for an Industrial Engineer
- Annex II – Minimum Program Outcomes and Sample Curriculum Map
- Annex III – Sample Course Specifications
- Annex IV – Laboratory Requirements
    - A. Natural/Physical Sciences
    - B. Professional Courses
- Annex V – Sample Course Syllabus

ANNEX I - COMPETENCY STANDARDS Bachelor of Science in Computer Engineering
Computer Engineer ***(noun)*** – is a professional who embodies the science and technology of design, development, implementation, maintenance and integration of software and hardware components in modern computing systems and computer-controlled equipment.
ATTRIBUTES AND COMPETENCIES OF A COMPUTER ENGINEER

ATTRIBUTES		COMPETENCY LEVEL		
		NEW GRADUATE	**1 - 7 YEARS ENGG. 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 computer engineering problems.	Propose innovations in process design and operations improvement and optimization and impart these to peers. Develop and continually upgrade proficiency in numerical and computational modeling in solving computer engineering problems.
2	Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and	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	Consolidate results of research and technical information in formulating solutions to computer engineering processes and adapt these into systems to achieve energy and process efficiency targets.Impart these technological advances to peers.

	engineering sciences.		outputs.	
3	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.	Study, investigate and gather data related to complex engineering problems and propose solutions based on the fundamentals of engineering principles while incorporating ethics, safety and environmental considerations.	Study, investigate and gather data related to problems in computer engineering 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.	Consolidate studies made on problems in computer engineering processes and operations and propose changes in operational parameters. Specialize in specific fields of practice in computer engineering and use the technical expertise in design of solutions to applicable complex engineering problems. 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.	Use available database information, coordinate with other technical experts, plan and design experiments in conducting investigations of complex engineering problems. Prepare reports and make presentations to concerned entities on the proposed solutions to the complex engineering problems.	Organize teams of experts, plan and design experiments in conducting investigations of complex engineering problems. Prepare feasibility, optimization reports, implementation plans and make presentations to the 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.	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.Recommend the applicable modern tools that can be used to solve complex engineering problems.	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.Prepare recommendations based on results considering optimization, practical applications and limitations of process parameters and equipment.	Be familiar 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 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 computer engineering professional practice. Make a personal commitment to societal, health, safety, legal and cultural issues recognizing 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 computer engineering professional practice. 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 computer 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 computer 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 computer 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.Impart learning to peers.	Be familiar with relevant applicable technical and engineering standards that can be applied in professional computer 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 professional ethics for computer engineers and apply and behave according to this code in professional practice.Apply ethical principles in conjunction with engineering practice.	Be familiar with the professional ethics for computer 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 professional ethics for computer 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 endeavor 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.	Supervise and manage processes, people and facilities locally or internationally enabling efficiency, improved performance, business profitability and safety. Train other engineers.

10	Communicate effectively on complex engineering 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.	Prepare reports, presentations and other engineering documents 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.	Prepare reports, presentations and other engineering documents 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.	Consolidate reports and make presentations to peers and superiors 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 computer engineering.	Plan, lead, organize and control small to medium-sized projects or tasks as may be deemed necessary in the practice of computer 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 computer engineering. Manage financial aspects of the project. Manage supervisors and peers. Prepare reports related to projects.

ANNEX II - SAMPLE CURRICULUM MAP
Bachelor of Science in Computer Engineering

PROGRAM OUTCOMES

Graduates of Bachelor of Science in Computer Engineering (BSCpE) program shall be able to:

a) *Ability to apply knowledge of mathematics and science to solve engineering problems;*
b) *Ability to design and conduct experiments, as well as to analyze and interpret data;*
c) *Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability, in accordance with standards;*
d) *Ability to function on multidisciplinary teams;*
e) *Ability to identify, formulate, and solve engineering problems;*
f) *Understanding of professional and ethical responsibility;*
g) *Ability to communicate effectively;*
h) *Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;*
i) *Recognition of the need for, and an ability to engage in life-long learning*
j) *Knowledge of contemporary issues;*
k) *Ability to use techniques, skills, and modern engineering tools necessary for engineering practice; and*
l) *Knowledge and understanding of engineering and management principles as a member and leader in a team, to manage projects and in multidisciplinary environments.*

SAMPLE CURRICULUM MAP

Code	***Descriptor***	***Descriptor***
I	*Introductory Course*	*An introductory course to an outcome*
E	*Enabling Course*	*A course that strengthens an outcome*
D	*Demonstrating Course*	*A course demonstrating an outcome*

Code	***Classification***
M	*Mathematics*
NPS	*Natural/Physical Sciences*
BES	*Basic Engineering Sciences*
A	*Allied Courses*
P	*Professional Courses*
TE	*Technical Electives*
GE	*General Education Courses*
GEM	*GEC Electives/Mandated Courses*
PE	*Physical Education*
NSTP	*National Service Training Program*

Professional / Technical Elective Courses	Units	Code	Student Outcome											
			a	b	c	d	e	f	g	h	i	j	k	l
Computer Engineering as a Discipline	*1*	*P-01*										*I*		
Programming Logic and Design	*2*	*P-02*			*I*									
Discrete Math	*3*	*P-03*	*I*											
Numerical Methods	*3*	*P-04*	*E*										*I*	
Object Oriented Programming	*2*	*P-05*			*E*								*I*	
Data Structures and Algorithms	*2*	*P-06*			*E*									
Software Design	*4*	*P-07*			*E*									
Logic Circuits and Design	*4*	*P-08*		*E*										
Fundamentals of Mixed Signals and Sensors	*3*	*A-09*	*E*											
Operating Systems	*3*	*P-10*											*E*	
Data and Digital Communications	*3*	*P-11*	*E*											
Introduction to HDL	*1*	*P-12*			*E*									
Feedback and Control Systems	*3*	*P-13*	*E*											
Basic Occupational Health and Safety	*3*	*P-14*								*E*				
Computer Networks and Security	*4*	*P-15*			*E*									
Microprocessors	*4*	*P-16*			*E*									
Methods of Research	*2*	*P-17*		*E*		*E*	*E*		*E*		*E*			
CpE Laws and Professional Practice	*2*	*P-18*						*E*						
Embedded Systems	*4*	*P-19*			*E*									
Computer Architecture and Organization	*4*	*P-20*			*E*									
Digital Signal Processing	*3*	*P-21*	*E*											
Emerging Technologies in CpE	*1*	*P-22*										*E*		
Seminars and Fieldtrips	*3*	*P-23*									*D*	*D*		
CpE Practice and Design 1	*1*	*P-24*					*D*	*D*	*D*	*D*		*D*		
CpE Practice and Design 2	*2*	*P-25*	*D*	*D*	*D*	*D*			*D*		*D*		*D*	*D*
On the Job Training	*3*	*P-26*			*D*	*D*	*D*	*D*			*D*		*D*	*D*
Cognate / Track Course 1	*3*	*P-27*												
Cognate / Track Course 2	*3*	*P-28*												
Cognate / Track Course 3	*3*	*P-29*												

Allied Courses	Units	Code	Student Outcome											
			a	b	c	d	e	f	g	h	i	j	k	l
Fundamentals of Electrical Circuits	*4*	*A-01*	*E*											
Fundamentals of Electronic Circuits	*4*	*A-02*	*E*											

