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

CHED MEMORANDUM ORDER
No. 101
Series of 2017

SUBJECT: POLICIES, STANDARDS AND GUIDELINES FOR THE BACHELOR OF SCIENCE IN ELECTRONICS ENGINEERING (BSECE) PROGRAM EFFECTIVE ACADEMIC YEAR (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 policies, standards and guidelines in the establishment of an outcomes-based education (OBE) system in higher education institutions offering engineering programs as advocated under CMO 37 s. 2012 and policy-standard to enhance quality assurance (QA) in Philippine higher education through an outcomes-based and typology-based QA as advocated under CMO 46 s. 2012, and by virtue of Commission en banc Resolution No. 788-2017 dated October 24, 2017 the following policies and standards are hereby adopted and promulgated by the Commission.

ARTICLE I
INTRODUCTION

Section 1. Rationale

This CMO integrates the establishment of an outcomes-based Based on the *Guidelines for the Implementation of CMO No. 46 series of 2012* and CMO 37 s. 2012, this PSG implements the shift to outcomes-based education (OBE) leading to competency-based standards. It specifies the "core competencies" expected of Bachelor of Science in Electronics Engineering (BSECE) graduates "regardless of the type of Higher Education Institutions (HEI) they graduate from." However, in recognition of outcomes-based education 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.

This CMO put emphasis on the incorporation of the specialized electives in consonance with the field of specializations of the Electronics Engineering profession stipulated in Republic Act 9292 also known as Electronics Engineering Law.

ARTICLE II
AUTHORITY TO OPERATE

Section 2. Government Recognition

All Private Higher Education Institutions (PHEIs) intending to offer BSECE program shall design their specializations and secure proper authority from the Commission in accordance with 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.

All PHEIs with an existing BSECE program are required to shift to an outcomes-based approach based on CMO 37, S. 2012 and guided by this PSG.

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. The Articles that follow provides minimum standards and other requirements and prescriptions. 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 9 as a **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 (Annex II) 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 also determined appropriate curriculum delivery methods shown in Article V Section 10. The sample course syllabi given in Article V Section 15 show some of these methods.

Based on the curriculum and the means of its delivery, the Commission through the Technical Panel determined the physical resource requirements for the library, laboratories and other facilities and the human resource requirements in terms of administration and faculty. See Article VI.

Section 4. The HEIs are allowed to design curricula suited to their own contexts, specializations 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 of Article VII.

This PSG is aligned with the new K-12 basic education system and the new General Education requirements, following the OBE system.

ARTICLE IV
PROGRAM SPECIFICATIONS

Section 5. Program Description

5.1 Definition

Electronics is the science dealing with the development and application of devices and systems involving the flow of electrons or other carriers of electric charge, in a vacuum, in gaseous media, in plasma, in semiconductors, in solid-state and/or in similar devices, including, but not limited to, applications involving optical, electromagnetic and other energy forms when transduced or converted into electronic signals. (RA 9292, 2004).

5.2 Degree Name

In consonance with the field of specializations of the Electronics Engineering Profession stipulated in Section 5, Article 1 of the Republic Act 9292 also known as Electronics Engineering Law, the degree program herein shall be called BACHELOR OF SCIENCE IN ELECTRONICS ENGINEERING (BSECE).

5.3 Nature and Scope of the practice of an ECE graduate

The scope and nature of practice of the Electronics Engineer shall embrace and consist of any work or activity relating to the application of engineering sciences and/or principles to the investigation, analysis, synthesis, planning, design, specification, research and development, provision, procurement, marketing and sales, manufacture and production, construction and installation, tests/measurements/control, operation, repair, servicing, technical support and maintenance of electronic components, devices, products, apparatus, instruments, equipment, systems, networks, operations and processes in the fields of electronics, including communications and/or telecommunications, information and communications technology (ICT), computers and their networking and hardware/firmware/software development and applications, broadcast/broadcasting, cable and wireless television, consumer and industrial electronics, electro optics/photonics/opto-electronics, electromagnetics, avionics, aerospace, navigational and military applications, medical electronics, robotics, cybernetics, biometrics and all other related and convergent fields; it also includes the administration, management, supervision and regulatory aspects of such works and activities; similarly included are those teaching and training activities which develop the ability to use electronic engineering fundamentals and related advanced knowledge in electronics engineering, including lecturing and teaching of technical and professional subjects given in the electronics engineering (RA9292, 2004).

5.4 Program Educational Objectives (PEOs)

Every engineering program shall define its program educational objectives consistent to the vision and mission statements of the HEI.

PEOs are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve within 3-5 years of graduation.

PEOs are based on the needs of the program's constituencies and these shall be determined, articulated, and disseminated to the general public, via HEI or department website and academic manuals, by the unit or department of the HEI offering the BSECE program.

The PEOs should be assessed and evaluated periodically for continuous quality improvement (CQI).

Example of a PEO:

The graduates of Bachelor of Science in Electronics Engineering will be engaged in the practice of electronics engineering (RA9292) with a deep sense of professionalism, environmental awareness, social and ethical responsibility.

5.5 Allied Programs

The allied programs of the BSECE program are the following:

a) Electrical Engineering
b) Computer Engineering

c) Computer Science
d) Information and Communications Technology
e) And other related and convergent fields or as defined in the specializations

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

Section 6. Institutional and Program Outcomes

The minimum standards for all Engineering programs are expressed in the following minimum set of institutional and program outcomes.

6.1 Institutional Outcomes

The minimum standards for the BS Electronics Engineering program are expressed in the following minimum set of institutional and BSECE 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 higher educational institutions must preserve and promote the Filipino historical and cultural heritage.

Graduates of State Universities and Colleges must, in addition, have the competencies to support "national, regional and local development plans." (RA 7722) while graduates of Private HEIs, at its option, may adopt mission-related program outcomes that are not included in the minimum set.

6.2 Program Outcomes

Program outcomes specify what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that the students acquire as they go through the program.

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

a) apply knowledge of mathematics and science to solve complex engineering problems

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

The program outcomes from a to m set the minimum requirements. HEIs/LUCs/SUCs may add additional outcomes when needed.

Section 7. Sample Performance Indicator

Performance criteria or performance indicators are "specific, measurable statements identifying the performance{s} required to meet the outcome, confirmable through evidence."

Annex VI provides an example of performance indicators from the list of program outcomes for electronics engineering graduates in the semiconductor industry derived from the PBEd-Stride workshop which can be used as reference by HEIs.

Table 1 gives sample performance indicators for Outcome (a) as defined on Section 6.

Table 1
Sample Performance Indicators of a Program Outcome

Program Outcomes		Performance Indicators	
a	Apply knowledge of mathematics and science to solve engineering problems	1	Ability to use calculus and differential equations in solving Electronics Engineering problems.
		2	Interpret mathematical/ scientific representations such as graphs, table etc. in solving Electronics Engineering problems.
		3	Use the concepts from physics in solving Electronics Engineering problems.

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 Assessment 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 the Tables below.

Table 2
Sample Matrix Linking Performance Indicators with Key Courses and Assessment Methods

Performance Indicators		Key Courses	Assessment Methods
1	Ability to use calculus and differential equations in solving Electronics Engineering problems.	Feedback and Control Systems	Locally developed exams
2	Interpret mathematical/ scientific representations such as graphs, table etc. in solving Electronics Engineering problems.	Electronics 1	Technical Report
3	Use the concepts from physics in solving Electronics Engineering problems.	Electromagnetics	Situational Case Study and Report

Table 3
Sample Matrix Linking Assessment Methods with Set Targets and Standards

Key Courses	Assessment Methods	Target and Standards*
Feedback and Control Systems	Locally developed exams	Students shall have a rating of at least "GOOD"
Electronics 1	Technical Report	Students shall have a rating of at least "GOOD"
Electromagnetics	Situational Case Study and Report	Students shall have a rating of at least "GOOD"

* Note: Targets and Standards may be expressed in numerical form (e.g. 70% of the students shall have a rating of at least 80%)

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 Electronics Engineering curriculum is designed to meet the BSECE Program Outcomes stated in Article IV, Section 6.2. This is articulated in a Curriculum Map discussed in Section 12. The curriculum must develop engineers who have a background in mathematics, natural, physical and allied sciences. As such the curriculum contains courses in mathematics, physics, chemistry, materials and environmental sciences. The Electronics Engineering curriculum also contains mandated general education and elective courses as connected to the desired program outcomes. This is to ensure that the Electronics engineering graduates can apply and articulate the nature of their special roles in society and the impact of their work on the environment. The curriculum is designed to guarantee a certain breadth of knowledge of the Electronics Engineering disciplines through a set of core courses. To ensure depth and focus to a certain field of Electronics Engineering discipline, a completion of at least one specialized field with elective courses is required. The list of specialized fields with the required minimum elective courses per field is included in this CMO. The choices and offering of such specialized fields should be designed based on the capability and available resources of the HEI and shall comply with the suggested minimum required elective courses. A minimum of 240 hours of immersion in electronics engineering activities outside the institution; design and a capstone project in electronics engineering design are the final requirements of the curriculum. Curriculum shall have major learning experiences like OJT or local/ international immersion experience, research, conferences, leadership seminars, etc.

Section 11. Minimum Curriculum

11.1 Components:

Below are the minimum curricular requirements for the BSECE 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 Number of Hours /week		Minimum Credit Units
	Lecture	Laboratory	
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
Sub - Total	**12**	**0**	**12**
B. Natural/ Physical Sciences			
Chemistry for Engineers	3	3	4
Physics for Engineers	3	3	4
Sub - Total	**6**	**6**	**8**
C. Basic Engineering Sciences			
Computer-Aided Drafting	0	3	1
Engineering Economics	3	0	3
Engineering Management	2	0	2
Technopreneurship 101	3	0	3
Sub - Total	**8**	**3**	**9**
D. Allied Courses			
Physics 2	3	3	4
Materials Science and Engineering	3	0	3
Computer Programming	0	6	2
Circuits 1	3	3	4
Circuits 2	3	3	4
Environmental Science and Engineering	3	0	3
Sub - Total	**15**	**15**	**20**

E. Professional Core Courses			
Advanced Engineering Mathematics for ECE	3	3	4
Electromagnetics	4	0	4
ECE Laws, Contracts, Ethics, Standards & Safety	3	0	3
Electronics 1: Electronic Devices and Circuits	3	3	4
Electronics 2: Electronic Circuit Analysis and Design	3	3	4
Electronics 3: Electronic Systems and Design	3	3	4
Signals, Spectra, Signal Processing	3	3	4
Communications 1: Principles of Communication Systems	3	3	4
Communications 2: Modulation and Coding Techniques	3	3	4
Communications 3: Data Communications	3	3	4
Communications 4: Transmission Media, Antenna System and Design	3	3	4
Digital Electronics 1: Logic Circuits and Switching Theory	3	3	4
Digital Electronics 2: Microprocessor & Microcontroller Systems and Design	3	3	4
Feedback and Control Systems	3	3	4
Methods of Research	3	0	3
Design 1 /Capstone Project 1	0	3	1
Design 2 /Capstone Project 2	0	3	1
Seminars/ Colloquium	0	3	1
Sub-total	**46**	**45**	**61**

F. Technical Electives			
ECE Elective 1	3	3	4
ECE Elective 2	3	3	4
Sub-total	**6**	**6**	**8**
G. On the Job Training (240 hours)**	3	0	3
Sub-total	**3**	**0**	**3**
Total (Technical Courses)	**96**	**75**	**121**

Classification/ Field / Course	**Minimum Number of Hours /week**		**Minimum Credit Units**
	Lecture	**Laboratory**	
II. NON - TECHNICAL COURSES			
A. General Education Courses (GEC) – Please refer to CMO No. 20, s. 2013			
Science, Technology and Society	3	0	3
The Contemporary World	3	0	3
Readings in Philippine History	3	0	3
Understanding the Self	3	0	3
Art Appreciation	3	0	3
Purposive Communication	3	0	3
Mathematics in the Modern World	3	0	3
Ethics	3	0	3
Sub-total	**24**	**0**	**24**
B. 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
Sub-total	**12**	**0**	**12**
C. Physical Education			
P.E. 1, 2, 3,4	8	0	8
Sub-total	**8**	**0**	**8**

D. National Service Training Program			
NSTP 1 & 2	6	0	6
Sub-total	**6**	**0**	**6**
Total (Non-Technical Courses)	**50**	**0**	**50**
GRAND TOTAL	**146**	**75**	**171**

*On the job training (240 hours) – HEIs shall establish appropriate guidelines for OJT which shall fully comply with the competency requirements of the ECE program.

Specialized Fields with Minimum Required Elective Courses

Technical Elective Courses are categorized into several specialized fields. Specialized Fields with prescribed minimum elective courses per field are listed below. HEIs may select one or more specializations from the suggested specialized fields based on their capability and available resources. The technical elective courses per field prescribed in this CMO are minimum, HEIs may also opt to enhance the selected fields by adding technical courses as deemed appropriate. A completion of at least one specialized field is a requirement for the BSECE Program.