Mathematics / Natural & Physical Sciences / Basic Engineering / Non-Technical Courses	Units	Code	Student Outcome											
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
Calculus 1	*4*	*M-01*	*I*											
Calculus 2	*4*	*M-02*	*I*											
Engineering Data Analysis	*3*	*M-03*	*I*	*I*										
Differential Equation	*3*	*M-04*	*I*											
Chemistry for Engineers	*4*	*NPS-01*	*I*											
Physics for Engineers	*4*	*NPS-02*	*I*											
Computer-Aided Drafting	*1*	*BES-01*	*I*					*I*						
Engineering Economics	*3*	*BES-02*					*I*							*E*
Technopreneurship 101	*3*	*BES-03*												
Science, Technology, Engineering and Society	*3*	*GE-01*								*I*		*I*		
Contemporary World	*3*	*GE-02*									*I*	*I*		
Readings in Philippine History	*3*	*GE-03*						*I*				*I*		
Understanding the Self	*3*	*GE-04*							*I*		*I*	*I*		
Art Appreciation	*3*	*GE-05*				*I*				*I*				
Purposive Communication	*3*	*GE-06*						*I*		*I*				
Mathematics for the Modern World	*3*	*GE-07*	*I*				*I*							
Ethics	*3*	*GE-08*								*I*		*I*		
Free Elective	*3*	*GEM-03*												
Life and Works of Rizal	*3*	*GEM-04*								*I*		*I*		
PE 1	*2*	*PE-01*				*I*								
PE 2	*2*	*PE-02*				*I*								
PE 3	*2*	*PE-03*				*I*								
PE 4	*2*	*PE-04*				*I*								
NSTP 1	*3*	*NSTP-01*				*I*						*I*		
NSTP 2	*3*	*NSTP-02*				*I*						*I*		

ANNEX III - COURSE SPECIFICATIONS
Bachelor of Science in Computer Engineering

TABLE OF CONTENTS

TECHNICAL COURSES

MATHEMATICS

Course Name	Calculus 1
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	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	None
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
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. Derivatives of Inverse Trigonometric Functions 14. Derivatives of Logarithmic and Exponential Functions 15. Derivatives of the Hyperbolic Functions 16. Solutions of Equations 17. Transcendental Curve Tracing 18. Parametric Equations 19. Partial Differentiation

Course Name	Calculus 2
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	3 units

Number of Contact Hours per Week	3 hours per week
Prerequisites	Calculus 1
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
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 Integrals 6.2. Triple Integrals 7. Surface Tracing 7.1. Planes 7.2. Spheres 7.3. Cylinders 7.4. Quadric Surfaces 7.5. Intersection of Surfaces 8. Multiple Integrals as Volume 8.1. Double Integrals 8.2. Triple Integrals

Course Name	Engineering Data and 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	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	Calculus 1
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
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

	5.1.1. Joint Probability Distributions 5.1.2. Marginal Probability Distribution 5.1.3. Conditional Probability Distribution 5.1.4. More than Two 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 6.3.1. Unbiased Estimator 6.3.2. Variance of a Point Estimator 6.3.3. Standard Error 6.3.4. Mean Squared Error of an Estimator 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 8.1.1. One-sided and Two-sided Hypothesis 8.1.2. P-value in Hypothesis Tests 8.1.3. General Procedure for Test of Hypothesis 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 10.4.1. Use of t-tests 10.4.2. Analysis of Variance Approach to Test Significance of Regression 10.5. Prediction of New Observations 10.6. Adequacy of the Regression Model 10.6.1. Residual Analysis 10.6.2. Coefficient of Determination 10.7. Correlation

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	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	Calculus 2
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Introduction / Definition 1.1. Definition and Classifications of Differential Equations (DE) 1.2. Solution of a DE 2. Solution of some 1^{st} order DE 2.1. Variable Separable 2.2. Exact Equation 2.3. Linear Equation 2.4. Substitution Methods 2.4.1. Homogeneous Coefficients 2.4.2. Bernoulli's Equation 2.4.3. Other Substitution Methods 2.5. Mixed Problems (method not pre-identified) 2.6. Introduction to Use of Computer in Solving Differential Equations 3. Application of 1^{st} 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 4.1.1. Standard form of a n^{th} order Linear DE 4.1.2. Differential Operators 4.1.3. Principle of Superposition 4.1.4. Linear Independence of a Set of Functions 4.2. Homogeneous Linear Differential Equation with Constant Coefficients

	4.2.1. Solution of a Homogeneous Linear Ordinary DE 4.2.2. Initial and Boundary Value Problems 4.3. Non-homogeneous Differential Equation With Constant Coefficients 4.3.1. Form of the General Solution 4.3.2. Solution by Method of Undetermined Coefficients 4.3.3. Solution by Variation of Parameters 4.3.4. Mixed Problems 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 6. The Heaviside Unit-Step Function 6.1. Definition 6.2. Laplace Transforms of Discontinuous Functions and Inverse Transform Leading to Discontinuous Functions 6.3. Solution of Initial Value Problems with Discontinuous Functions by Laplace Transform Method 7. Application of Laplace Transforms (Problems on Vibration) 8. Solution of Systems of Linear Differential Equation with Initial Values/Simultaneous Solution to DE (Laplace Transform Method)

NATURAL/PHYSICAL SCIENCES

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	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	None
Co-requisites	Chemistry for Engineers Laboratory

Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Energy 1.1 Electrochemical energy 1.2 Nuclear chemistry and energy 1.3 Fuels 2. The Chemistry of Engineering Materials 3. Basic Concepts of Crystal Structure 3.1 Metals 3.2 Polymers 3.3 Engineered Nanomaterials 4. The Chemistry of the Environment 5. The Chemistry of the atmosphere 5.1 The Chemistry of Water 5.2 Soil chemistry 6. Chemical Safety 7. Special topics specific to field of expertise

Course Name	**Chemistry for Engineers Laboratory**
Course Description	A fundamental laboratory course designed to provide opportunity to observe and apply the principles and theories taught in the chemistry for engineers.
Number of Units for Laboratory	1 unit
Number of Contact Hours per Week	3 hours per week
Prerequisites	None
Co-requisites	Chemistry for Engineers
Program Outcomes	a-l, b-l, k-l
Course Outline	1. Rules and Regulations in the Chemistry Laboratory 2. Safety Precautions in the Chemistry Laboratory 3. Rules in Performing an Laboratory Experiment 4. Making Preliminary and Final Reports 5. Familiarization of Equipment/Apparatus 6. Performance of Laboratory Experiments
Laboratory Experiments	Laboratory exercises to be identified by the program. Each major topic should have a corresponding laboratory exercise. For semestral program, 15 exercises per semester. For trimestral program, 12 exercises per trimester. For quarterm program, 9 exercises per quarter.
Laboratory Equipment	See Annex of Lab Requirements

Course Name	**Physics for Engineers**
Course Description	This course covers 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	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	Calculus 1
Co-requisites	Physics for Engineers Laboratory
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
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

Course Name	**Physics for Engineers Laboratory**
Course Description	A fundamental laboratory course designed to provide opportunity to observe and apply the principles and theories taught in the physics for engineers.
Number of Units for Laboratory	1 unit
Number of Contact Hours per Week	3 hours per week
Prerequisites	None

Co-requisites	Physics for Engineers
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Rules and Regulations in the Physics Laboratory 2. Safety Precautions in the Physics Laboratory 3. Rules in Performing an Laboratory Experiment 4. Making Preliminary and Final Reports 5. Familiarization of Equipment/Apparatus 6. Performance of Laboratory Experiments
Laboratory Experiments	Laboratory exercises to be identified by the program. Each major topic should have a corresponding laboratory exercise. For semestral program, 15 exercises per semester. For trimestral program, 12 exercises per trimester. For quarterm program, 9 exercises per quarter.
Laboratory Equipment	See Annex of Lab Requirements

BASIC ENGINEERING SCIENCE

Course Name	**Computer Aided Drafting**
Course Description	Concepts of computer-aided drafting (CAD); introduction to the CAD environment; terminologies; and the general operating procedures and techniques in entering and executing basic CAD commands.
Number of Units Laboratory	1 unit
Number of Contact Hours per Week	3 hours per week
Prerequisites	2^{nd} Year Standing
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Introduction to CAD Software 2. CAD Drawing 3. Snapping, Construction Elements 4. Dimensioning 5. Plotting, Inputting Images 6. 3D and Navigating in 3D 7. Rendering
Laboratory Equipment	See Annex of Lab Requirements

Course Name	Engineering Economics
Course Description	This course deals with the study of concepts of the time value of money and equivalence; basic economic study methods; decisions under certainty; decisions recognizing risk; and decisions admitting uncertainty.
Number of Units Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	
Program Outcomes	e-E, k-E
Course Outcomes	After completing this course, the student must be able to: 1. Solve problems involving interest and the time value of money; 2. Evaluate project alternatives by applying engineering economic principles and methods and select the most economically efficient one; and 3. Deal with risk and uncertainty in project outcomes by applying the basic economic decision making concepts.
Course Outline	1. Introduction 1.1. Definitions 1.2. Principles of Engineering Economics 1.3. Engineering Economics and the Design Process 1.4. Cost Concepts for Decision Making 1.5. Present Economic Studies 2. Money-Time Relationships and Equivalence 2.1. Interest and the Time Value of Money 2.2. The Concept of Equivalence 2.3. Cash Flows 3. Economic Study Methods 3.1. The Minimum Attractive Rate of Return 3.2. Basic Economic Study Methods: Present Worth, Future Worth, Annual Worth, Internal Rate of Return, External Rate of Return 3.3. Other Methods: Discounted Payback Period, Benefit/Cost Ratio 4. Decisions Under Certainty 4.1. Evaluation of Mutually Exclusive Alternatives 4.2. Evaluation of Independent Projects 4.3. Effects of Inflation 4.4. Depreciation and After-Tax Economic Analysis 4.5. Replacement Studies 5. Decisions Recognizing Risk 5.1. Expected Monetary Value of Alternatives 5.2. Discounted Decision Tree Analysis 6. Decisions Admitting Uncertainty 6.1. Sensitivity Analysis 6.2. Decision Analysis Models

Course Name	Technopreneurship 101
Course Description	Technopreneurship is a philosophy, a way of building a career or perspective in life. The course covers the value of professional and life skills in entrepreneurial thought, investment decisions, and action that students can utilize in starting technology companies or executing R&D projects in companies as they start their careers. The net result is a positive outlook towards wealth creation, high value adding, and wellness in society.
Number of Units Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	
Program Outcomes	To be identified by the program.
Course Outcomes	After completing this course, the student must be able to: 1. Evaluate and define the market needs 2. Solicit and apply feedback from mentors, customers and other stakeholders 3. Experience the dynamics of participating on a business team 4. Pitch a business plan for a technology idea 5. Develop an initial idea into a prototype
Course Outline	1. Introduction • Entrepreneurial Mindset • Innovation and Ideas • Products and Services • Team Formation 2. Customers 3. Value Proposition 4. Market Identification and Analysis 5. Creating Competitive Advantage 6. Business Models 7. Introduction to Intellectual Property 8. Execution and Business Plan 9. Financial Analysis and Accounting Basics 10. Raising Capital 11. Ethics, social responsibility, and Globalization

ALLIED COURSES

Course Name	Fundamentals of Electrical Circuits
Course Description	This course introduces the fundamental concepts, circuit laws, theorems and techniques used in electrical circuit analysis and transient analysis, as well as its application. The course covers

	circuit topologies and DC excitations, transient response, AC response, and polyphase circuits. The use of computer software for circuit simulation and design are emphasized to expose students to computer-based tools.
Number of Units for Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	Physics for Engineers
Co-requisites	Fundamentals of Electrical Circuits Laboratory
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Circuit Topologies and DC Excitations 1.1 Introductory Concepts 1.2 Electrical Properties of Materials 1.3 Passive Elements 1.4 Network Laws and Theorems 1.5 Electric Circuit Theorems 2. Transient Response 2.1 RC Circuits 2.2 RL Circuits 2.3 RLC Circuits 3. AC Response and Polyphase Circuits 3.1 Reactance and Impedance 3.2 Introduction to Single-Phase AC 3.3 AC Power Analysis 3.4 Sinusoidal Steady-State Analysis 3.5 Three-Phase Circuits 3.6 Transformer

Course Name	**Fundamentals of Electrical Circuits Laboratory**
Course Description	This course allows the students to verify the laws and theorems discussed in Fundamentals of Electrical Circuits (lecture) through simulation, experimentation and project construction. The course topics include experimental determination of the characteristics of the different circuit configurations (series, parallel, series/parallel, delta, and wye), electrical power, Ohm's Law, Kirchhoff's Voltage and Current Laws, Superposition Theorem, Thevenin's equivalent circuit, and maximum power transfer. The use of computer software for circuit simulation and design are used as basis in verifying experimental results and to expose students to computer-based tools.
Number of Units for Laboratory	1 unit

Number of Contact Hours per Week	3 hours per week
Prerequisites	Physics for Engineers
Co-requisites	Fundamentals of Electrical Circuits
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Rules and Regulations in the Electrical Engineering Laboratory 2. Safety Precautions in the Electrical Engineering Laboratory 3. Rules in Performing an Laboratory Experiment 4. Making Preliminary and Final Reports 5. Familiarization of Equipment/Apparatus 6. Performance of Laboratory Experiments
Laboratory Experiments	Laboratory exercises to be identified by the program. Each major topic should have a corresponding laboratory exercise. For semestral program, 15 exercises per semester. For trimestral program, 12 exercises per trimester. For quarterm program, 9 exercises per quarter.
Laboratory Equipment	Program shall provide complete tools and equipment necessary to perform the identified laboratory exercise. 1 set of tools and equipment per maximum of 5 students per group.

Course Name	**Fundamentals of Electronic Circuits**
Course Description	This course discusses the construction, operation and characteristics of basic electronic devices such as junction diodes, bipolar junction transistors, Field Effect Transistors and MOS Field Effect Transistors and oscillators.
Number of Units for Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	Fundamentals of Electrical Circuits
Co-requisites	Fundamentals of Electronic Circuits Laboratory
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Introduction to Electronics 2. Solid State Fundamentals 3. Semiconductor PN Junction Diode 4. Diode Circuit Analysis and Applications 5. DC Regulated Power Supply

	6. IC Regulator 7. Light Emitting Diode (LED) 8. Bipolar Junction Transistor (BJT) 9. Field Effect Transistor (FET) 10. Switching Transistor Circuits 11. Resistor Transistor Logic (RTL) 12. Direct-Coupled Transistor Logic (DCTL) 13. Integrated-Injection Logic (I2L) 14. Schottky-Diode Non-Saturating Logic (Schottky-Clamped Logic for TTL/I2L) 15. Emitter-Coupled Logic (ECL) 16. MOSFET Logic 17. Comparison of Different Logic Families (Summary) 18. Oscillator Circuits

Course Name	**Fundamentals of Electronic Circuits Laboratory**
Course Description	This course is the laboratory component of the course Fundamentals of Electronic Circuits (Lecture) that allows students to verify theoretical concepts pertaining to the operation of electronic devices such as the PN junction diodes, BJT and FET and their subsequent applications to electronics circuits involving rectification, amplification and switching applications. The use of laboratory equipment and apparatus to verify the characteristics of diodes and transistor devices, and their operations in circuits such as rectifiers, voltage regulators, amplifiers, oscillators and switches are emphasized. Such equipment includes but not limited to the curve tracer, the oscilloscope, signal generator and multi-meters.
Number of Units for Laboratory	1 unit
Number of Contact Hours per Week	3 hours per week
Prerequisites	Fundamentals of Electrical Circuits
Co-requisites	Fundamentals of Electronic Circuits
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Rules and Regulations in the Electronics Engineering Laboratory 2. Safety Precautions in the Electronics Engineering Laboratory 3. Rules in Performing an Laboratory Experiment 4. Making Preliminary and Final Reports 5. Familiarization of Equipment/Apparatus 6. Performance of Laboratory Experiments
Laboratory Experiments	Laboratory exercises to be identified by the program. Each major topic should have a corresponding laboratory exercise. For semestral program, 15 exercises per semester.

	For trimestral program, 12 exercises per trimester. For quarterm program, 9 exercises per quarter.
Laboratory Equipment	Program shall provide complete tools and equipment necessary to perform the identified laboratory exercise. 1 set of tools and equipment per maximum of 5 students per group.