A. TELECOMMUNICATIONS

Course No.	Descriptive Title	lec	lab	Units	Pre-requisites
ECE Elective 1	Advanced Communication System & Design (wireless)	3	3	4	Communication 4
ECE Elective 2	Advanced Networking	3	3	4	Communication 4
Sub total		6	6	8	

B. MICROELECTRONICS

Course No.	Descriptive Title	lec	lab	Units	Pre-requisites
ECE Elective 1	Analog IC Design	3	3	4	Electronics 3
ECE Elective 2	Digital IC Design	3	3	4	Electronics 3
Sub total		6	6	8	

C. POWER ELECTRONICS

Course No.	Descriptive Title	lec	lab	Units	Pre-requisites
ECE Elective 1	Advanced Power Supply Systems	3	3	4	Electronics 2
ECE Elective 2	Renewable Energy Systems	3	3	4	Circuits 2
	Sub total	6	6	8	

D. BIOTECH/BIOMEDICAL ELECTRONICS

Course No.	Descriptive Title	lec	lab	Units	Pre-requisites
ECE Elective 1	Fundamentals of Biomedical Engineering	3	3	4	Physics 2
ECE Elective 2	Medical Imaging	3	3	4	Physics 2
	Sub total	6	6	8	

E. INSTRUMENTATION AND CONTROL

Course No.	Descriptive Title	lec	lab	Units	Pre-requisites
ECE Elective 1	Advanced Instrumentation & Control Systems	3	3	4	Feedback and Control Systems
ECE Elective 2	Robotics Technology	3	3	4	Electronics 3
	Sub total	6	6	8	

F. BUILDING INFORMATION AND COMMUNICATIONS TECHNOLOGY INFRASTRUCTURE

Course No.	Descriptive Title	lec	lab	Units	Pre-requisites
ECE Elective 1	ICT Infrastructure	3	3	4	
ECE Elective 2	Electronics Ancillary System	3	3	4	Electronics 3
	Sub total	6	6	8	

G. COMPUTER

Course No.	Descriptive Title	lec	lab	Units	Pre-requisites
ECE Elective 1	Computer Systems Architecture	3	3	4	Computer Prog
ECE Elective 2	Operating Systems & Advanced Programming Languages	3	3	4	Computer Prog
	Sub total	6	6	8	

H. BROADCASTING

Course No.	Descriptive Title	lec	lab	Units	Pre-requisites
ECE Elective 1	Broadcast production Engineering	3	3	4	Communications 4
ECE Elective 2	Broadcast Transmission & Distribution	3	3	4	Broadcast Prod Eng'g
	Sub total	6	6	8	

I. EMERGING TECHNOLOGIES*

**Specifications for these courses shall be developed by the HEIs in accordance with their needs but shall likewise be submitted to CHED.*

SUMMARY OF THE BSECE CURRICULUM

Classification/ Field	Minimum No. of Hours		Total No. of Units
	Lecture	Laboratory	
I. TECHNICAL COURSES			
A. Mathematics	12	0	12
B. Natural/Physical Sciences	6	6	8
C. Basic Engineering Sciences	8	3	9
D. Allied Courses	15	15	20
E. Professional Core Courses	46	45	61
F. Technical Electives	6	6	8
G. On-the-Job Training (240 hours)	3	0	3
Sub- Total	**96**	**75**	**121**
II. NON- TECHNICAL COURSES			
A. General Education (Courses (please refer to CMO 20, s. 2013)	24	0	24
B. GEC Elective/Mandated Courses	12	0	12
C. Physical Education			8
D. National Service Training Program			6
Sub-Total	**36**	**0**	**50**
GRAND TOTAL			**171**

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 minimum 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.

SAMPLE SEMESTRAL PROGRAM OF STUDY

FIRST YEAR

1st Year – First Semester

Courses	No. of Hours		Units	Pre-requisites
	lec	lab		
Calculus 1	3	0	3	
Engineering Data Analysis	3	0	3	
Chemistry for Engineers	3	3	4	
Mathematics in the Modern World	3	0	3	
Computer-Aided Drafting	0	3	1	
Understanding the Self	3	0	3	
P.E. 1	0	2	2	
NSTP1	0	3	3	
Total	**15**	**14**	**22**	

1st Year – Second Semester

Courses	No. of Hours		Units	Pre-requisites
	lec	lab		
Calculus 2	3	0	3	Calculus 1
Physics for Engineers	3	3	4	Calculus 1
Materials Science and Engineering	3	0	3	Chemistry
Computer Programming	0	6	2	
Science, Technology and Society	3	0	3	

Physics 2	3	3	4	Co-req Physics for Engineers
P.E. 2	0	2	2	PE 1
NSTP2	0	3	3	NSTP 1
Total	**15**	**17**	**24**	

SECOND YEAR

2nd Year – First Semester

Courses	No. of Hours		Units	Pre-requisites
	lec	lab		
Differential Equations	3	0	3	Calculus 2
Circuits 1	3	3	4	Physics 2
Electronics 1: Electronic Devices and Circuits	3	3	4	Co-req Circuits 1
ECE Laws, Contracts, Ethics, Standards & Safety	3	0	3	
Purposive Communication	3	0	3	
Engineering Economics	3	0	3	
P.E. 3	0	2	2	
Total	**18**	**8**	**22**	

2nd Year – Second Semester

Courses	No. of Hours		Units	Pre-requisites
	lec	lab		
Advanced Engineering Mathematics for ECE	3	3	4	Differential Equations
Circuits 2	3	3	4	Circuits 1
Electronics 2: Electronic Circuit Analysis and Design	3	3	4	Electronics 1
Communications 1: Principles of Communication Systems	3	3	4	Co-req Electronics 2
Electromagnetics	4	0	4	Differential Equations
Engineering Management	2	0	2	
P.E. 4	0	2	2	
Total	**18**	**14**	**24**	

THIRD YEAR

3rd Year – First Semester

Courses	No. of Hours		Units	Pre-requisites
	lec	lab		
Ethics	3	0	3	
Digital Electronics 1: Logic Circuits and Switching Theory	3	0	4	Electronics 1
Electronics 3: Electronic Systems and Design	3	3	4	Electronics 2
Signals, Spectra, Signal Processing	3	3	4	Advanced Engineering Math
Communications 2: Modulation and Coding Techniques	3	3	4	Communications 1
GEC Elective 1	3	0	3	
Total	**18**	**9**	**22**	

3rd Year – Second Semester

Courses	No. of Hours		Units	Pre-requisites
	lec	lab		
Technopreneurship 101	3	0	3	
GEC Elective 2	3	0	3	
Communications 3: Transmission Media and Antenna System & Design	3	3	4	Communications 2
Communications 4: Data Communications	3	3	4	Communications 2
Digital Electronics 2: Microprocessor, Microcontroller Systems & Design	3	3	4	Digital Electronics 1
Feedback and Control Systems	3	3	4	Advanced Engineering Math
Total	**18**	**12**	**22**	

SUMMER

On the Job Training – 3 units

FOURTH YEAR

4th Year – First Semester

Courses	No. of Hours		Units	Pre-requisites
	lec	lab		
Methods of Research	3	0	3	n^{th} year standing*
Design 1 /Capstone Project 1	0	3	1	n^{th} year standing*
ECE Elective 1	3	3	4	
Environmental Science and Engineering	3	0	3	
Art Appreciation	3	0	3	
Life and Works of Rizal	3	0	3	
Total	15	6	17	

4th Year – Second Semester

Courses	No. of Hours		Units	Pre-requisites
	lec	lab		
Seminars/ Colloquium	0	3	1	n^{th} year standing*
Design 2 /Capstone Project 2	0	3	1	Design 1 /Capstone Project 1
The Contemporary World	3	0	3	
Readings in Philippine History	3	0	3	
GEC Elective 3	3	0	3	
ECE Elective 2	3	3	4	
ECE Elective**	0	0	0	
Total	12	9	15	

GRAND TOTAL = 171

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

** HEIs may add more ECE Electives based on the designed Specializations.

Section 12. Sample Curriculum Map

Curriculum map is "a matrix relating all the courses listed in the program curriculum with one or more of the declared student/program outcomes."

The HEI/LUC/SUC may develop their own Curriculum Map. (Refer to **Annex II** for the Minimum Program Outcomes and a Sample 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. The four power principles of OBE are (1) clarity of focus (2) Expanded Opportunity (3) High Expectation and (4) Design Down.

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. Curriculum Delivery

All HEIs are expected to create their Curriculum Delivery Plan. The purpose of the plan is to give clear guidance on the school's curriculum, and to give a statement of expectations that will form the basis for reviewing quality and effectiveness.

Section 15. Course Syllabus and Course Specifications:

The Course Syllabus must contain at least the following components:

15.1. General Course Information (Title, Description, Code, Credit Units, Prerequisites)
15.2 Links to Program Outcomes
15.3 Course Outcomes
15.4 Course Outline (Including Unit Outcomes)
15.5 Teaching and Learning Activities
15.6 Assessment Methods
15.7 Final Grade Evaluation
15.8 Learning Resources
15.9 Course Policies and Standards
15.10 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 Electronics Engineering program.

All other requirements on Administration, Library and Laboratory facilities, and buildings for BS Engineering Program are contained in CMO No.86, s. 2017, Policies, Standards and Guidelines for Requirements Common to all BS Engineering Programs issued by the Commission.

Section 16. Administration

The qualifications of the Program Head/ Chair/ Director of the BSECE program shall be:

a) holder of baccalaureate degree in ECE;
b) holder of master's degree in electronics engineering, engineering education, management engineering, mathematics, sciences or allied related fields as defined in this CMO
c) should have a minimum teaching experience of not less than three (3) years or preferably at least three (3) years industry experience relevant to BS Electronics Engineering program.
d) registered engineer with valid PRC license, (Preferably PECE)

All administrators shall provide leadership in the following:

a) curriculum development and coordination of curricular offerings, textbook adoption, evaluation procedures, methodologies of instruction, departmental activities and professional development for school personnel;
b) recruitment, placement and promotion of faculty members and other administrative staff in the school/college of engineering;
c) budgeting, allocation and requisitions.

Section 17. Faculty

There must be adequate number of competent and qualified faculty to teach all of the curricular areas of the Electronics Engineering program and appropriate student-faculty ratio to effectively implement dynamic minimum program requirements set by CHED.

All faculty members teaching professional courses in BS Electronics Engineering program must have the following qualifications:

1. Holder of BS Electronics Engineering degree
2. Registered Electronics Engineer with valid PRC license

In addition, by AY 2018-2019, all full-time faculty members teaching professional courses in BS Electronics Engineering must be holder of Master's and preferably Doctoral degree in Electronics Engineering or allied fields as defined in this CMO.

All faculty members teaching technical elective courses in BS Electronics Engineering program must be a holder of BS Electronics Engineering with specialization aligned to the technical elective or equivalent industry experience.

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 the courses being taught and research specializations.

Faculty members teaching Electronics Engineering Design and other professional courses in Electronics Engineering must preferably have relevant industry training or experience.

Section 18. Laboratory and Physical Facilities

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 BS in Electronics Engineering Program

The program shall provide laboratory facilities for the following professional courses:

1. Chemistry for Engineers
2. Physics for Engineers
3. Physics 2
4. Circuits 1
5. Circuits 2
6. Electronics 1
7. Electronics 2
8. Electronics 3
9. Communications 1
10. Communications 2
11. Communications 3
12. Communications 4
13. Logic Circuits and Switching Theory
14. Microprocessor & Microcontroller Systems
15. Feedback and Control Systems
16. ECE Electives

The program must provide computing laboratories for the following courses:

1. Computer-Aided Design
2. Computer Programming
3. Advanced Engineering Mathematics
4. Signals, Spectra and Signal Processing

The program shall provide adequate computing facilities for courses in Computer Fundamentals and Programming, Computer-Aided Drafting, and open computer laboratory.

Refer to **Annex IV** for the laboratory equipment and resources required for the program.

18.2 Laboratories for the BS Electronics Engineering Program

There shall be at least one full-time laboratory technician (preferably licensed ECT) or assistant for maintenance and distribution of apparatus and equipment in electronics engineering.

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 Electronics 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 Electronics Engineering programs a Monitoring Workbook (CMO 37-MW-2017-HEI-BSEC) and Self-Assessment Rubric (SAR) (CMO-37-HEI-SAR-2017-BSECE). The current five-year BSECE 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 BSECE 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 BSECE programs with low SAR total scores may be asked to submit a one- or two-year development plan to CHED before they shall be allowed to apply to continue their BSECE program for AY 2018-2019.

19.3 Exemptions

HEIs with BSECE 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-BSECE). 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 BSECE program for AY 2018-2019 shall be made to complete a new Application Workbook (AW-2018-HEI-BSECE) 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 BSECE programs with COE or COD status submitting their completed Application Workbooks shall automatically receive Certificates of Compliance 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 BSECE 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 BSECE 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 higher education institutions (HEIs), state universities and colleges (SUCs), and local universities and colleges (LUCs) with existing authorization to operate the Bachelor of Science in Electronics 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
- Annex II – Minimum Program Outcomes and Sample Curriculum Map
- Annex III – Sample Course Specifications
- Annex IV – Laboratory Requirements
- Annex V – Sample Course Syllabus

Electronics Engineer (***noun***) – is a professional who conceptualizes, develops, designs, improves and applies safe, healthy, ethical and economic ways in the field of electronics for the benefit of society and environment through the knowledge of mathematics, physical sciences, basic engineering sciences, information technology, electronics engineering and other natural, applied and social sciences, gained by study, research and practice.