PROFESSIONAL COURSES

Course Name	**Computer Engineering as a Discipline**
Course Description	This course discusses the curriculum for Computer Engineering as well as how to prepare students for success through engineering design process, ethical decision-making, teamwork, and communicating to diverse audiences.
Number of Units for Lecture	1 unit
Number of Contact Hours per Week	1 hour per week
Prerequisites	None
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. CpE Curriculum 2. Introduction to the Engineering Profession 3. Preparing for an Engineering Career 4. Introduction to Engineering Design 5. Engineering Communication 6. Engineering Ethics

Course Name	**Discrete Mathematics**
Course Description	This course deals with logic, sets, proofs, growth of functions, theory of numbers, counting techniques, trees and graph theory.
Number of Units for Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	Calculus 1
Program Outcomes	To be Identified by the program.
Course Outcomes	To be Identified by the program.
Course Outline	1. Logic, Sets, Proofs, and Functions 2. Algorithms, Integers and Matrices 2.1 Growth of Functions

	2.2 Complexity of Algorithms 2.3 Number Theory 2.4 Matrices 3. Counting Techniques 4. Relations 5. Graph Theory 6. Trees 7. Introduction to Modeling Computation

Course Name	**Numerical Methods**
Course Description	This course covers the concepts of numerical analysis and computer software tools in dealing with engineering problems. It includes techniques in finding the rots of an equation, solving systems of linear and non-linear equations, eigenvalue problems, polynomial approximation and interpolation, ordinary and partial differential equations. The Monte-Carlo method, simulation, error propagation and analysis, the methods of least squares and goodness-of-fit tests are also discussed
Number of Units for Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	Differential Equations
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Introduction 2. Non Linear Transcendental and Polynomial Function Techniques 3. Iterative Bracketing Method 4. Iterative Non-Bracketing/Open Method 5. Iterative Polynomial Function Techniques 6. System of Linear Equations 7. Direct Methods 8. Iterative Methods 9. Curve Fitting Techniques 10. Least Square Regression 11. Interpolation Techniques 12. Numerical Integration Techniques 13. Numerical Differentiation 14. Ordinary Differential Equations

Course Name	**Fundamentals of Mixed Signals and Sensors**
Course Description	This course covers operational amplifiers, signal converters, power switching devices and the construction and operation of sensors and transducers for converting physical parameters into electrical signals and vice-versa. The course focuses on the application of these devices in developing signal conversion circuits that allows measurement, processing and control of physical parameters by digital processing systems such as a finite state machine or a digital computer. Topics on actuators are also included.
Number of Units for Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	Fundamentals of Electronic Circuits
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Differential Amplifiers 2. Operational Amplifiers 3. Linear and Non-Linear Applications of Op-Amp 4. Analog to Digital Conversion 5. Digital to Analog Conversion 6. Other Mixed Signals 7. Basic Measurement Theory 8. Sensors and Transducers 9. Other Types of Sensors and Transducers 10. Basic Control Devices

Course Name	**Programming Logic and Design**
Course Description	This is an introductory course in computer programming logic. The student will learn algorithms applicable to all programming languages, including: identifiers, data types, arrays, control structures, modular programming, generating reports, and computer memory concepts. The student will learn to use charts commonly used in business and information processing. Program logic will be developed using flowcharts and pseudo code. Programs will be written using any programming language.
Number of Units for Laboratory	2 units
Number of Contact Hours per Week	6 hours per week
Prerequisites	None

Program Outcomes	c – l
Course Outcomes	After completing this course, the student must be able to: 1. Identify important steps in program development cycle 2. Draw a flowchart to represent the program's logic 3. Break down programming problems into modules
Course Outline	1. Introduction to Computers and Logic 2. Tools for Developing Program Logic: Flowchart and Pseudocode Instructions 3. Logical Control Structures: Sequence, Selection/Decision, Iteration/Loop, Case 4. Data and Data Types, Constants and Variables, Operators And Its Hierarchy 5. Looping: While Loop, Do…While Loop, For Loop 6. Lists and Arrays: Representation, Arrays Interpolation, Add and Delete, Operators and Functions, Slicing 7. Debugging Techniques: Steps/Process in Debugging, Approaches, Debugging Tools
Laboratory Experiments	Laboratory exercises to be identified by the program. Each major topic should have a corresponding laboratory exercise. For semestral program, 15 exercises per semester. For trimestral program, 12 exercises per trimester. For quarterm program, 9 exercises per quarter.
Laboratory Equipment	Computer and object-oriented programming software tool Depending on the class size 1 computer per student

Sample Model Course Specification

Course Name	**Object Oriented Programming**
Course Description	Introduces the fundamental concepts of programming from an object oriented perspective. Topics are drawn from classes and objects, abstraction, encapsulation, data types, calling methods and passing parameters, decisions, loops, arrays and collections, documentation, testing and debugging, exceptions, design issues, inheritance, and polymorphic variables and methods. The course emphasizes modern software engineering and design principles.
Number of Units for Laboratory	2 units
Number of Contact Hours per Week	6 hours per week
Prerequisites	Programming Logic and Design
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Introduction to Object Oriented Programming and UML

	1.1. Fundamental Concepts: Classes, Objects, and Methods, Inheritance, Encapsulation and Abstraction, Polymorphism 1.2. Unified Modeling Language (UML): Basic Concepts, Association, Aggregation, Composition, and Multiplicity, UML Diagrams 2. Object Oriented Analysis and Design 2.1. Cohesion and Coupling Concepts 2.2. Data-Driven Design 2.3. Responsibility-Driven Design 2.4. Object-Oriented Design using UML 3. Programming Language Fundamentals 3.1. Coding Conventions and Data Types 3.2. Constants and Variables 3.3. Attributes, Methods, and Constructors 3.4. Control and Iterative Statements 3.5. Characters and Strings 3.6. Arrays 4. Advanced Programming Language Fundamentals 4.1. Inheritance 4.2. Abstract Classes 5. Exception Handling 5.1. Understanding Errors and Exceptions 5.2. Try, Catch, and Finally 6. Graphical User Interface Programming 6.1. Forms and Widgets 6.2. Graphics, Images, and Sound 6.3. Layout Managers 6.4. Event Handling
Laboratory Experiments	Laboratory exercises to be identified by the program. Each major topic should have a corresponding laboratory exercise. For semestral program, 15 exercises per semester. For trimestral program, 12 exercises per trimester. For quarterm program, 9 exercises per quarter.
Laboratory Equipment	Computer and object-oriented programming software tool Depending on the class size 1 computer per student

Course Name	**Data Structures and Algorithms**
Course Description	Solving computational problems that involve manipulating collections of data, study a core set of data abstractions, data structures, and algorithms that provide a foundation for writing efficient programs.
Number of Units for Laboratory	2 units
Number of Contact Hours per Week	6 hours per week
Prerequisites	Object Oriented Programming

Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Pointers, Dynamic Memory Allocation, Pointers, Arrays, Structures 2. Abstract Data Types (ADT) and Fundamentals of Linked Lists 3. Linked Lists Operations 4. Stack Abstract Data Type and Its Linked Lists Operations 5. Queue Abstract Data Type and Its Linked Lists Operations 6. Algorithm Analysis and Linked List Types: Doubly Linked Lists 7. Tree ADT and Binary Search Tree 8. AVL Tree 9. Heaps 10. Basic Algorithmic Analysis 11. Algorithmic Strategies 12. Classic Algorithms For Common Tasks 13. Analysis and Design of Application-Specific Algorithms 14. Parallel Algorithms and Multithreading 15. Algorithmic Complexity 16. Scheduling Algorithms 17. Basic Computability Theory
Laboratory Experiments	Laboratory exercises to be identified by the program. Each major topic should have a corresponding laboratory exercise. For semestral program, 15 exercises per semester. For trimestral program, 12 exercises per trimester. For quarterm program, 9 exercises per quarter.
Laboratory Equipment	Computer and any programming software tool Depending on the class size 1 computer per student

Course Name	**Software Design**
Course Description	This course focuses on programming paradigms and constructs, data structures and use of standard library functions for manipulating them, object-oriented design and the use of modeling languages, testing and software quality concepts, and tradeoffs among different software design methods.
Number of Units for Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	Data Structures and Algorithms
Co-requisites	Software Design Laboratory
Program Outcomes	To be identified by the program.

Course Outcomes	To be identified by the program.
Course Outline	1. History and Overview 2. Relevant Tools, Standards, and/or Engineering Constraints 3. Programming Constructs and Paradigms 4. Problem-Solving Strategies 5. Data Structures 6. Recursion 7. Object-Oriented Design 8. Software Testing and Quality 9. Data Modeling 10. Database Systems 11. Event-Driven and Concurrent Programming 12. Using Application Programming Interfaces 13. Data Mining 14. Data Visualization

Course Name	**Software Design Laboratory**
Course Description	This course focuses on providing hands-on experience in software design.
Number of Units for Lecture	1 unit
Number of Contact Hours per Week	3 hours per week
Prerequisites	Data Structures and Algorithms
Co-requisites	Software Design
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Laboratory Experiments	Laboratory exercises to be identified by the program. Each major topic should have a corresponding laboratory exercise. For semestral program, 15 exercises per semester. For trimestral program, 12 exercises per trimester. For quarterm program, 9 exercises per quarter.
Laboratory Equipment	Computer and object-oriented programming software tool Depending on the class size 1 computer per student

Course Name	**Logic Circuits and Design**
Course Description	The course includes design and analysis or digital circuits. This course covers both combinational (synchronous and asynchronous) logic circuits with emphasis on solving digital problems using hardwired structures of the complexity of medium and large-scale integration.

Number of Units for Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	Fundamentals of Electronic Circuits
Co-requisites	Logic Circuits and Design Laboratory
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Gates, Truth Tables, Boolean Algebra, Function Simplification 2. K-Maps, Circuit Implementation Using K-Maps, SOP and POS Representation, NAND/NOR Implementations. 3. Mux, Demux, Decoders, Code Conversion (BCD to Binary, Excess-3 to Binary, Gray Code) 4. Latches and Flip-Flops: SR, D, JK, T 5. Counter Design, Register Design, ALU Function 6. Sequential Circuits, Excitation Function, State Table, State Diagram. 7. Sequential Circuit Design with Different Flip-Flops. 8. Synchronous and Asynchronous Circuits Analysis and Design, Excitation Function, Flow Table 9. Algorithmic State Machine 10. Addressing and Decoding of Memory and I/O Systems

Course Name	**Logic Circuits and Design Laboratory**
Course Description	This course focuses on providing hands-on experience in designing digital circuits.
Number of Units for Lecture	1 unit
Number of Contact Hours per Week	3 hours per week
Prerequisites	Fundamentals of Electronic Circuits
Co-requisites	Logic Circuits and Design
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Laboratory Experiments	Laboratory exercises to be identified by the program. Each major topic should have a corresponding laboratory exercise. For semestral program, 15 exercises per semester. For trimestral program, 12 exercises per trimester. For quarterm program, 9 exercises per quarter.

Laboratory Equipment	Program shall provide complete tools and equipment necessary to perform the identified laboratory exercise. 1 set of tools and equipment per maximum of 5 students per group.

Course Name	**Operating Systems**
Course Description	This course includes different policies and strategies used by an operating system. Topics include operating systems structures, process management, storage management, file management and distributed systems.
Number of Units for Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	Data Structures and Algorithms
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Overview of the Operating System 2. Process Management 3. Process Coordination 4. Memory Management 5. Storage Management 6. Protection and Security 7. Interfacing to Operating Systems 8. Special-Purpose Systems

Course Name	**Data and Digital Communications**
Course Description	This course focuses on the fundamental concepts of digital and data communications. It also includes topics on data security and integrity.
Number of Units for Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	Fundamentals of Electronic Circuits
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Elements of Digital Communication 2. Pulse Code Modulation 3. Digital Modulation Techniques

	4. Information Theory 5. History of Data Communication 6. Transmission Media and Transmission Technologies 7. Data Transmission Modes and Standards 8. Protocols 9. Error Detection and Correction 10. Encryption and Decryption 11. Virus, Worms, And Hacking

Course Name	**Introduction to HDL**
Course Description	A laboratory course that introduces hardware description language as a tool for designing and testing combinational and sequential circuits. It covers fundamental of concepts of HDL and the basic building blocks of HDL programming.
Number of Units for Laboratory	1 unit
Number of Contact Hours per Week	3 hours per week
Prerequisites	Programming Logic and Design Fundamentals of Electronic Circuits
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Introduction to Hardware Description Language Programming 2. Gate Level Modeling 3. Dataflow Modeling 4. Behavioral Modeling 5. Combinational Circuit 6. Sequential Circuit 7. Counters 8. State Machine Design 9. Task and Functions
Laboratory Experiments	Laboratory exercises to be identified by the program. Each major topic should have a corresponding laboratory exercise. For semestral program, 15 exercises per semester. For trimestral program, 12 exercises per trimester. For quarterm program, 9 exercises per quarter.
Laboratory Equipment	Computer and any HDL software tool Depending on the class size 1 computer per student

Course Name	**Feedback and Control Systems**
Course Description	The course includes the control devices, equations of a systems and block diagram of systems.

Number of Units for Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	Numerical Methods Fundamentals of Electrical Circuits
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Introduction to Control System 2. Block Diagram Algebra and Transfer Function 3. Review of Frequency Response Transfer Function 4. Block Diagram of Control Systems 5. Types of Feedback 6. Frequency Response of Feedback Systems 7. Root Locus and Nyquist Criteria 8. Stability and Compensation 9. Step Response

Course Name	**Computer Engineering Drafting and Design**
Course Description	This course focuses on the principles of layout of electrical, electronics, and logic drawings; stressing modern representation used for block diagrams, wiring/assembly, drawings, printed circuit board layouts, and etching.
Number of Units for Laboratory	1 unit
Number of Contact Hours per Week	3 hours per week
Prerequisites	Fundamentals of Electronic Circuits
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Block Diagrams and Flowcharts 2. Electrical, Electronic and Logic Components 3. Designation, Standards and Abbreviations 4. Hand-sketched Schematic Diagrams 5. Circuit Layout Simulation Tool 6. Wiring and Cabling Diagrams Electronic Packaging 7. PCB Design Process 8. PCB Design Issues 9. Etching

Laboratory Experiments	Laboratory exercises to be identified by the program. Each major topic should have a corresponding laboratory exercise. For semestral program,15 exercises per semester. For trimestral program, 12 exercises per trimester. For quarterm program, 9 exercises per quarter.
Laboratory Equipment	Program shall provide complete tools and equipment necessary to perform the identified laboratory exercise. 1 set of tools and equipment per maximum of 5 students per group.

Course Name	**Basic Occupational Health and Safety**
Course Description	This course tackles key Occupational Health and Safety (OSH) concepts, principles and practices that are foundational knowledge requirements applicable in almost all industries. Specifically, it assists learners in identifying the key elements in the OSH situation both here and abroad; determine existing and potential safety and health hazards; identify the range of control measures; discuss pertinent provisions of Philippine laws that refer to occupational safety and health; explain key principles in effectively communicating OSH; identify components of effective OSH programs and demonstrate some skills in identifying hazards and corresponding control measures at the workplace.
Number of Units for Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	3rd Year Standing
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Introductory Concepts 2. Occupational Safety 3. Industrial Hygiene 4. Control Measures for OSH Hazards 5. Occupational Health 6. Personal Protective Equipment 7. OSH Programming 8. Training of Personnel on OSH 9. OSH Legislation 10. Plant Visit Simulation

Course Name	**Computer Networks and Security**
Course Description	The course includes the basic principles of network architecture, computer network design, services, technologies and network security.
Number of Units for Lecture	3 units

Number of Contact Hours per Week	3 hours per week
Prerequisites	Data and Digital Communications
Co-requisites	Computer Networks and Security Laboratory
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Evolution of Computer Networks and Services 2. Applications and Layered Architectures 3. Local Area Networks (LAN)/Wide Area Networks (WAN) 3.1 Devices and Protocols 3.2 Standards 4. Internetworks 4.1 Principles of Internetworking 4.2 Architectures 4.3 IP Addressing and Architecture 5. Network Security 5.1 Internet Protocol and Standards 5.2 Internet Authentication and Applications 5.3 Wireless Network Security 5.4 Web Security 6. Introduction to Cybersecurity

Course Name	**Computer Networks and Security Laboratory**
Course Description	This course provides hands-on laboratory activities on computer networking. It focuses on the configuration of TCP/IP, routers and switches, network security and wireless fidelity.
Number of Units for Laboratory	1 unit
Number of Contact Hours per Week	3 hours per week
Prerequisites	Data and Digital Communications
Co-requisites	Computer Networks and Security
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Laboratory Experiments	Laboratory exercises to be identified by the program. Each major topic should have a corresponding laboratory exercise. For semestral program, 15 exercises per semester. For trimestral program, 12 exercises per trimester. For quarterm program, 9 exercises per quarter.