ANNEX I - COMPETENCY STANDARDS
ATTRIBUTES AND COMPETENCIES OF AN ELECTRONICS ENGINEER

	ATTRIBUTES	COMPETENCY LEVEL: NEW GRADUATE	COMPETENCY LEVEL: 1 - 7 YEARS ENGG. EXPERIENCE	COMPETENCY LEVEL: GLOBALLY QUALIFIED ENGINEER (APEC/ASEAN)
1	Apply knowledge of mathematics, physical sciences, Information Technology, and engineering principles	Understand the principles of mathematics, physical sciences, engineering principles including information technology. Determine relevant and appropriate applied science, engineering principles and techniques that can be used to address engineering concerns related to electronics design and operations.	Use relevant and appropriate applied science, engineering principles and techniques in formulating process design and operations improvement. Develop simple computer programs to solve electronics 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 electronics engineering problems.
2	Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	Use relevant information gathered from research literature and other available technological information sources in coming out with solutions to complex engineering problems.	Apply results research literature and other technological advances in design and operations improvement. Propose changes to achieve the desired outputs.	Consolidate results of research and technical information in formulating solutions to electronics engineering processes and adapt these into systems to achieve targets. Impart these technological advances to peers.
3	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health	Study, investigate and gather data related to complex engineering problems and propose solutions based on the fundamentals of engineering principles while incorporating	Study, investigate and gather data related to problems and prepare proposals to implement solutions while incorporating ethics, safety and environmental considerations.	Consolidate studies made and propose changes. Specialize in specific fields of practice in the Electronics Engineering Professional and use the technical expertise in

	and safety, cultural, societal, and environmental considerations.	ethics, safety and environmental considerations.	Conduct test runs and prepare final recommendations based on results gathered.	design of solutions to applicable complex engineering problems. Prepare project proposals, budget and reports related to improvements. 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. Conduct lab scale and plant scale trials as may be deemed necessary to validate conclusions. Prepare reports and make presentations to concerned entities on the proposed solutions to the complex engineering problems.	Organize teams of experts, plan and design experiments in conducting investigations of complex engineering problems. Conduct lab scale and plant scale trials as may be deemed necessary to validate conclusions. Prepare feasibility, 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 practical applications and limitations of process parameters and equipment.	Be familiarized with applicable modern tools and techniques to solve electronics engineering problems taking into consideration its 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 Electronics 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 Electronics 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 Electronics 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 electronics 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 electronics engineering practice. Use gained experience in industrial professional practice to measure impacts on society and environment. Impart learning to peers.	Be familiar with relevant applicable technical and engineering standards that can be applied in professional electronics engineering practice. Use gained experience in industrial professional practice to measure impacts on society and environment. Do research, develop projects and prepare implementation plans to implement and assess professional engineering works in relation to complex engineering problems. Impart learning to peers.

8	Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.	Be familiar with the Philippine Code of Ethical Standards of Electronics Engineers and apply and behave according to this code in professional practice. Apply ethical principles in conjunction with engineering practice.	Be familiar with the Philippine Code of Ethical Standards of Electronics Engineers and apply and behave according to this code in professional practice. Be familiar with corporate and industrial policies. Apply ethical principles in conjunction with engineering practice incorporating public safety as a priority. Be an example to upcoming engineers in terms of integrity, morality and ethics.	Be familiar with the Philippine Code of Ethical Standards of Electronics 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	Prepare reports, presentations and other engineering documents in an organized way and relay information related to these effectively.	Prepare reports, presentations and other engineering documents in an organized way and relay information related to these effectively.	Consolidate reports and make presentations to peers and superiors on projects or on assigned endeavors.

	design documentation, make effective presentations, and give and receive clear instructions.	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 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.	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 electronics engineering.	Plan, lead, organize and control small to medium-sized projects or tasks as may be deemed necessary in the practice of electronics 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 electronics engineering. Manage financial aspects of the project. Manage supervisors and peers. Prepare reports related to projects.
12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	Attend trainings, seminars, conferences or participate in projects that encourage continued learning in the electronics engineering profession. Pursue graduate studies.	Attend trainings, seminars, conferences and participate in professional organizations that encourage continued learning in the electronics engineering profession Pursue graduate studies. Comply with CPD units required annually. Conduct research studies and impart results to peers.	Attend trainings, seminars, conferences and participate in professional organizations that encourage continued learning in the electronics engineering profession. Prepare modules for training peers, subordinates and students. Organize seminars, trainings or conferences. Publish research papers.

ANNEX II – MINIMUM PROGRAM OUTCOMES AND SAMPLE CURRICULUM MAP

BS ELECTRONICS ENGINEERING

Program outcomes specify what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that the students acquire as they go through the program.

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

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

The program outcomes from a to m set the minimum requirements. HEIs/LUCs/SUCs may add additional outcomes when needed.

SAMPLE CURRICULUM MAP

The sample curriculum maps below are for mathematics and science courses representing their connections to SOs/POs.

LEGEND

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

A. Mathematics

Course	Relationship to Program Outcomes												
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*
Calculus 1	I												
Calculus 2	E												
Engineering Data Analysis	I												
Differential Equations	E												

B. Natural/Physical Sciences

Course	Relationship to Program Outcomes												
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*
Chemistry for Engineers	I												
Physics for Engineers	I	I											

C. Basic Engineering Sciences

Course	Relationship to Program Outcomes												
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*
Computer-Aided Drafting											I		
Engineering Management												I	
Engineering Economics												I	

D. Allied Courses

Course	Relationship to Program Outcomes												
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*
Physics 2	E												
Materials Science and Engineering	I												
Computer Programming											I		
Circuits 1	E	E											
Circuits 2	E	E											
Technopreneurship												E	
Environmental Science and Engineering	E												

E. Professional Courses

Course	Relationship to Program Outcomes												
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*
Advanced Engineering Mathematics for ECE	E												
Electromagnetics	E				E								
ECE Laws, Contract, Ethics, Standards & Safety						E							
Electronics 1: Electronic Devices and Circuits	E	E			E				E				
Electronics 2: Electronic Circuit Analysis and Design		E			E				E				
Electronics 3: Electronic Systems and Design		E	E		E								
Signals, Spectra, Signal Processing		E			E								
Communications 1: Principles of Communication Systems		E			E								
Communications 2: Modulation and Coding Techniques		E			E								
Communications 3: Data Communications		E			E								
Communications 4: Transmission Media, Antenna System and Design		E			E								
Digital Electronics 1: Logic Circuits and Switching Theory		E			E								
Digital Electronics 2: Microprocessor & Microcontroller Systems and Design		E			E								
Feedback and Control Systems		E			E								
Methods of Research								E					
Design 1 / Capstone Project 1			D					D				D	
Design 2 / Capstone Project 2			D					D				D	
Seminars / Colloquium							D						

F. Technical Electives

Course	Relationship to Program Outcomes												
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*
ECE Elective													D
ECE Elective													D

G. On the Job Training

Course	Relationship to Program Outcomes												
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*
OJT (240 hours)				D					D				

ANNEX III

BS ELECTRONICS ENGINEERING

COURSE SPECIFICATIONS

A. 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 and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours per week
Prerequisites	None
Program Outcome/s	a-l
Course Outcomes	At the end of the course, the students must be able to: 1. Differentiate algebraic and transcendental functions 2. Apply the concept of differentiation in solving word problems 3. Analyze and trace transcendental curves
Course Outline	1. Functions 2. Continuity and Limits 3. The Derivative 4. The Slope 5. Rate of Change 6. The Chain Rule and the General Power Rule 7. Implicit Differentiation 8. Higher – Order derivatives 9. Polynomial curces 10. Applications of the Derivative 11. The Differential 12. Derivatives of Trigonometric Functions 13. Derivative of Inverse Trigonometric Functions 14. Derivative of Logarithmic and Exponential Functions 15. Derivative of the Hyperbolic Functions 16. Solutions of Equations 17. Transcendental Curve Tracing 18. Parametric Equations 19. Partial differentiation

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 and Laboratory	3 units lecture

Number of Contact Hours per Week	3 hours per week
Prerequisites	Calculus 1
Program Outcome/s	a-E
Course Outcomes	After completing this course, the student must be able to: 1. Apply integration to the evaluation of areas, volumes of revolution, force and work 2. Use integration techniques on single and multi-variable functions 3. Explain the physical interpretation of the double and triple integral
Course Outline	I. Integration Concepts/Formulas A. Anti-differentiation B. Indefinite Integrals C. Simple Power Formula D. Simple Trigonometric Functions E. Logarithmic Function F. Exponential Function G. Inverse Trigonometric Functions H. Hyperbolic Functions (sinh u & cosh u only) I. General Power formula (include Substitution Rule) J. Constant of Integration K. Definite Integral (include absolute, odd & even functions) II. Integration Techniques A. Integration by Parts B. Trigonometric Integrals C. Trigonometric Substitution D. Rational Functions E. Rationalizing Substitution III. Improper Integrals IV. Application of Definite Integral A. Plane Area B. Areas between Curves V. Other Applications A. Volumes B. Work C. Hydrostatic Pressure VI. Multiple Integrals (Inversion of order/ change of coordinates) A. Double Intecrals B. Triple Integrals VII. Surface Tracing A. Planes B. Spheres C. Cylinders D. Quadric Surfaces E. Intersection of Surfaces VIII. Multiple Integrals as Volume A. Double Integrals

	B. Triple Integrals

Course Name	**ENGINEERING DATA ANALYSIS**
Course Description	This course is designed for undergraduate engineering students with emphasis on problem solving related to societal issues that engineers and scientists are called upon to solve. It introduces different methods of data collection and the suitability of using a particular method for a given situation. The relationship of probability to statistics is also discussed, providing students with the tools they need to understand how "chance" plays a role in statistical analysis. Probability distributions of random variables and their uses are also considered, along with a discussion of linear functions of random variables within the context of their application to data analysis and inference. The course also includes estimation techniques for unknown parameters; and hypothesis testing used in making inferences from sample to population; inference for regression parameters and build models for estimating means and predicting future values of key variables under study. Finally, statistically based experimental design techniques and analysis of outcomes of experiments are discussed with the aid of statistical software.
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours per week
Prerequisites	None
Program Outcome/s	a-l
Course Outcomes	After completing this course, the student must be able to: 1. Apply statistical methods in the analysis of data 2. Design experiments involving several factors
Course Outline	1. Obtaining Data 1.1. Methods of Data Collection 1.2. Planning and Conducting Surveys 1.3. Planning and Conducting Experiments: Introduction to Design of Experiments 2. Probability 2.1. Sample Space and Relationships among Events 2.2. Counting Rules Useful in Probability 2.3. Rules of Probability 3. Discreet Probability Distributions 3.1. Random Variables and their Probability Distributions 3.2. Cumulative Distribution Functions 3.3. Expected Values of Random Variables 3.4. The Binomial Distribution 3.5. The Poisson Distribution 4. Continuous Probability Distribution 4.1. Continuous Random Variables and their Probability Distribution 4.2. Expected Values of Continuous Random Variables 4.3. Normal Distribution 4.4. Normal Approximation to the Binomial and Poisson Distribution 4.5. Exponential Distribution

	5. Joint Probability Distribution
	    5.1. Two or Random Variables
	        5.1.1. 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
	11. Multiple Linear Regression

	11.1. Multiple Linear Regression Model 11.2. Hypothesis Test in Multiple Linear Regression 11.3. Prediction of New Observations 11.4. Model Adequacy Checking 12. Design and Analysis of Single Factor Experiments 12.1. Completely Randomized Single Factor Experiments 12.1.1. Analysis of Variance (ANOVA) 12.1.2. Multiple Comparisons following the ANOVA 12.1.3. Residual Analysis and Model Checking 12.1.4. Determining Sample Size 12.2. The Random-Effects Model 12.2.1. Fixed versus Random Factors 12.2.2. ANOVA and Variance Components 12.3. Randomized Complete Block Design 12.3.1. Design and Statistical Analysis 12.3.2. Multiple Comparisons 12.3.3. Residual Analysis and Model Checking 13. Design of Experiments with Several Factors 13.1. Factorial Experiments 13.2. Two-Factor Factorial Experiments 13.2.1. Statistical Analysis of the Fixed-Effects Model 13.2.2. Model Adequacy Checking 13.3. 2^k Factorial Design 13.3.1. Single Replicate 13.3.2. Addition of Center Points 13.4. Blocking and Confounding in the 2^k Design 13.5. Fractional Replication of the 2^k Design 13.6. Response Surface Methods

Course Name	**DIFFERENTIAL EQUATIONS**
Course Description	This course is intended for all engineering students to have a firm foundation on differential equations in preparation for their degree-specific advanced mathematics courses. It covers first order differential equations, nth order linear differential equations and systems of first order linear differential equations. It also introduces the concept of Laplace Transforms in solving differential equations. The students are expected to be able to recognize different kinds of differential equations, determine the existence and uniqueness of solution, select the appropriate methods of solution and interpret the obtained solution. Students are also expected to relate differential equations to various practical engineering and scientific problems as well as employ computer technology in solving and verifying solutions
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours per week
Prerequisites	Calculus 2
Program Outcome/s	a-E

Course Outcomes	After completing this course, the student must be able to: 1. Apply integration for the evaluation of areas, volumes of revolution, force and work 2. Use integration techniques on single and multi-variable functions 3. Explain the physical interpretation of the double and triple integral
Course Outline	1. Introduction / 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)

B. 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 and Laboratory	4 units: 3 units lecture; 1 unit laboratory
Number of Contact Hours per Week	6 hours: 3 hours lecture; 3 hours laboratory
Prerequisites	None
Co-requisites	Chemistry for Engineers Lab
Program Outcome/s	a-l
Course Objectives	At the end of the course, the students must be able to: 1. Discuss the application of chemistry in relation to the generation of energy 2. Explain the chemical principles and concepts of structures and bonding of common materials 3. Discuss the chemical processes that takes place in the environment 4. Identify key chemistry concepts related to the specific field of engineering
Course Outline	1. Energy a. Electrochemical energy b. Nuclear chemistry and energy c. Fuels 2. The Chemistry of Engineering Materials a. Basic Concepts of Crystal Structure b. Metals c. Polymers d. Engineered Nanomaterials 3. The Chemistry of the Environment a. The Chemistry of the atmosphere b. The Chemistry of Water c. Soil chemistry 4. Chemical Safety 5. Special Topics specific to field of expertise
Laboratory Equipment	None