Laboratory Equipment	Program shall provide complete tools and equipment necessary to perform the identified laboratory exercise. 1 set of tools and equipment per maximum of 5 students per group.

Course Name	**Microprocessors**
Course Description	This course provides understanding of architecture of microprocessor-based systems; registers, study of microprocessor operation, assembly language, arithmetic operations, and interfacing.
Number of Units for Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	Logic Circuits and Design
Co-requisites	Microprocessors Laboratory
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Structural Components of Microprocessor/Microcontroller 1.1 Internal CPU Interconnection 1.2 ALU 1.3 CU 1.4 Registers 1.5 Other Peripherals 2. Fetch-Decode-Execute Cycle 3. Functional Operations of Microprocessor/Microcontroller 3.1 Data Movement 3.2 Data Processing 3.3 Control 3.4 Data Storage 4. Instruction Set 5. I/O Interfacing 5.1 Interfacing of Input/Output Devices 5.2 Interface Devices 5.3 Time-Based I/O 5.4 Handshaking

Course Name	**Microprocessors Laboratory**
Course Description	This course provides understanding of architecture of microprocessor-based systems; study of microprocessor operation, assembly language, arithmetic operations, and interfacing
Number of Units for Laboratory	1 unit

Number of Contact Hours per Week	3 hours per week
Prerequisites	Logic Circuits and Design
Co-requisites	Microprocessors
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Laboratory Experiments	Laboratory exercises to be identified by the program. Each major topic should have a corresponding laboratory exercise. For semestral program, 15 exercises per semester. For trimestral program, 12 exercises per trimester. For quarterm program, 9 exercises per quarter.
Laboratory Equipment	Computer and assembly language programming software tool Depending on the class size 1 computer per student

Course Name	**Methods of Research**
Course Description	This course will provide in-depth understanding of research through exploration of different research methodologies and ethics. It includes qualitative and quantitative research, descriptive and other applicable research methodologies, inferential statistics and introduction to data mining.
Number of Units for Lecture	2 units
Number of Contact Hours per Week	2 hours per week
Prerequisites	Engineering Data Analysis Purposive Communication Logic Circuits and Design
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Academic Honesty/Plagiarism 2. Types of Research 3. Problem Identification 4. Literature Search and Review 5. Quantitative and Qualitative Methods 6. Data Sampling, Collection, and Testing 7. Data Analysis and Interpretation 8. Validity, Reliability, and Sources of Error 9. Citation and Style Mechanics (E.G., APA) 10. Article Writing (E.G., IEEE, ACM) 11. Presentation and Publication

Course Name	CpE Laws and Professional Practice
Course Description	This course provides the importance of the professional and ethical responsibilities of practicing computer engineers and the effects of their work on society; the importance of understanding contemporary issues, lifelong learning strategies; and applicable IT laws in the field of computer engineering.
Number of Units for Lecture	2 units
Number of Contact Hours per Week	2 hours per week
Prerequisites	3rd Year Standing
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Philippine IT Laws and Policies a. E-Commerce Law (RA 8792) b. Intellectual Property Code of the Philippines (RA 8293) c. Optical Media Act Of 2003 (RA 9239) d. Data Privacy Act Of 2012 (RA 10173) e. Department of Information and Communications Technology Act of 2015 (RA 10844) f. Cybercrime Prevention Act of 2012 (RA 10175) 2. Philosophical Frameworks and Cultural Issues 3. Engineering Solutions and Societal Effects 4. Professional and Ethical Responsibilities 5. Contemporary Issues 6. Lifelong Learning Strategies 7. Business and Management Issues 8. Tradeoffs in Professional Practice

Course Name	Embedded Systems
Course Description	This course provides advanced topics in embedded systems design using contemporary practice; interrupt-driven, reactive, real-time, object- oriented, and distributed client/server embedded systems.
Number of Units for Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	Microprocessors
Co-requisites	Embedded Systems Laboratory

Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. History and Overview 1. Relevant Tools, Standards, and/or Engineering Constraints 2. Characteristics of Embedded Systems 3. Basic Software Techniques for Embedded Applications 4. Parallel Input and Output 5. Asynchronous and Synchronous Serial Communication 6. Periodic Interrupts, Waveform Generation, Time Measurement 7. Data Acquisition, Control, Sensors, and Actuators 8. Implementation Strategies for Complex Embedded Systems 9. Techniques for Low-Power Operation 10. Mobile and Networked Embedded Systems 11. Advanced Topics on Input/Output 12. Computing Platforms for Embedded Systems

Course Name	**Embedded Systems Laboratory**
Course Description	This course will provide hands-on activities designed to advanced topics in embedded systems design using contemporary practice; interrupt-driven, reactive, real-time, object- oriented, and distributed client/server embedded systems.
Number of Units for Laboratory	1 unit
Number of Contact Hours per Week	3 hours per week
Prerequisites	Microprocessors
Co-requisites	Embedded Systems
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Laboratory Experiments	Laboratory exercises to be identified by the program. Each major topic should have a corresponding laboratory exercise. For semestral program, 15 exercises per semester. For trimestral program, 12 exercises per trimester. For quarterm program, 9 exercises per quarter.
Laboratory Equipment	Program shall provide complete tools and equipment necessary to perform the identified laboratory exercise. 1 set of tools and equipment per maximum of 5 students per group.

Course Name	**Computer Architecture and Organization**
Course Description	This course includes the study of the evolution of computer architecture and the factors influencing the design of hardware and software elements of computer systems. The focus is on the understanding of the design issues specifically the instruction set architecture and hardware architecture.
Number of Units for Lecture	3 units lecture
Number of Contact Hours per Week	3 hours per week
Prerequisites	Microprocessors
Co-requisites	Computer Architecture and Organization Laboratory
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. History and Overview of Computer Architecture 2. Relevant Tools, Standards and/or Engineering Constraints 3. Instruction Set Architecture 4. Measuring Performance 5. Computer Arithmetic 6. Processor Organization 7. Memory System Organization and Architectures 8. Input/Output Interfacing and Communication 9. Peripheral Subsystems 10. Multi/Many-Core Architectures 11. Distributed System Architectures

Course Name	**Computer Architecture and Organization Laboratory**
Course Description	This course will provide hands-on activities designed to focus on the computer hardware issues specifically the instruction set architecture and hardware architecture.
Number of Units for Laboratory	1 unit laboratory
Number of Contact Hours per Week	3 hours per week
Prerequisites	Microprocessors
Co-requisites	Computer Architecture and Organization
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.

Laboratory Experiments	Laboratory exercises to be identified by the program. Each major topic should have a corresponding laboratory exercise. For semestral program, 15 exercises per semester. For trimestral program, 12 exercises per trimester. For quarterm program, 9 exercises per quarter.
Laboratory Equipment	Program shall provide complete tools and equipment necessary to perform the identified laboratory exercise. 1 set of tools and equipment per maximum of 5 students per group.