Course Name	**PHYSICS FOR ENGINEERS**
Course Description	Vectors; kinematics; dynamics; work, energy, and power; impulse and momentum; rotation; dynamics of rotation; elasticity; and oscillation. Fluids; thermal expansion, thermal stress; heat transfer; calorimetry; waves; electrostatics; electricity; magnetism; optics; image formation by plane and curved mirrors; and image formation by thin lenses.
Number of Units for Lecture and Laboratory	4 units: 3 units lecture, 1 unit laboratory
Number of Contact Hours per Week	6 hours: 3 hours lecture, 3 hours laboratory
Prerequisites	Calculus 1: Co-requisite – Engineering Calculus 2
Program Outcome/s	a-l, b-l
Course Outcomes	After completing this course, the student must be able to: 1. Use calculus to solve problems in force statics and kinematics; 2. Apply the Newton's Laws of Motion; 3. Use calculus to solve work and energy problems; 4. Apply the law of conservation of energy to problems; 5. Solve problems on impulse and momentum and collisions; 6. Determine the stress and strain on a body; 7. Solve simple harmonic motion applications; 8. Describe the characteristics of fluids at rest and in motion; 9. Solve basic problems in fluid statics and kinematics 10. Describe the three methods of heat transfer; 11. Solve basic problems in heat transfer; 12. Discuss the properties of waves, modes of vibration of strings and air columns; 13. Define electric current, electric resistance and voltage; 14. Compute the electric force between electric charges; 15. Solve problems on resistance and cells in series and parallel; 16. State Kirchhoff's rules and apply them in a given circuit; 17. Describe electromagnetism and apply its principles to problem on magnetic field and torque. 18. Describe image formation by mirrors and lenses and solve basic optics problems
Course Outline	1. Work, Energy and Power 2. Impulse and Momentum 3. Kinematics 4. Dynamics 5. Rotation 6. Dynamics of Rotation 7. Elasticity 8. Oscillations 9. Fluids 10. Heat Transfer 11. Waves 12. Electrostatics 13. Electricity

	14. Magnetism 15. Optics
Laboratory Equipment	Physics Laboratory (see attached)

C. BASIC ENGINEERING SCIENCES

Course Name	**Computer-Aided Design**
Course Description	This course covers the concepts of computer-aided drafting with introduction on CAD terminologies and environment with the application of techniques in inputting and executing CAD commands
Number of Units for Lecture and Laboratory	1 laboratory unit
Number of Contact Hours per Week	3 laboratory hours per week
Prerequisites	None
Co-requisites	None
Program Outcome/s	k-l
Course Outcomes	After the completion of the course, the student must be able to: 1. Define the terms related to computer-aided drafting; 2. Identify the important tools use dto create technical drawings in CAD; 3. Create electronic drawings using the CAD software
Course Outline	1. Introduction to CAD Software and its environment 2. Snapping and construction elements 3. Dimensioning 4. Plotting and inputting of images 5. 3D and Navigating in 3D 6. Rendering
Laboratory Equipment	1. Personal computers with operating system and installed CAD software 2. Printer or plotter

Course Name	**Engineering Economics**
Course Description	The course involves the analysis and evaluation of factors for the economic success of engineering projects to ensure the best of capital.
Number of Units for Lecture and Laboratory	3 lecture units
Number of Contact Hours per Week	3 hours per week

Prerequisites	None
Co-requisites	None
Program Outcome/s	I-I
Course Outcomes	At the completion of the course, the students must be able to: 1. Apply the various principles of engineering economy to various engineering problems 2. Apply engineering economy equations and techniques to solve problems related to the economic aspect of engineering projects 3. Prepare a depreciation and recovery plan for engineering projects 4. Compare engineering projects based on economic factors 5. Recommend the best use of capital for engineering projects based on the evaluation of economic factors
Course Outline	1. Introduction 1.1. Definitions 1.2. Principles of Engineering Economy 1.3. Engineering Economy and the Design Process 1.4. Costs and Concepts for Decision Making 1.5. Present Economy 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. Basic Economy Study Methods 3.1. The Minimum Attractive Rate of Return 3.2. The Present Worth Method 3.3. The Future Worth Method 3.4. The Annual Worth Method 3.5. The Internal Rate of Return Method 3.6. The External Rate of Return Method 3.7. The Payback Period 3.8. The Benefit/Cost Ratio Method 4. Decisions Under Certainty 4.1. Evaluation of Mutually Exclusive Alternatives 4.2. Evaluation of Independent Projects 4.3. Depreciation and After-Tax Economic Analysis 4.4. Replacement Studies 4.5. Break-Win analysis 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
Laboratory Equipment	none

Course Name	Engineering Management
Course Description	This course will entail students to learn the basic function of a manager applicable in decision making which are applicable to the real world problems. Furthermore, students would learn how to apply planning, leading, organizing and control principles into the resources in order to increase the efficiency.
Number of Units for Lecture and Laboratory	2 units lecture
Number of Contact Hours per Week	2 hours per week
Prerequisites	None
Co-requisites	None
Program Outcome/s	I-I
Course Outcomes	At the end of the course, the students must be able to: 1. Know the basic functions of management 2. Describe the cultural setting within which managers make decision and the moral framework of their management philosophies 3. Describe the basic functions of a manager 4. Learn the stages of strategic planning and to know the hierarchy of plans and competitive strategies 5. Describe and apply in case studies the elements and the different types of leadership 6. Describe the structure of formal organization 7. Describe the basic principles of controlling and the essential elements of a control system
Course Outline	1. Evolution of Management Theory 2. Management and Its Functions 3. Planning 3.1. Mission and Vision 3.2. Stages of Strategic Planning 3.3. Strategy Formulation 3.4. SWOT Analysis, PEST Analysis and Porter's Five Forces Model 4. Leading 4.1. Leadership Across Cultures 4.2. Sources of Power 4.3. Leadership Models 4.4. Kinds/Types of Leaders 5. Organizing 5.1. Organizational Design 5.2. Determinants of Structure 5.3. Job Design and Job Characteristics Model 6. Controlling 6.1. Control Systems 6.2. Control Process 6.3. Types of Organizational Control Systems 7. Managing Product and Service Operations 8. Managing the Marketing Function

	9. Managing the Finance Function
Laboratory Equipment	none

D. ALLIED COURSES

Course Name	**PHYSICS 2**
Course Description	Thermodynamics (1st & 2nd Law, basic concepts on heat engine and refrigerators), Energy Conversion (EM Induction, magnetic flux, generators), Semiconductor Physics
Number of Units for Lecture and Laboratory	4 units: 3 units lecture, 1 unit laboratory
Number of Contact Hours per Week	6 hours: 3 hours lecture, 3 hours laboratory
Prerequisites	Calculus 1: Co-requisite – Physics for Engineers
Program Outcome/s	a-E
Course Outcomes	After completing this course, the student must be able to: 1. Use calculus to solve problems in Thermodynamics; 2. Describe the three methods of heat transfer; 3. Solve basic problems in heat transfer; 4. Describe electromagnetism and apply its principles to problem on magnetic field and torque. 5. Define electric current, electric resistance and voltage; 6. Solve problems on Inductance, reactance, impedance, RLC, resonance. 7. Solve problems on resistance and capacitances in series and parallel; 8. State Kirchhoff's rules and apply them in a given circuit; 9. Describe concepts on nuclear physics; 10. Describe formation of semiconductors, superconductors, crystals
Course Outline	1. Thermodynamics: 1st & 2nd law, heat engine and refrigerators 2. Electricity: electric force, field, flux, potential, current, resistance, emf, capacitance, series, parallel, Kirchoff's 3. Magnetism: force, field sources 4. EM induction: magnetic flux, generators 5. Inductance: self, mutual, RL, LC 6. AC: reactance, impedance, RLC, resonance 7. Optics: Interference, diffraction, polarization, laser 8. Atomic/ nuclear: photoelectric effect, atomic spectra, radioactive decay, plasma 9. Condensed Matter: Semiconductor (Diodes), superconductors, crystals
Laboratory Equipment	Physics Laboratory (refer Physics lab list of related experiments)

Course Name	**MATERIALS SCIENCE AND ENGINEERING**
Course Description	This course introduces the students to a broad study on the structure and composition of materials (metals, polymers, ceramics, and composite materials) and their properties and behavior in service environments.
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours lecture per week
Prerequisites	Chemistry
Program Outcome/s	a-l
Course Objectives	After completing this course, the student must be able to: 1. Describe the most important engineering materials, their behavior, properties and applications. 2. Describe the relationship between macroscopic properties and molecular structure 3. Suggest appropriate materials for specific applications.
Course Outline	1. Review fundamentals 2. Modern materials Atomic structure and interatomic bonding 3. The structure of crystalline solids 4. Crystalline and non-crystalline materials 5. Imperfections in solids 6. Diffusion in solids 7. Mechanical properties of metals 8. Applications and processing of metal alloys 9. Structure and properties of ceramics 10. Applications and processing of ceramics 11. Polymer structures and properties 12. Applications and processing of polymers 13. Composites 14. Electrical properties 15. Dielectric behavior 16. Magnetic properties 17. Optical properties 18. Thermal properties 19. Economic, environmental, and societal issues in Materials Science and Engineering
Laboratory Equipment	None

Course Name	**Computer Programming (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 laboratory
Number of Contact Hours per Week	6 hours per week
Prerequisites	none
Program Outcome/s	k-l
Course Outcomes	1. Familiarize with fundamentals of Programming Languages 2. Apply programming concepts in engineering problems 3. Create Graphic User Interfaces in application to engineering problems
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	Each major topic should have a corresponding laboratory exercise.
Laboratory Equipment	Computer and object-oriented programming software tool 1 computer per student

Course Name	CIRCUITS 1
Course Description	Fundamental relationships in circuit theory, mesh and node equations; resistive networks, network theorems; solutions of network problems using Laplace transform; transient analysis; methods of circuit analysis.
Number of Units for Lecture and Laboratory	4 units: 3 units lecture, 1 unit lab
Number of Contact Hours per Week	3 hours lec, 3 hours lab
Prerequisite	Physics 2
Program Outcome/s	a-E,b-E
Course Objectives	Upon completion of the course, the student must be able to: 1. Identify the different dc circuit parameters and components 2. Solve problems in application of the different principles, theorems and laws in dc circuits. 3. Identify and solve circuit problems using circuit theories and principles
Course Outline	1. Fundamental Relationship in Circuit Theory 2. Resistive Network 3. Mesh and Node Equations 4. Network Theorems 5. Transient Analysis 6. Solution of Network Problems Using Laplace Transform 7. Methods of Analysis for Special Circuits
Laboratory Equipment	DC Training Module that can perform the following experiments: 1. Familiarization with DC Equipment 2. Parallel & Series connection of linear resistors 3. Delta-Wye transformation of resistive networks 4. DC power measurement 5. Kirchhoff's Law 6. Superposition Law 7. Thevenin's Theorem 8. Bridge circuits 9. RC/RL Time constant curve 10. Maximum Power Transfer

Course Name	CIRCUITS 2
Course Description	Complex algebra and phasors; simple AC circuits, impedance and admittance; mesh and node analysis for AC circuits; AC network theorems; power in AC circuits; resonance; three-phase circuits; transformers; two-port network parameters and transfer function.
Number of Units for Lecture and Laboratory	3 units lecture, 1 unit lab
Number of Contact Hours per Week	3 hours lec, 3 hours lab
Prerequisite	Circuits 1

Program Outcome/s	a-E, b-E
Course Objectives	Upon completion of the course, the student must be able to: 1. Identify the different ac circuit parameters and components 2. Solve problems involving single phase and three- phase systems
Course Outline	1. Complex Algebra and Phasors 2. Impedance and Admittance 3. Simple AC Circuits 4. Transformers 5. Resonance 6. Mesh and Node Analysis for AC Circuits 7. AC Network Theorems 8. Power in AC Circuits 9. Three-Phase Circuits 10. Two-Port Network Parameters and Transfer Function
Laboratory Equipment	AC Training Module that can perform the following experiments: 1. Familiarization with AC instruments 2. Impedance of RC circuits 3. Impedance of RLC circuits 4. Power dissipation in AC circuits 5. Measurement of Power Factor 6. Three Phase circuit 7. Power in 3-phase balanced load 8. Transformer 9. Frequency response of RL and RC 10. Maximum Power transfer

Course Name	**TECHNOPRENEURSHIP**
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 for Lecture and Laboratory	3 units lecture
Number of Contact Hours per week	3 hours lecture
Prerequisite	none
Program Outcome/s	I-E
Course Learning Outcomes	The course should enable the student 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 "pretotype"
Course Outline	1. Introduction o Entrepreneurial Mindset

	o Innovation and Ideas o Products and Services o 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
Laboratory Equipment	None

Course Name	**ENVIRONMENTAL SCIENCE AND ENGINEERING**
Course Description	Environmental Science Knowledge in Ecology and Human Population Control, Variety of Resources and Outline Plans for Attaining Sustainable Society, The Enigma of Pollution and the Legal, Technical and Personal Solutions for it. Study of Environmental Impact Assessment and Environmental Crisis.
Number of Units for Lecture and Laboratory	lecture – 3 units
Number of Contact Hours per Week	lecture – 3 hours
Prerequisite	None
Program Outcome/s	a-E
Course Objectives	1. To be able to understand the engineer's role in the manipulation of materials and resources. 2. To be able have a high level of awareness in the environment and its significance. 3. Understand the effect of design and creation of productive and efficient safety measures to be implemented in the workplace and all manufactured products.
Course Outline	1. Nature and Ecology 2. Natural Systems and Resources 3. Environmental Concerns and Crises 4. Environmental Impact Assessment 5. Sustainable Development
Laboratory Equipment	None

E. PROFESSIONAL CORE COURSES

Course Name	ADVANCED ENGINEERING MATHEMATICS (FOR ECE)
Course Description	A study of selected topics in mathematics and their applications in advanced courses in engineering and other allied sciences. It covers the study of Complex numbers and complex variables, Laplace and Inverse Laplace Transforms, Power series, Fourier series, Fourier Transforms, z-transforms, power series solution of ordinary differential equations, partial differential equations and numerical methods in engineering
Number of Units for Lecture and Laboratory	3 lecture units, 1 unit laboratory
Number of Contact Hours per week	3 hours/week lecture, 3 hours/ week laboratory
Prerequisite	Differential Equations
Program Outcome/s	a-E
Course Objectives	After completing this course, the student must be able to: 1. familiarize the different parameters, laws, theorems and the different methods of solutions in advance mathematics. 2. apply the different laws, methods and theorems particularly in complex problems. 3. solve simultaneous linear and nonlinear equations 4. prepare algorithms, write computer programs, use computer software and implement these to the solution of engineering problems.
Course Outline	1. Complex numbers and complex variables 2. Laplace and Inverse Laplace Transforms 3. Power Series 4. Fourier Series 5. Fourier Transforms 6. Power Series solution of differential equations 6.1 Legendre Equation 6.2 Bessel Equations 7. Simultaneous linear and nonlinear equations 8. Numerical Differentiation and Integration 9. Ordinary and Partial Differential Equations 10. Optimization
Laboratory Equipment	Computer programming and exercises using available software such as Matlab, Mathematica, MathCad, or equivalent.