Course Name	**Emerging Technologies in CpE**
Course Description	This course is designed to provide flexibility in the curriculum by discussing any emerging technologies applicable to computer engineering.
Number of Units for Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	4th Year Standing
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	Depending on the topic chosen by the institution.

Course Name	**Seminars and Fieldtrips**
Course Description	The course includes seminars and lecturers on current trends and issues on Computer Engineering developments. Include field trips to different companies and plants dealing with computer system facilities.
Number of Units for Laboratory	1 unit
Number of Contact Hours per Week	3 hours per week
Prerequisites	4th Year Standing
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Seminars 1.1 Technical Seminars (Minimum of 3) 1.2 Non-Technical Seminars

	1.2.1 Career Development 1.2.2 Labor Education 2. Fieldtrips (Minimum of 2 Company Visits) 3. Submission of Student Portfolio

Course Name	**Digital Signal Processing**
Course Description	The course includes the need for and tradeoffs made when sampling and quantizing a signal; linear, time-invariant system properties; frequency as an analysis domain complementary to time; and filter design.
Number of Units for Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Prerequisites	Feedback and Control Systems
Co-requisites	Digital Signal Processing Laboratory
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. History and Overview 2. Relevant Tools, Standards, and/or Engineering Constraints 3. Convolution 4. Transform Analysis 5. Frequency Response 6. Sampling and Aliasing 7. Digital Spectra and Discrete Transforms 8. Finite and Infinite Impulse Response Filter Design 9. Window Functions 10. Multimedia Processing

Course Name	**Digital Signal Processing Laboratory**
Course Description	This course is designed to provide hands-on activities on different applications of digital signals processing.
Number of Units for Laboratory	1 unit
Number of Contact Hours per Week	3 hours
Prerequisites	Feedback and Control Systems
Co-requisites	Digital Signal Processing
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.

Laboratory Experiments	Laboratory exercises to be identified by the program. Each major topic should have a corresponding laboratory exercise. For semestral program, 15 exercises per semester. For trimestral program, 12 exercises per trimester. For quarterm program, 9 exercises per quarter.
Laboratory Equipment	Computer and DSP software tool Depending on the class size 1 computer per student

Course Name	**CpE Practice and Design 1**
Course Description	This course is the first course in a two-semester sequence that constitutes the design experience for undergraduate computer engineers. It provides essential ideas, concepts and principles in engineering design process and emphasizes other design issues including engineering standards and multiple constraints as well as effective communication strategies. Students work in teams to develop project proposals for assigned open-ended problems. Students are required to make oral presentations and submit written proposal for their projects.
Number of Units for Laboratory	1 unit
Number of Contact Hours per Week	3 hours per week
Prerequisites	Microprocessors Methods of Research
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Orientation 2. Relevant Tools, Standards, and/or Engineering Constraints 3. Effective Communication Strategies 4. Intellectual Property and Legal Issues 5. Submission of Design Proposal 6. Presentation of Design Proposal 7. Submission of Approved Proposal
Laboratory Equipment	Computer and any programming language and/or simulation software tool; materials, components and tools needed for prototype development and testing.

Course Name	**CpE Practice and Design 2**
Course Description	This course is the second of the design experience for undergraduate computer engineering students. In this course, students will be expected to build/fabricate their design, test and evaluate the design against their design specifications, and demonstrate a fully functional project to their design review committee. Students make oral presentations and submit final reports documenting their projects.
Number of Units for Laboratory	2 units

Number of Contact Hours per Week	6 hours per week
Prerequisites	CpE Practice and Design 1
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Orientation 2. Final oral presentation 3. Submission of final document
Laboratory Equipment	Computer and any programming language and/or simulation software tool; materials, components and tools needed for prototype development and testing.

Course Name	**On the Job Training**
Course Description	This course enables students to relate their acquired competencies to the realities and problems of industries in a multidisciplinary environment. This may include involvement in the industry's manpower requirements, development and research concerns, trainings, applications of principles, environmental concerns, ethical and behavioral concerns, decision making, and equipment and materials concerns.
Number of Units for Lecture	3 units
Number of Contact Hours per Week	3 hours per week
Minimum Number of Hours Required for Field Work	240 hours of field work
Prerequisites	4th Year Standing
Program Outcomes	To be identified by the program.
Course Outcomes	To be identified by the program.
Course Outline	1. Orientation and Presentation of Policies and Guidelines 2. Multidisciplinary Team Approaches 3. Assertion of Student's OJT on the Company 4. Completion of 240 Hours 5. Submission of Progress Reports 6. Final Oral Presentation 7. Submission of Final Report

ANNEX IV-I – LABORATORY REQUIREMENTS (CHEMISTRY AND PHYSICS)
Bachelor of Science in Computer Engineering

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NATURAL/PHYSICAL SCIENCES

Chemistry for Engineers Laboratory

Required Tools/Equipment	Required Quantity
Activated charcoal	5 g
Al strips	5 pieces
Alcohol	30 mL
Alligator clip	10 pieces
Alligator clip	10 pieces
Battery	5 pieces
Beaker	5 pieces
Burner	5 pieces
Conductivity apparatus	1 set-up
Cu strips	10 pieces
$CuSO_4$ solution	25 mL
Distillation apparatus	1 set-up
Electrolyte solution	25 mL
Evaporating dish	5 pieces
Fe $(NO_3)_3$ solution	25 mL
$FeCl_3$ solution	25 mL
Filter stand	5 pieces
Food color	5 g
Glass funnel	5 pieces
Glass tubing	5 pieces
Graduated cylinder	5 pieces
HCl solution	80 mL
Hexane	25 mL
I_2 crystals	8 g
KCl solution	25 mL
$KClO_3$ solid	3 g
$KMnO_4$ solution	25 mL
KSCN solution	25 mL
Mg strips	10 pieces
NaCl	5 g
NaCl solution	50 mL
NaOH solution	25 mL
NH_4OH solution	5 mL
Oil	5 mL
Pb $(NO_3)_2$ solution	50 mL
Pb strips	5 pieces
Petri dish	5 pieces
pH paper	20 pieces
Sand bag	5 pieces
Staple wire	50 pieces
Sugar	5 g
Sugar solution	25 mL
Syringe	5 pieces
Test tube	50 pieces

Thermometer	5 pieces
Triple beam balance	5 pieces
Urea	5 g
Zn $(NO_3)_2$ solution	25 mL
Zn strips	15 pieces

- Maximum of 5 students per group and minimum required quantity is based on class size of 25 students.

Physics for Engineers Laboratory

Required Tools/Equipment	Required Quantity
Atwood's machine	5 pieces
Bar magnets	10 pieces
Beaker	5 pieces
Beam balance	5 pieces
Blackwood ballistic pendulum	5 pieces
Bridging plugs/connecting wires	5 sets
Calorimeter	5 pieces
Centripetal force apparatus	5 pieces
Clamp	5 pieces
Coil	5 pieces
Compass	5 pieces
Component holder	15 pieces
concave lens	5 pieces
Connecting wires	5 sets
Convex lens	5 pieces
Crossed arrow target	5 pieces
Cylindrical lens	5 pieces
DC power supply	5 pieces
Demonstration balance	5 pieces
Dynamic cart	5 pieces
Electric calorimeter	5 pieces
Field mapper kit/mapping Apparatus	5 pieces
Fixed capacitor (330 microfarad)	5 pieces
Fixed resistors	15 pieces
Fluorescent lamp	2 sets
Force table Set	5 pieces
Frame for bar magnets	5 pieces
Free fall apparatus	5 pieces
Friction block with different surfaces	5 pieces
Friction board with pulley	5 pieces
Frictionless dynamic track	5 pieces
Galvanometer	5 pieces
Glass plate	5 pieces
Glass plate of size similar to friction board	5 pieces
Horseshoe magnets	5 pieces
Hydrometer jar	5 pieces
Inclined plane	5 pieces
Inverted U-tube	5 pieces