Course Name	ELECTROMAGNETICS
Course Description	This course deals with vector algebra, vector calculus, vector analysis, and their applications in electric and magnetic fields, resistive, dielectric and magnetic materials, coupled circuits, magnetic circuits and fields, time-varying electromagnetic fields, and Maxwell's equations.
Number of Units for Lecture and Laboratory	4 units lec

Number of Contact Hours per Week	4 hours lec
Prerequisite	Differential Equations
Program Outcome/s	a-E, e-E
Course Objectives	Upon completion of the course, the student must be able to: 1. perform algebraic operations on vectors 2. analyze and solve vector quantities in Cartesian, cylindrical and spherical coordinate systems 3. Define electromagnetic quantities 4. Write the expressions for and explain Maxwell's equations 5. Apply Maxwell's equations in solving electromagnetic problems 6. Identify and observe safety measures relating to Electromagnetic fields.
Course Outline	1. Introduction to Vector Analysis - algebra of vectors, vector product, calculus of vectors and vector identities, derivative of a vector functions, directional derivative, gradient, divergence, curl, Integral Theorems, Green's Lemma, Divergence Theorem and Strokes' Theorem 2. Steady Electric and Magnetic Fields 3. Dielectric and Magnetic Materials 4. Coupled and Magnetic Circuits 5. Time-Varying Fields and Maxwell's Equation 6. Field and Circuit Relationships 7. Transmission Lines

Course Name	**ECE LAWS, CONTRACT, ETHICS, STANDARDS & SAFETY**
Course Description	Contracts; warranties; liabilities; patents; bids; insurance; other topics on the legal and ethical positions of the professional engineer. Includes Safety and other standards related to the ECE profession.
Number of Units for Lecture and Laboratory	3 units lec
Number of Contact Hours per Week	3 hours lec
Prerequisite	None
Program Outcome/s	f-E
Course Objectives	Upon completion of the course, the student must be able to: 1. To define, enumerate, and understand the concept of the different laws that governs the ECE profession. 2. To apply the laws to a given situation and know the rights and obligations of the parties. 3. Learn the intricacies of obligations and contracts. 4. apply Safety Standards and other standards related to the engineering profession. 5. familiarize with the PEC Codes

Course Outline	1. Fundamentals of the Laws, Obligations and Contracts 2. Pledge of ECE & CSC Guidelines 3. The Board Examination 4. Regulating the ECE Profession(PRC) 5. Practicing the ECE Profession 6. Other ECE Related Statutes 6.1 TELECOMMS Interconnection 6.2 IECEP 6.3 RA 9292 6.4 International Professional Practice 6.5 ASEAN & APEC Registry 6.6 Engineering Institutions 7. Safety Standards 7.1 Basic Safety procedures in high risk activities and industries 7.2 Value Based Safety and Off-the-Job Safety 7.3 Disaster Prevention and Mitigation 7.4 Incident Investigation and reporting 8. PEC Codes

Course Name	**ELECTRONICS 1: ELECTRONIC DEVICES AND CIRCUITS**
Course Description	Introduction to quantum mechanics of solid state electronics; diode and transistor characteristics and models (BJT and FET); diode circuit analysis and applications; transistor biasing; small signal analysis; large signal analysis; transistor amplifiers; Boolean logic; transistor switch.
Number of Units for Lecture and Laboratory	3 units lecture; 1 unit lab
Number of Contact Hours per Week	3 hours lec, 3 hours lab
Prerequisite	Co-requisite: Circuits 1
Program Outcome/s	a-E, b-E, e-E, i-E
Course Objectives	Upon completion of the course, the student must be able to: 1. Familiarize and solve problems on semiconductor physics; diode and diode circuit analysis; 2. Analyze and solve problems on MOS and BJT (small and large signal) circuit analysis.
Course Outline	1. Fundamentals of tubes and other devices 2. Introduction of Semiconductors 3. Diode Equivalent Circuits 4. Wave Shaping Circuits 5. Special Diode Application 6. Power Supply And Voltage Regulation 7. Filtered power supply, voltage multipliers and regulators 8. Bipolar Junction Transistor 9. Small- Signal Analysis (BJT) 10. Field Effect Transistor 11. Small-Signal Analysis (FET)

Laboratory Equipment	Electronics Training Module or set of equipment and components that can perform the following experiments: 1. Solid state Diode familiarization 2. Diode Applications 3. Power Supply 3. Transistor familiarization 4. Transistor applications 5. JFET familiarization and characteristic curves 6. BJT familiarization and characteristic curves 7. Pre-amplifiers Recommended List of Equipment: 1. Power Supplies 2. Signal Generator 3. Oscilloscope 4. Curve Tracer 5. Digital Multimeter

Course Name	**ELECTRONICS 2: ELECTRONIC CIRCUITS ANALYSIS AND DESIGN**
Course Description	High frequency transistor models; analysis of transistor circuits; multi-stage amplifier, feedback, differential amplifiers and operational amplifiers; integrated circuit families (RTL, DTL, TTL, ECL, MOS)
Number of Units for Lecture and Laboratory	3 unit lecture, 1 unit lab
Number of Contact Hours per Week	3 hours lec, 3 hours lab
Prerequisite	Electronics 1
Program Outcome/s	b-E, e-E, i-E
Course Objectives	Upon completion of the course, the student must be able to: 1. Review the basic electronics learned in Electronics 1. 2. Analyze different circuits and models at high frequency. 3. Analyze and solve transistor circuit problems. 4. Familiarize concepts on operational amplifier. 5. Analyze combinational and sequential devices for logic circuits. 6. Familiarize with the integrated circuit families.
Course Outline	1. Introduction and Review of Logarithms and Decibels 2. BJT Lower Critical Frequency Response 3. JFET Lower Critical Frequency Response 4. BJT Higher Critical Frequency Response 5. JFET Higher Critical Frequency Response 6. Cascade and Cascode Connection 7. CMOS Circuit, Darlington and Feedback Pair Connection 8. Current Mirrors and Current Source 9. Differential Amplifier 10. Operational Amplifiers 10.1 Practical Operational Amplifier 10.2 Operational Amplifier Specification 11. Feedback Systems

	11.1 Feedback Connections and Practical Feedback Circuits 11.2 Negative Feedback System 11.3 Positive Feedback 12. Oscillator Circuits 12.1 RC Feedback Oscillator Circuits 12.2 LC Feedback Oscillator Circuits 12.3 Other Types of Oscillator 13. Filters 13. 1 Designing Filters 13.2 Types of Filters 14. Transistor Fabrication 15. Designing Integrated Circuit Families
Laboratory Equipment	Electronics Training Module or set of equipment and components that can perform the following experiments: 1. Frequency response of a transistor amplifier 2. Cascaded transistor amplifier 3. The differential amplifier 4. The operational amplifier 5. The transistor as a switch 6. Familiarization with digital circuits 7. Filters Recommended List of Equipment: 1. Power Supplies 2. Signal Generators 3. Oscilloscope 4. Digital Multimeter 5. Spectrum Analyzer 6. Logic Analyzer

Course Name	**ELECTRONICS 3: ELECTRONIC SYSTEMS AND DESIGN**
Course Description	Theory, operating characteristics and design of electronic devices and control circuits for industrial processes; industrial control applications; electronics instrumentation; transducers; data acquisition system; interfacing techniques; sensors
Number of Units for Lecture and Laboratory	3 units lecture, 1 unit lab
Number of Contact Hours per Week	3 hours lec, 3 hours lab
Prerequisite	Electronics 2
Program Outcome/s	b-E, c-E, e-E
Course Objectives	Upon completion of the course, the student must be able to: 1. Apply electronic concepts in the design of control circuits in industrial applications 2. Analyze different circuits for electronics instrumentation 3. Analyze and design interfacing circuits. 4. Familiarize concepts and solve problems on Programmable Logic Circuits 5. design interfacing circuits

Course Outline	1. SCRs, UJT, PUT 2. TRIAC, DIAC and other Thyristors 3. Optoelectonic Devices and Sensors 4. Transducers 5. Interfacing techniques 6. Programmable Logic Controllers 7. Building Management Systems including HVAC Controls 8. Security and Surveillance Control System 9. Audio-Video and Lighting Controls 10. Supervisory Controls and Data Acquisition 11. Fire and Life Safety Controls
Laboratory Equipment	Electronics Training Module or set of equipment and components that can perform the following experiments: 1. SCRs, UJT, PUT 2. TRIAC, DIAC and other Thyristors 3. Optoelectonic Devices and Sensors 4. Transducers 5. Interfacing techniques 6. Programmable Logic Controllers Plus design of at least (2) systems applications included in the outline. Recommended List of Equipment: 1. Power Supplies 2. Signal Generators 3. Oscilloscope 4. Digital Multimeter 5. Spectrum Analyzer 6. Logic Analyzer 7. PLCs

Course Name	**SIGNALS SPECTRA, AND SIGNAL PROCESSING**
Course Description	Fourier transform; z transform; convolution; FIR filters; IIR filters; random signal analysis; correlation functions; DFT; FFT; spectral analysis; applications of signal processing to speech, image, etc.
Number of Units for Lecture and Laboratory	3 units lecture, 1 unit lab
Number of Contact Hours per Week	3 hours lec, 3 hours lab
Prerequisite	Advanced Engineering Mathematics
Program Outcome/s	b-E, e-E
Course Objectives	Upon completion of the course, the student must be able to conceptualize, analyze and design signals, spectra and signal processing system.

Course Outline	1. Classification and Characteristics of signals 2. Sampling theorem and Aliasing 3. Difference equations for FIR and IIR filters 4. Convolution and correlation 5. Z transforms 6. Pole-zero-gain filters 7. Fourier transforms 8. Filtering 9. FIR/IIR
Laboratory Equipment	Training module in signal processing or equivalent to perform the following experiments: 1. Periodic Signals 2. Non-periodic Signals 3. Computation of Transforms 4. Sampling and Quantization 5. Measurements on Filter Response 6. FIR Filter Analysis and Design 7. IIR Filter Analysis and Design Software requirement: Signal Processing

Course Name	**COMMUNICATIONS 1: PRINCIPLES OF COMMUNICATION SYSTEMS**
Course Description	Bandwidth; filters; linear modulation; angle modulation; phase locked loop; pulse modulation; multiplexing techniques; noise analysis; radio transmitters and receivers
Number of Units for Lecture and Laboratory	3 unit lecture, 1 unit lab
Number of Contact Hours per Week	3 hours lec, 3 hours lab
Prerequisite	Co-requisite Electronics 2
Program Outcome/s	b-E, e-E
Course Objectives	Upon completion of the course, the student must be able to 1. Conceptualize and analyze a communication system. 2. Solve problems on communication circuits and subsystems
Course Outline	1. Introduction to Communications Systems 2. Noise 3. Amplitude Modulation 4. Single-Sideband Techniques 5. Frequency Modulation 6. Radio Receivers 7. Radiation and Propagation of Waves 8. Pulse Modulation 9. Digital Modulation 10. Broadband Communication System

Laboratory Equipment	Training modules in Analog Communications or equivalent to perform the following experiments: 1. Passive, Active Filters, Tuned Circuits 2. AM Transmitter 3. Frequency Modulation 4. Pulse Amplitude Modulation 5. Diode Detection 6. Time Division Multiplexing 7. Frequency Division Multiplexing Suggested *Project*: superheterodyne receiver

Course Name	**COMMUNICATIONS 2: MODULATION AND CODING TECHNIQUES**
Course Description	Random variables, bit error rate; matched filter; Digital modulation techniques; ASK, FSK, QAM, PSK/QPSK, CDMA and W-CDMA systems; signal space; generalized orthonormal signals; information measures-entropy; channel capacity; efficient encoding; error correcting codes information theory; data compression; coding theory.
Number of Units for Lecture and Laboratory	3 units lec, 1 unit lab
Number of Contact Hours per week	3 hours lec, 3 hours lab
Prerequisite	Communications 1: Principles of Communication Systems
Program Outcome/s	b-E, e-E
Course Objectives	Upon completion of the course, the student must be able to conceptualize, analyze and design an application of modulation and coding techniques.
Course Outline	1. Introduction to Digital Communications Systems 2. Digital Transmission 3. PAM, PWM, PPM 4. Pulse Code Modulation 5. Digital Communications, ASK, FSK 6. Bandwidth Considerations for ASK, FSK, PSK, QAM 7. Basics of Information Theory 8. Error Detection 9. FDM, TDM 10. WDM, Applications of Multiplexing 11. Multiple Access Channeling Protocols, FDMA, CDMA,TDMA
Laboratory Equipment	Digital Training Modules or equivalent to perform the following experiments. 1. PAM 2. Noise 3. FSK 4. ASK 5. PSK 6. PCM 7. Error Detection and Correction *Suggested Project*: A hardware or a computer simulation to illustrate the application of modulation and coding techniques.

Course Name	**COMMUNICATIONS 3: DATA COMMUNICATIONS**
Course Description	Data communication systems; terminals, modems; terminal control units; multiplexers; concentrators; front-end processors; common carrier services; data communication system design; computer network models; TCP/IP; principles; LAN; WAN
Number of Units for Lecture and Laboratory	3 unit lecture, 1 unit lab
Number of Contact Hours per Week	3 hours lec, 3 hours lab
Prerequisite	Communications 2: Modulation and Coding Techniques
Program Outcome/s Addressed by the Course	b-E, e-E
Course Objectives	Upon completion of the course, the student must be able to conceptualize, analyze and design a data communication system.
Course Outline	1. Introduction to Data Communications 2. Category of Data Communication 3. Configurations and Network Topology 4. Transmission Modes 5. Two-wire vs. Four Wire Circuits 6. Types of Synchronization 7. Network Components (Terminal, multiplexer, concentrators) 8. Network Components (LCU,FEP,Serial Interface) 9. Security 10. Cryptography 11. Open System Interconnection 12. System Network Architecture 13. TCP/IP Architecture 14. Character-Oriented Protocols 15. Bit-Oriented Protocols 16. LAN/MAN/WAN/GAN 17. ISDN/B-ISDN
Laboratory Equipment	Training modules in two wire and four wire circuits, modems, SDH, SONET Suggested design project in data communication system design and networking

Course Name	**COMMUNICATIONS 4: TRANSMISSION MEDIA, ANTENNA SYSTEM AND DESIGN**
Course Description	Transmission media; radio wave propagation wire and cable transmission systems; fiber-optic transmission system; transmission lines and antenna systems.
Number of Units for Lecture and Laboratory	3 unit lecture, 1 unit lab
Number of Contact Hours per Week	3 hours lec, 3 hours lab
Prerequisite	Communications 2: Coding and Modulation Techniques

Program Outcome/s	b-E, e-E
Course Objectives	Upon completion of the course, the student must be able to conceptualize, analyze and design transmission lines and antenna systems. 1. Describe the types of transmission lines and calculate the line constants. 2. Differentiate the types of radio wave propagation and be familiar with their applications 3. Understand the principle and characteristics of antennas, the different types as well as the methodology in the design of each. 4. Be able to design and construct a wideband antenna (VHF and UHF).
Course Outline	1. Transmission Lines Circuits, losses and parameters 2. Matching TL 3. Smith Chart 4. Radio Wave Propagation 5. Power Density and Field Strength Calculations 6. Antenna Systems 7. Wave guides 8. Fiber Optics
Laboratory Equipment	Training Modules in Transmission lines, antennas, microwave and Optical Fiber Communications Systems to perform the following laboratory exercises: 1. Transmission Lines 2. Antennas 3. Measurement of Frequency, Wavelength, Phase Velocity in Waveguides 4. Generation of Microwaves 5. Detection of Microwaves 6. Attenuation measurement 7. Optical Fiber System: numerical aperture, attenuation, modal theory

Course Name	**DIGITAL ELECTRONICS 1: LOGIC CIRCUITS AND SWITCHING THEORY**
Course Description	Review of number systems, coding and Boolean algebra; inputs and outputs; gates and gating networks; combinational circuits; standard form; minimization; sequential circuits; state and machine equivalence; asynchronous sequential circuits; race conditions; algorithmic state machines; design of digital subsystems.
Number of Units for Lecture and Laboratory	3 units lec, 1 unit lab (4 credit units)
Number of Contact Hours per Week	3 hours lec, 3 hours lab
Prerequisite	Electronics 1
Program Outcome/s	b-E, e-E

Course Objectives	Upon completion of the course, the student must be able to: 1. Define and identify important logic switching circuit theories and terminologist 2. Use Boolean Algebra in simplifying logic circuits and solving related problems 3. Apply minimization techniques in designing combinational circuits and in solving related problems 4. Design combinational and/or sequential digital system or sub-system
Course Outline	1. Number System 2. Other Number System and Number Conversion System 3. Boolean Algebra and Logic Gates 4. Minimization of Boolean Functions 5. Sequential Circuits 6. Algorithmic State Machine (ASM) 7. Asynchronous Sequential Logic
Laboratory Equipment	Training modules or equivalent to perform the following experiments: 1. Diode digital logic gates 2. Transistor digital logic gates 3. Integrated digital logic gates 4. Flip Flops 5. Registers 6. Counters (binary, ripple, decade, etc…) Logic Circuit Project Design, construction and testing

Course Name	**DIGITAL ELECTRONICS 2: MICROPROCESSOR & MICROCONTROLLER SYSTEMS AND DESIGN**
Course Description	The course covers concepts involving microprocessor/ microcontroller systems architecture/organization including microprocessor/microcontroller programming, interfacing techniques, memory systems and bus standards. In the laboratory, the students will be involved with experiments using micro controllers and the use of microprocessor/ micro controller development systems and other tools.
Number of Units for Lecture and Laboratory	3 unit lecture, 1 unit lab
Number of Contact Hours per Week	3 hours lec, 3 hours lab
Prerequisite	Digital Electronics 1
Program Outcome/s	b-E, e-E

Course Objectives	Upon completion of the course, the student must be able to: 1. explain the concepts behind microprocessor systems and their components 2. differentiate between microprocessors and microcontrollers, between microprocessors, and between microcontrollers based on architecture 3. develop programs to run on microprocessors/ micro controller system using both assembly language and high-level language via cross compilation 4. interface microprocessors/ microcontrollers to memory, I/O devices, and other system devices 5. able to organize and explain the architecture of existing computer systems (Ex. desktops, workstations, etc.) 6. analyze the capabilities of different processors 7. program a specific microcontroller system to accept input, process data and control physical devices.
Course Outline	1. Computer Architecture 2. Assembly Language Programming Building Microcomputer 3. I/Q Interface 4. Overview of Microcontroller Family; Development & Environment 5. Source Code Components; Target System Components and Connections; Basic Debugger Operations and Creating Programs 6. Creating Programs 7. Basic I/Q and Basic Programming 8. Speaker and Relays Interfacing; and One Time Programming 9. Interrupts and Hardware Timers 10. Seven Segment Display; and Analog Interface 11. Project Design
Laboratory Equipment	Experiment topics include: 1. assembly language programming topics, 2. interfacing with input and output devices, 3. data transfer between micro controller-based circuits and the PC via the serial port and parallel port Microcontroller/microprocessor trainers or equivalent, emulators, personal computers if not provided by trainer, include the following: 1. Assembler, cross-compiler, debugger 2. Seven-segment or LCD displays 3. Switches and keypads 4. Motors with TTL-input drivers Suggested Project: An embedded system using a microcontroller demonstrating integration with I/O devices and communication with a PC.

Course Name	**FEEDBACK AND CONTROL SYSTEMS**
Course Description	This course deals with time and frequency response of feedback control systems. The topics covered include, time response of first order and second order systems, modeling, transfer functions, pole-zero map, stability analysis, root locus, bode plots, compensators, PID controllers, and introduction to state space techniques.
Number of Units for Lecture and Laboratory	3 units lec, 1 unit lab

Number of Contact Hours per Week	3 hours lec, 3 hours lab
Program Outcome/s	b-E, e-E
Prerequisite	Advanced Engineering Mathematics
Course Objectives	Upon completion of the course, the student must be able to: 1. familiar with various systems exhibiting control mechanisms and understand their operation 2. able to develop the value of being analytic and able to apply learned concepts to improve systems. 3. able to understand and appreciate feedback control. 4. able to apply system-level thinking 5. able to demonstrate knowledge of concepts in dealing with feedback and control systems
Course Outline	1. Introduction to feedback control systems. 2. Control system terminology. 3. Review of the Laplace transforms. 4. Introduction to system modeling and the transfer function. 5. Introduction to LTI systems. 6. The concept of linearization. 7. Poles and zeros of transfer functions. The pole-zero map. 8. Introduction to time response and different types of test signals. First order LTI system transient response analysis. 9. Second-order LTI system transient response analysis 10. Block diagram representation of systems and block diagram algebra. 11. Signal flow graphs. 12. Stability theory. 13. Steady-state errors. 14. Sensitivity and Disturbance rejection. 15. Root Locus. 16. Controllers, Compensators, PID Controller 17. Frequency response analysis: Bode plot, Nyquist diagram, and Nichols chart. 18. Introduction to State-space concepts and applications.
Laboratory Equipment	Control system software

Course Name	**METHODS OF RESEARCH**
Course Description	This course deals with research preparation methods, research tools, research proposals, and the implementation, presentation and publication of research work
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 lecture hours
Prerequisites	n^{th} year standing

Program Outcome/s	h-E
Course Outcomes	After completing this course, the student must be able to: 1. Look for and identify a research topic of interest; 2. Prepare and present a research proposal on the identified topic; 3. Design and conduct experiments, as well as to analyze and interpret data 4. Understand professional and ethical responsibilities as they become familiar with the design and conduct of experiments or other research activities and aware of research publication requirements 5. Communicate effectively as they understand contemporary issues and the impact of engineering solutions in a global, economic, environmental and social context. 6. Use techniques, skills and modern engineering tools needed in the electronics engineering practice.
Course Outline	1. Research Preparation 1.1. Definitions 1.1.1. Research and its Importance 1.1.2. Pure and Applied Research 1.1.3. Thesis 1.2. The Research Process 1.2.1. Choosing A Research Topic 1.2.2. Identifying A Mentor (Thesis Adviser) 1.2.3. Safety and Ethics in Research 1.3. The Scientific Method 1.3.1. Steps of the Scientific Research 1.3.2. Common Mistakes Made by Beginning Researchers 1.4. The Scientific Literature Review 1.4.1. Locating Publications 1.4.2. Primary and Secondary Sources 1.4.3. Elements of Scientific Literature 1.4.4. Summarizing and Recording 1.4.5. Critical Review 1.4.6. Research Forum 2. Research Tools 2.1. Data Collection & Instrumentation 2.1.1. Sampling and Instrumentation 2.1.2. Designing & Administering Surveys 2.1.3. Sources of Error 2.1.4. Data Presentation 2.2. Statistics 2.2.1. Research Questions/Data Types 2.2.2. Measures of Central Tendency 2.2.3. Measures of Variation 3. Elements of Research Proposals 3.1. Components of Research Proposals 3.2. Characteristics of a Good Proposal 4. Research Implementation 4.1. Research Project Implementation 4.2. Research Project Data Collection 4.3. Research Project Re-evaluation 5. Research Presentation and Publication 5.1. Use of Presentation Software and Visual Aids

	5.2. Public Speaking 5.3. Requests for Journal Format / Guidelines for Authors 5.4. Submission of Scientific Paper 5.5. Research Posters 5.6. Hints for Presentation of Research Project to a Panel of Members of the Professional Community

Course Name	**DESIGN 1/ CAPSTONE PROJECT 1 & DESIGN 2/ CAPSTONE PROJECT 2**
Course Description	This is the capstone course which utilizes the fundamentals of electronics engineering in the design of an electronic system. It includes the synthesis of processes, analysis of process conditions and the analytic, heuristic and optimum design of equipment and processes. Economic analysis is included to estimate the cost of equipment, capital investment, total product cost and profitability.
Number of Units for Lecture and Laboratory	1 unit laboratory
Number of Contact Hours per Week	3 hours laboratory per week
Prerequisites	Electronics Systems and Design, Engineering Economy, Digital Electronics 2, Communications 4
Program Outcome/s	c-D; h-D; I-D;
Course Outcomes	After completing this course, the student must be able to: 1. Include the essential elements of an electronic design project 2. Use engineering economics to evaluate profitability. 3. Apply analytic and heuristic techniques in the design 4. Use software and simulation techniques to design systems and processes and to analyze their performance. 5. Analyze and improve the performance of equipment and processes by incorporating technical standards, ethics, health, safety, and environmental issues. 6. Model or simulate project or system design 7. Develop oral and written communication skills. 8. Work as a member of a design team.