Light source	5 pieces
Light source, sodium/mercury lamps	5 pieces
Linear air track with blower and trolley	5 pieces
Mass with hook	5 pieces
Masses	5 sets
Mechanical equivalent of heat apparatus	5 pieces
Metal ball	5 pieces
Metal balls of different sizes	12 pieces
Metal conductor with insulated handle	2 sets
Metal stand	5 pieces
Meter stick	5 pieces
Micrometer caliper	5 pieces
Natural magnets	5 pieces
Ohmmeter/VOM	5 pieces
Optics bench	5 pieces
Panel board/circuit board	5 pieces
Parallel ray lens	5 pieces
Platform/triple beam balance	5 pieces
Potentiometer	5 pieces
Ramp/launcher	5 pieces
Ray optics mirror	5 pieces
Ray table and base	5 pieces
Reversing switch	5 pieces
Rheostat	5 pieces
Ring	5 pieces
Rubber hammer	5 pieces
Set of Weights	5 sets
slide wire/ wheatstone bridge	5 pieces
Slit mask	5 pieces
Slit plate	5 pieces
Slotted masses, 5-500g	5 sets
Solenoid	5 pieces
Sonometer	5 pieces
SPDT switch	5 pieces
Specimen for shot	5 sets
spherical mirror	5 pieces
Spring	5 pieces
SPST switch	5 pieces
Steam generator	5 pieces
Stirrer for shot	5 pieces
Stop watch	5 pieces
Stopwatch	5 pieces
Support rod	5 pieces
Switch	5 pieces
Thermal expansion apparatus	5 pieces
Thermometer	5 pieces
Timer/stopwatch	5 pieces
Tuning forks of three different frequencies	5 sets
U-tube	5 pieces

Van de Graff generator	2 sets
Vernier caliper	5 pieces
VOM or multitester	5 pieces
Weight holder	5 pieces

* Maximum of 5 students per group and minimum required quantity is based on class size of 25 students.

ANNEX IV-II – LABORATORY REQUIREMENTS (PROFESSIONAL COURSES)
Bachelor of Science in Computer Engineering

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BASIC ENGINEERING SCIENCES

Computer Aided Drafting

Required Tools/Equipment	Required Quantity
Complete set of computer system	1:1 ratio
Computer-aided design software	1:1 ratio

ALLIED COURSES

Fundamentals of Electrical Circuits

Required Tools/Equipment	Required Quantity Per Group	Minimum Required Quantity
Complete set of computer system	1	5
Open or commercial simulation tools in Fundamentals of Electrical Circuits	1	5
Circuits trainer	1	5
Analog DC ammeter (100 mA DC)	1	5
Analog DC voltmeter (20V DC)	1	5
Digital multimeter	1	5
Watt meter	1	5
Potentiometer	1	5
Strain transducer	1	5
Function generator	1	5
Oscilloscope	1	5
Variable power supply (0-20V DC and 0-5V AC)	1	5
Resistive load (e.g., 100Ω, 470Ω, 1KΩ)	1	5
Capacitive load (e.g., 2.2μF)	1	5
Inductive load (e.g., 100mH, 150mH)	1	5
Practical inductor (e.g., 100-200 mH)	1	5
Test bed	1	5
Purely resistive impedance (e.g., 3KΩ)	1	5
Balanced 3-phase source (e.g., $220V_{RMS}$ at 60Hz)	1	5

* Maximum of 5 students per group and minimum required quantity is based on class size of 25 students.

Fundamentals of Electronic Circuits

Required Tools/Equipment	Required Quantity Per Group	Minimum Required Quantity
Complete set of computer system	1	5
Open or commercial simulation tools in Fundamentals of Electronic Circuits	1	5

Required Tools/Equipment	Required Quantity Per Group	Minimum Required Quantity
Variable power supply (0-20V DC and 0-5V AC)	1	5
Analog DC ammeter (100 mA DC)	1	5
Analog DC voltmeter (20V DC)	1	5
Breadboard	1	5
Oscilloscope	1	5
Complete set of computer system	1	5
Function generator	1	5
Semiconductor devices circuit board	1	5
Transistor amplifier circuit board	1	5
FET fundamentals circuit board	1	5
Transistor power amplifier circuit board	1	5
Operational amplifier circuit board	1	5
Transistor feedback circuit board	1	5
Digital circuit training module	1	5

* Maximum of 5 students per group and minimum required quantity is based on class size of 25 students.

PROFESSIONAL COURSES

Programming Logic and Design

Required Tools/Equipment	Required Quantity
Complete set of computer system	1:1 ratio
Programming language environment	1:1 ratio

Object Oriented Programming

Required Tools/Equipment	Required Quantity
Complete set of computer system	1:1 ratio
Programming language environment	1:1 ratio

Data Structures and Algorithms

Required Tools/Equipment	Required Quantity
Complete set of computer system	1:1 ratio
Programming language environment	1:1 ratio

Software Design Laboratory

Required Tools/Equipment	Required Quantity
Complete set of computer system	1:1 ratio
Programming language environment	1:1 ratio
Computer-aided design software	1:1 ratio

Logic Circuits and Design Laboratory

Required Tools/Equipment	Required Quantity Per Group	Minimum Required Quantity
Complete set of computer system	1	5
Open or commercial simulation tools in Logic Circuits and Design	1	5
Power supply	1	5
Breadboard	1	5
Complete set of different logic gates	1	5
Logic probe	1	5
Oscilloscope	1	5

* Maximum of 5 students per group and minimum required quantity is based on class size of 25 students.

Introduction to HDL

Required Tools/Equipment	Required Quantity
Complete set of computer system	1:1 ratio
Programming language environment	1:1 ratio
Computer-aided design software	1:1 ratio

Computer Engineering Drafting and Design

Required Tools/Equipment	Required Quantity Per Group	Minimum Required Quantity
Complete set of computer system	1	5
Computer-aided design software	1	5
Open or commercial simulation tools in Computer Engineering Drafting and Design	1	5
Complete set of PCB etching tools	1	5

* Maximum of 5 students per group and minimum required quantity is based on class size of 25 students.

Computer Networks and Security Laboratory

Required Tools/Equipment	Required Quantity Per Group	Minimum Required Quantity
Complete set of computer system	1	5
Open or commercial simulation tools in Computer Networks and Security	1	5
Complete set of network cable fabrication tools	1	5
NIC	1	5
Network operating system	Depends on class size	Depends on class size
Switch/hub	Depends on class size	Depends on class size
Router	Depends on class size	Depends on class size

* Required quantity is based on a class size of 25 students.

Microprocessors Laboratory

Required Tools/Equipment	Required Quantity Per Group	Minimum Required Quantity
Complete set of computer system	1	5
Programming language environment	1	5
Open or commercial simulation tools in Microprocessors	1	5
Power supply	1	5
Breadboard	1	5
Microprocessor or microcontroller	1	5
I/O devices	1	5

* Maximum of 5 students per group and minimum required quantity is based on class size of 25 students.

Embedded Systems Laboratory

Required Tools/Equipment	Required Quantity Per Group	Minimum Required Quantity
Complete set of computer system	1	5
Programming language environment	1	5
Open or commercial simulation tools in Embedded Systems	1	5
Power supply	1	5
Breadboard	1	5
Microprocessor or microcontroller	1	5
I/O devices	1	5

* Maximum of 5 students per group and minimum required quantity is based on class size of 25 students.

Computer Architecture and Organization Laboratory

Required Tools/Equipment	Required Quantity Per Group	Minimum Required Quantity
Complete set of computer system	1	5
Open or commercial simulation tools in Computer Architecture and Organization	1	5
Power supply	1	5
Breadboard	1	5
Microprocessor or microcontroller	1	5
I/O devices	1	5
Memory devices	1	5

* Maximum of 5 students per group and minimum required quantity is based on class size of 25 students.

Digital Signal Processing Laboratory

Required Tools/Equipment	Required Quantity Per Group	Minimum Required Quantity
Complete set of computer system	1	5
Graphing software	1	5
Mathematical software	1	5
Open or commercial simulation tools in Digital Signal Processing	1	5

* Maximum of 5 students per group and minimum required quantity is based on class size of 25 students.