Course Name	**SEMINARS/ COLLOQUIUM**
Course Description	This course deals with a series of lectures and seminars on selected topics that are highly relevant to electronics engineering but are not covered in any of the other formal courses. It covers recent advances in electronics engineering. It is also a venue for the students to present their projects and researches.
Number of Units for Lecture and Laboratory	1 unit lab

Number of Contact Hours per Week	3 hours seminars per week
Prerequisites/ co-requisites	N^{th} year standing
Program Outcome/s	g-D
Course Outcomes	By the end of the course, the students will be able to: 1. Organize seminars relevant to electronics engineering. 2. Develop a sense of responsibility in fulfilling assigned tasks particularly in organizing seminars, colloquium and fora.
Course Outline	1. Orientation 1.1. Presentation of different types of electronic industries 1.2. Economic profile of Philippine electronics industry 1.3. School policies and procedures regarding the conduct of seminars 2. At least 6 seminars (specific dates subject to the availability of speakers) 2.1. Advances in the fields of Electronics Engineering 3. Oral presentations of seminars 4. Culminating activity - profiles

Course Name	**ELECTRONICS ENGINEERING IMMERSION / ON THE JOB TRAINING (OJT)**
Course Description	Actual On-the-Job Training or Industry Internship in the field of specialization.
Number of Units for Lecture and Laboratory	3 units
Number of Contact Hours per Week	240 hours
Prerequisites	None
Program Outcome/s	d-D; i-D
Course Outcomes	By the end of the course, the students will be able to: 1. Relate theories learned in school to the actual technical and/or practical solutions to industrial problems; 2. Familiarize with varied plant operations and processes, operational techniques used and current management control; 3. Develop responsible attitude and self-motivation by systematically handling tasks in design and other activities relevant to Electronics Engineering; 4. Develop good human relations in industrial operations.
Course Outline	Activities 1. Choose the particular industry in relation with their respective major course. 2. Submit to the company requirements needed for the industry program 3. Coordinate with the faculty in charge of the industry internship program

	4. Accomplish at least 240 hours within the semester 5. Secure the papers needed including DTR, the weekly accomplishments, industry internship program completion report 6. Final presentation

F. ELECTIVE COURSES

a. TELECOMMUNICATIONS

Course Name	**Advanced Communication System & Design**
Course Description	Covers Signal Transmission Modes; Spread Spectrum Modulation System; Terrestrial Microwave; Satellite Systems; Satellite Multiple Access Techniques; Terrestrial and Satellite Systems Path Calculations and Link Budgets.
Number of Units for Lecture and Laboratory	3 units lecture, 1 unit laboratory
Number of Contact Hours per Week	3 hours lecture, 3 hours laboratory
Prerequisites	Communications 4
Program Outcome/s	m-D
Course Objectives	Upon completion of the course, the student must be able to conceptualize, analyze and design a wireless communication system.
Course Outline	1. Microwave communication system diagram and components Microwave Equipments 2. Radio Equipments, Multiplexers, Antenna Towers and Waveguides 3. Microwave signal propagation and factors affecting the signal 4. Microwave Repeaters, Microwave Devices, and Microwave Tubes 5. Earth Bulge, Fresnel Zone, Contour Reading, Path Profiling, and Tower Computations 6. System Gains and Losses 7. Link Budget and Path Calculations 8. System Reliability, Protection switching and Diversity 9. Satellite Communications, systems, techniques, link capacity and budget 10. VSAT, INTELSAT
Laboratory Equipment	Design Project: Microwave System Design Communications Equipment to demonstrate topics included

Course Name	**Advanced Networking**
Course Description	Operating performance and interface standards for voice and data circuits; telecommunications facility planning; outside plant engineering; surveying; switching and handling systems; mobile systems and standards; cellular radio systems; PSTN

Number of Units for Lecture and Laboratory	3 units lecture, 1 unit laboratory
Number of Contact Hours per Week	3 hours lecture, 3 hours laboratory
Prerequisites	Communications 4
Program Outcome/s	m-D
Course Objectives	Upon completion of the course, the student must be able to conceptualize, analyze and design a wireless communication system.
Course Outline	1. PSTN Components /Equipment 2. Switching Fundamentals 3. Signaling 4. Transmission Engineering (PDH, SDH) 5. Fiber Optic System; Power budget 6. Traffic Engineering 7. PLMN 8. GSM Architecture, call flow 9. Cell Planning 10. Frequency Planning 11. Access Networks; Components 12. EML Calculation
Laboratory Equipment	Design Examples: Plate 1. Fiber optic Transmission and Network Cable Design Plate 2: GSM System Design Communications equipment to demonstrate topics included

b. MICROELECTRONICS

Course Name	**ANALOG INTEGRATED CIRCUIT DESIGN**
Course Description	Focuses on Analog IC Fabrication processes, Analog device Modeling and Circuit simulation. Design and Characterization of Analog circuit building blocks such Amplifiers, Comparators, Operational Amplifiers and other analog systems.
Number of Units for Lecture and Laboratory	3 units lecture, 1 unit lab
Number of Contact Hours per week	3 hours lec, 3 hours lab
Program Outcome/s	m-D
Prerequisite	Electronics 3
Course Objectives	At the end of the course student must be able to 1. analyze low-frequency characteristics of single-stage amplifiers and differential amplifiers 2. analyze and design current sources/sinks/mirrors 3. analyze and design voltage and current references including bandgap references 4. analyze high-frequency response of amplifiers

	5. understand stability compensation for amplifiers 6. design and characterize amplifiers according to design specifications in CAD software
Course Outline	1. Review of MOSFET Device Models 2.Review of BJT Device Models 3. IC Technology 4. Review of Single-Stage Amplifier 5. Differential Amplifiers 6. Current Mirrors 7. Opamp Design 8. Frequency Response 9. Stability and Compensation 10. Noise – optional 11. Two-stage Amplifiers
Laboratory Equipment	Unix Workstation Cadence, Synopsis, Mentor Graphics design tools or equivalent MatLab or equivalent

Course Name	**DIGITAL IC DESIGN**
Course Description	Focuses on the practice of designing VLSI systems from circuits to architectures and from sub-systems to systems. Top-down design techniques are taught using VHDL to design and model digital systems.
Number of Units for Lecture and Laboratory	3 units lecture, 1 unit lab
Number of Contact Hours per week	3 hours lec, 3 hours lab
Program Outcome/s	m-D
Prerequisite	Electronics 3
Course Objectives	The aim of this course is to provide an introduction to the design and layout of Very Large Scale Integrated (VLSI) circuits for complex digital systems. It covers custom design, cell-based hierarchical design, and algorithmic aspects of VLSI CAD tools for MOS with focus on CMOS technology. By the end of this course, the students will have designed, laid out and verified a CMOS device subsystem on engineering workstations in an associated laboratory.
Course Outline	1. Concepts, economics and trends of integrated circuits 2. CMOS technology and theory of operation 3. CMOS circuits and logic design 4. CMOS layout rules and techniques 5. CMOS circuit characterization and performance estimation 6. Subsystem Design Approaches 7. FPGA, PLD, VHDL 8. VHDL techniques and design tools 9. VLSI system design methods 10. VLSI CAD tools
Laboratory Equipment	Unix Workstation Cadence, Synopsis, Mentor Graphics design tools or equivalent

c. POWER ELECTRONICS

Course Name	ADVANCED POWER SUPPLY SYSTEMS
Course Description	This course introduces power electronics scope and applications. The semiconductor devices for power electronics applications are presented. Ideal switch model is used in the study of converter topologies. Fast recovery diodes are discussed for switch mode dc-dc converters and dc-to-ac inverters; Developments on resonant-mode converter topologies for zero-loss switching; switch mode and uninterruptible power supplies.
Number of Units for Lecture and Laboratory	3 units lecture, 1 unit lab
Number of Contact Hours per week	3 hours lec, 3 hours lab
Program Outcome/s	m-D
Prerequisite	Electronics 2
Course Objectives	Upon completion of the course, the student must be able to: 1. discuss applications of power electronics 2. identify different types of electronic power supply 3. analyze various power supply designs 4. evaluate power supply performance 5. evaluate energy efficiency of power supplies 6. design switch mode and UPS
Course Outline	1. Semiconductor switches 2. Passive components for electronic power supply 3. Rectifiers 4. Phase controlled rectifiers and converters 5. Switch-Mode Power Supply 6. Inverters 7. Resonant Converters 8. Power Conditioners and UPS 9. Power supply design and applications in DC motor drives, synchronous motor drives, step motor drives, servo motor system, variable frequency motor control, harmonics and electromagnetic interference
Laboratory Equipment	Experiments that demonstrate concepts listed above to include: 1. Spectrum Analyzer 2. Oscilloscope 3. Signal Generator 4. Multimeter 5. Watt meter 6. Clamp meter Design of an uninterruptible power supply

Course Name	RENEWABLE ENERGY SYSTEMS
Course Description	The course provides an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application. The class will explore society's present needs and future energy demands, examine conventional energy sources and systems, including fossil fuels and nuclear

	energy, and then focus on alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, and hydro. Energy conservation methods will be emphasized.
Number of Units for Lecture and Laboratory	3 units lecture, 1 unit lab
Number of Contact Hours per week	3 hours lec, 3 hours lab
Program Outcome/s	m-D
Prerequisite	Circuits 2
Course Objectives	1. List and generally explain the main sources of energy and their primary applications in the Philippines, and the world. 2. Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment. 3. Discuss remedies/potential solutions to the supply and environmental issues associated with fossil fuels and other energy resources. 4. List and describe the primary renewable energy resources and technologies. 5. Describe/illustrate basic electrical concepts and system components. 6. Convert units of energy—to quantify energy demands and make comparisons among energy uses, resources, and technologies. 7. Collect and organize information on renewable energy technologies as a basis for further analysis and evaluation.
Course Outline	1. Introduction to energy systems and resources 2. Energy, sustainability & the environment 3. Quantifying energy & energy arithmetic Heat to motive power 4. Electricity - a primer Fossil fuels - past, present & future 5. Remedies & alternatives for fossil fuels CHP/cogeneration Energy efficiency and conservation 7. Nuclear 8. Green building Solar - thermal Solar - PV 9. Wind – small & large Hydro – small & large 10. Wave & tidal Geothermal 11. Sizing residential systems Batteries and Inverters Governmental incentives 12. Biomass & Biofuels overview Biogas - anaerobic digesters Bioenergy from wastes 13. Dedicated bioenergy crops Woody biomass Liquid biofuels 13 Progress EXAM 2 Ethanol - issues & future prospects 14. Biodiesel - uses, production, processes Biomass & Bioenergy wrap-up 15. Fuel cells Transportation - hybrids, flex fuels, fuel cells
Laboratory Equipment	Experiments that demonstrate concepts listed above to include: 1. Spectrum Analyzer 2. Oscilloscope 3. Signal Generator 4. Multimeter 5. Watt meter 6. Clamp meter Design of a system using renewable energy

d. BIOMEDICAL ELECTRONICS

Course Name	FUNDAMENTALS OF BIOMEDICAL ENGINEERING
Course Description	Introduction to the concepts of Human Anatomy and Medical Terminology; Basic Pathology, Diagnostics and Therapy; Origins and Meaning of Bio-signals; Electrodes for Measurement of Bio-signals; Physiological Instrumentation; Methods for Measurements of pressure flow and volume in the context of blood and respiratory gases; Sources of ionizing radiation; Radiation protection and safety, societal issues in biomedical engineering
Number of Units for Lecture and Laboratory	3 units lecture, 1 unit lab
Number of Contact Hours per week	3 hours lec, 3 hours lab
Program Outcome/s	m-D
Prerequisite	Physics 2
Course Objectives	Upon completion of the course, the student will: 1. define the basic terminologies and basic concepts of biomedical engineering 2. develop an appreciation for biomedical engineering and an awareness if the social issues involved. 3. develop specific knowledge in different aspects of biomedical engineering such as biomechanics, prostheses, biomaterials, biomedical instrumentation, biomedical imaging and equipment
Course Outline	1. Introduction to Biomedical Engineering 2. Bioelectricity, bio-potentials, electrophysiology 3. Biomechanics 4. Physiological systems: cardiovascular, neuromuscular, respiratory 5. Mathematical modelling 6. Transport processes: mass, fluid, energy, heat, oxygen 7. Neural Engineering and prostheses 8. Biomedical signals and images, Biosensors, bio-optics 9. Biomedical Instrumentation, Bioelectronics 10. Biomedical imaging and Biomedical Equipment 11. Social issues in Biomedical Engineering
Laboratory Equipment	Physiological Equipment; Computers and Simulation Softwares

Course Name	MEDICAL IMAGING
Course Description	Focuses on the on the theory of 2-D Signals and systems; Image Sampling and Quantization; Image Transforms: 2-D Discrete; Fourier Transforms: 2-D Discrete Cosine Transform; Image Enhancement; Image Restoration; Image coding (JPEG, MPEG); electromagnetic spectrum, ultrasound physics, Basic Atomic and Nuclear Physics, Principles of operation of X-ray machine and film developer, computed tomography Scan, Magnetic Resonance Imaging, Positron Emission Tomography, Gamma Camera, Ultrasound Machine. Image creation and its acquisition by equipment and nuclear image processing
Number of Units for Lecture and Laboratory	3 units lecture, 1 unit lab

Number of Contact Hours per week	3 hours lec, 3 hours lab
Program Outcome/s	m-D
Prerequisite	Physics 2
Course Objectives	Upon completion of the course, the student will: 1. describe the principles of operation of various medical imaging techniques. 2. be familiar with Biomedical Imaging, Instrumentation, and equipment 3. understand how an image is created in each of the major imaging modalities including x-ray, computed tomography, magnetic resonance, ultrasound, and nuclear. 4. implement common image processing methods and algorithms using software tools
Course Outline	1. Introduction to Imaging 2. Image processing: enhancement, restoration, feature extraction, modelling, recognition and interpretation 3. Radiation 4. X-ray imaging and fluoroscopy 5. computed tomography 6. Ultrasound imaging 7. Magnetic resonance imaging 8. Nuclear imaging including 9. New emerging modalities
Laboratory Equipment	Computer and simulation software - Laboratory exercises on basic Image processing operations - Exercises that allow students to implement basic image processing techniques used in medical imaging Project: Students will give a presentation related to medical imaging on a topic of their choice.

e. INSTRUMENTATION AND CONTROL

Course Name	**ADVANCED INSTRUMENTATION AND CONTROL**
Course Description	Introduction to advanced instrumentation and control systems to include study on Non Linear Systems, Stability, Model Reference Adaptive Control, Self Tuning Regulators, Recent trends and applications of adaptive Control and Optimal Control
Number of Units for Lecture and Laboratory	3 units lecture, 1 unit lab
Number of Contact Hours per week	3 hours lec, 3 hours lab
Program Outcome/s	m-D
Prerequisite	Feedback and Control Systems
Course Objectives	Upon completion of the course, the student will: 1. analyze first and second order systems 2. analyze system performances 3. design a model for an industrial application

Course Outline	1. Non Linear Systems 2. Stability 3. Model Reference Adaptive Control 4. Self Tuning Regulators 5. Recent trends and applications of adaptive Control 6. Optimal Control
Laboratory Equipment	Perform experiments using MATLAB or any equivalent software out of following 1. Analysis of first order/second order non-linear system. 2. Effect of Dominant pole and Critical pole on system performance. 3. Stability analysis of first order/ second order system by describing function method. 4. Obtain the stability of a system by Frequency domain criteria. 5. Study of Direct/indirect model reference adaptive control system. 6 Study of multivariable self-tuning regulators. 7. Analysis of Multivariable systems using step input 8. Any one Industrial Application of model reference control-a Survey. 9. Design of state observer 10. Design of linear filter.

Course Name	**ROBOTICS TECHONOLOGY**
Course Description	Introduction to Robotics to include Actuators & Drives, Control Components, Control Software, Kinematics, Differential Motion, Statics, Energy Method, Hybrid Position – Force Control, Non-holonomic Systems, Dynamics, Computed Torque Control
Number of Units for Lecture and Laboratory	3 units lecture, 1 unit lab
Number of Contact Hours per week	3 hours lec, 3 hours lab
Program Outcome/s	m-D
Prerequisite	Electronics 3
Course Objectives	Upon completion of the course, the student will: 1. familiarize with the basic robotic concepts 2. analyze system performances 3.design and implement a prototype
Course Outline	1. Introduction to Robotics 2. Actuators & Drives 3. Control Components 4. Control Software 5. Kinematics 6. Differential Motion 7. Statics, Energy Method 8. Hybrid Position – Force Control 9. Non-holonomic Systems 10. Dynamics 11. Computed Torque Control 12. Sensors
Laboratory Equipment	Perform experiments using any available software 1. Embedded Root Controller 2. I/O Interface and PWM Amplifier

	3. Controller software and Sensor Inputs 4. Implement Basic Sensor-based controls Prototype implementation

f. BUILDING INFORMATION AND COMMUNICATIONS TECHNOLOGY INFRASTRUCTURE

Course Name	**ICT INFRASTRUCTURE**
Course Description	ICT infrastructure covers the composite hardware, software, network resources and services required for the existence, operation and management of an enterprise IT environment. Topics on Hardware: Servers, computers, data centers, switches, hubs and routers, and other equipment; Software: Enterprise resource planning (ERP), customer relationship management (CRM), and other productivity applications; Network: Network enablement, internet connectivity, firewall and security.
Number of Units for Lecture and Laboratory	3 units lecture, 1 unit lab
Number of Contact Hours per week	3 hours lec, 3 hours lab
Program Outcome/s	m-D
Prerequisite	None
Course Objectives	1. Identify the key components of an ICT Infrastructure 2. Understand the stages and technology drivers of ICT Infrastructure Evolution 3. Evaluate the trends in Computer Hardware and Software platforms 4. Analyze and solve the challenges/ problems of managing IT Infrastructure
Course Outline	1. Defining IT Infrastructure, Evolution of IT Infrastructure, Technology Drivers of Infrastructure Evolution 2. Infrastructure Components: Computer Hardware Platforms, Operating System Platforms, Enterprise Software applications, Data Management and Storage, Networking/ Telecommunications Platforms, Internet Platforms, Consulting and System Integration Services 3. Hardware Platforms: The Emerging Mobile Digital Platform, Grid Computing, Virtualization, Cloud Computing, Green Computing, High performance and Power Saving Processors, Automatic Computing and other latest trends 4. Software Platforms: Linux and Open Source Software, Software for the Web, Web Services and Service-Oriented Architecture, Software Outsourcing and Cloud Services 5. Management Issues: Dealing with Platform and Infrastructure Change, Management and Governance, Making wise Infrastructure Investments
Laboratory Equipment	Any available software and equipment to perform experiments with the topics included.

Course Name	ELECTRONICS ANCILLARY SYSTEM
Course Description	This course deals with the different types of Electronic Building Auxiliary Systems such as Voice and Data, FDAS, PABGM, CCTV and Access Control, including its components and functions. Design and production of electronics layout plan with technical specifications based on the best practices of bill of quantities.
Number of Units for Lecture and Laboratory	3 units lecture, 1 unit lab
Number of Contact Hours per week	3 hours lec, 3 hours lab
Program Outcome/s	m-D
Prerequisite	Electronics 3
Course Objectives	1. Design an Electronic Building Auxiliary System 2. Prepare cost Estimates and Bill of Quantities 3. Implement and troubleshoot an Electronic Building Auxiliary System
Course Outline	1. Introduction to Electronic Building Auxiliary Systems, types, familiarization with standard symbols and Electronics Layout Plan 2. Transmission Media 3. Familiarization of Structured Cabling Standards 4. Structured Cabling Fundamentals and Elements 5. Cabling System Design 6. Building Code and Fire Safety Issues 7. Fire Detection and Alarm System 8. Public Address and Background Music System 9. Fundamentals of CCTV and Access Control 10. Bonding and Grounding 11. Design Estimation & Preparation of Bill of Quantities 12. Wiring, Installation and Troubleshooting
Laboratory Equipment	Any available software and equipment to perform experiments with the topics included.

g. COMPUTER

Course Name	COMPUTER SYSTEMS ARCHITECTURE
Course Description	This course deals with the design and performance evaluation of advanced/high performance computer systems. The emphasis is on microprocessors, chip-multiprocessors and memory hierarchy design. Historical information is presented as well along with data storage and low-power dissipation schemes. Special attention is paid to pipelining, ILP (instruction-level parallelism), DLP (data-level parallelism) and TLP (thread-level parallelism) using hardware and/or software techniques to yield high performance.
Number of Units for Lecture and Laboratory	3 units lecture, 1 unit lab
Number of Contact Hours per week	3 hours lec, 3 hours lab
Program Outcome/s	m-D
Prerequisite	Computer Prog

Course Objectives	1. Understand the inner workings and performance capabilities of advanced microprocessors. 2. An ability to evaluate hardware accelerators targeting at applications with substantial data-level parallelism (DLP). 3. Learn software-driven techniques to match application requirements to available pipelined hardware in order to obtain high performance. 4. An ability to estimate the static and dynamic power dissipation of given hardware modules. 5. An ability to design microprocessor-based systems by accounting for performance and power dissipation. 6. An ability to anticipate hardware performance improvements based on established rules from past experiences with computer technology. 7. Improve report-writing skills when presenting results for computer design and evaluation. 8. Learn the differences among multiscalar, superpipelined, multithreaded, simultaneous multithreaded, vector, and multicore processors. 9. Understand the forces behind the computer industry's shift to multicore processors. 10. Understand cache coherence issues. 11. An ability to design advanced memory hierarchies. 12. Understand the basic differences between shared-memory and message-passing interprocessor connection networks. 13. An ability to select appropriate computer systems for given application domains. 14. Understand what hardware and software problems will require solutions for future generations of multicore processors targeting at thread-level parallelism (TLP) and heterogeneous systems.
Course Outline	1. Fundamentals of Quantitative Design and Analysis 2. Instruction Set Principles 3. Pipelining: Basic and Intermediate Concepts 4. Review of Memory Hierarchy 5.Memory Hierarchy Design 6. Instruction-Level Parallelism and Its Exploitation 7. Thread-Level Parallelism 8. Data-Level Parallelism in Vector, SIMD, and GPU Architectures
Laboratory Equipment	Any available software and equipment to perform experiments with the topics included.

Course Name	**OPERATING SYSTEMS & ADVANCED PROGRAMMING LANGUAGES**
Course Description	The topics are primarily based on CPU and memory management starting from the hardware architecture before moving to process scheduling and resource allocation. Here only central memory allocation is considered because the disk allocation has been considered in the first part of the course. Some general properties of process synchronization are investigated dealing with the classical problem of critical regions, producer-consumer relationship and the more general framework of the client-server schema.
Number of Units for Lecture and Laboratory	3 units lecture, 1 unit lab
Number of Contact Hours per week	3 hours lec, 3 hours lab

Program Outcomes Link(s) addressed by the course	m-D
Prerequisite	Computer Prog
Course Objectives	1. The aim of the course is to acquaint the student with the software machinery devoted to control the processing operations of a computer. 2. to understand the fundamental mechanisms which are the normal working background of the current computer systems. 3. The course terminates with a short presentation of O.S. kernels.
	1. Computer Architectures - RISC versus CISC architecture - Event-driven versus instruction-driven computing - RISC architectures: ARM, PowerPC, SPARC, MIPS, Alpha, Cell **2. Operating Systems Services** - User Interface - Program Execution - I/O Operation - File System manipulation - Resource Allocation - Accounting - System Calls **3. Processes** - Process Concept - Process Scheduling - Operations on Process - Interprocess Communication **4. Client-Server Systems Threads** - Multithreading Models - Thread Libraries and Issues - Operating System Example: 1. Windows XP Threads 2. Linux Threads **5. CPU Scheduling** - Basic Concepts - Scheduling: Criteria & Algorithms - Thread Scheduling - Multiple-Processor Scheduling - Operating Systems Examples - Algorithm Evaluation **6. Process Synchronization** - Definition - The Critical-Section Problem - Synchronization Hardware - Semaphores - Synchronization Problems - Monitors - Synchronization Examples - Atomic Transactions

Course Outline	**7. Deadlocks** - The Deadlock Problem - System Model - Deadlock Characterization - Methods for Handling Deadlocks: 1. Deadlock Prevention 2. Deadlock Avoidance 3. Deadlock Detection - Recovery from Deadlock **8. Memory Management** - Background - Swapping - Contiguous Memory Allocation - Paging - Structure of the Page Table - Segmentation - Example: The Intel Pentium **9. Virtual Memory** - Background - Demand Paging - Copy-on-Write - Page Replacement - Allocation of Frames - Thrashing - Memory-Mapped Files - Allocating Kernel Memory - Other Considerations - Operating-System Examples
Laboratory Equipment	Any available software and equipment to perform experiments with the topics included.

h. BROADCASTING

Course Name	BROADCAST PRODUCTION ENGINEERING
Course Description	Discusses operation of audio and video equipment including amplifiers, processors, audio/video mixers, distribution amps, TV cameras, microphones, monitors systems integration, studio electro-acoustics and lighting, TV and radio transmitters and propagation, coverage map calculation and frequency analysis, broadcast networking, broadcast ancillary services (STL's and satellite links). Also includes CATV technology and DTH.
Number of Units for Lecture and Laboratory	3 units lec, 1 unit lab
Number of Contact Hours per week	3 hours lec, 3 hours lab
Program Outcome/s	m-D
Prerequisite	Communications 4

Course Objectives	Upon completion of the course, the student must be able to:
	1. To understand, identify and analyze the broadcast communications systems concepts, elements and applications. To differentiate the different broadcasting techniques such as AM, FM and TV.
	2. To design AM, FM and TV broadcasting network which includes coverage mapping and interference.
	3. To understand the principle and application of Acoustic system.
	4. To introduce digital broadcasting; Digital Television (DTV) and Digital Audio Broadcasting (DAB).
	5. To design a AM, FM and TV station which includes the design of the following:
	  1. Studio System.
	  2. Technical Operation Center (TOC)
	  3. Transmission System
	  4. Coverage mapping and prediction
	  5. Interference study

Course Outline	1. Introduction to AM Broadcasting System and Standards 2. AM Studio System design 3. AM Transmission System Design 4. AM Coverage Mapping and Prediction 5. Introduction to FM Broadcasting System and Standards 6. FM Studio System Design 7. FM Transmission System Design 8. FM Coverage Mapping and Prediction 9. Introduction to TV Broadcasting System and Standards 10. RF System 11. NTSC-Color TV Broadcasting 12. TV Studio System Design 13. Studio Wiring Diagram 14. Technical Operation Center (TOC) System Design 15. TOC Wiring Diagram 16. Transmission System Design 17. TV Coverage Mapping and Prediction 18. Introduction to Engineering Acoustic 19. Room Acoustic 20. Microphones 21. Speakers

Laboratory Equipment	Broadcast Training Modules to perform the following experiments:
	1. Sound level measurements
	2. Microphones
	3. Speakers
	4. Characteristics of Mixers, Tone Controls, and Crossover Networks
	5. Design projects to cover at least two of the following areas:
	  • AM or FM radio station
	  • TV station
	  • CATV

Course Name	BROADCAST PRODUCTION ENGINEERING
Course Description	Course includes the applications in different areas of broadcasting such as television, AM, FM, cable television, telecommunications, data communications, studio acoustics etc. through experiments and field researches; basic equipment or devices used for transmission of signals such as filters and oscillators, radio frequency power amplifiers and mixers, basic circuits of modulation and demodulation, transmitters and studio equipment
Number of Units for Lecture and Laboratory	3 units lec, 1 unit lab
Number of Contact Hours per week	3 hours lec, 3 hours lab
Program Outcome/s	m-D
Prerequisite	Communications 4
Course Objectives	Upon completion of the course, the student must be able to: 1. familiarize with the applications in different areas of broadcasting such as television, AM, FM, cable television, telecommunications, data communications, studio acoustics etc. through experiments and field researches 2. identify basic equipment or devices used for transmission of signals such as filters and oscillators, radio frequency power amplifiers and mixers, basic circuits of modulation and demodulation, transmitters and studio equipment 3. understand the basic concepts of broadcasting and obtain the knowledge of designing a simple AM/FM transmitter
Course Outline	**1. Audio Principles** 1.1. Decibel scale and units 1.2. Balanced lines 1.3. Principles and types of microphones 1.4. Basic audio measurements and test gear 1.5. Sampling theory and its application to audio signals 1.6. Audio data rate reduction systems for recording and transport of audio signals including an overview of psychoacoustic techniques **2. Television Principles** 2.1. Concepts of Scanning 2.2. Video waveform signal bandwidth 2.3. Low frequency response and DC restoration 2.4. Sampling theory and its application to the digital studio standard 2.5. Effect of distortion and bit errors on picture 2.6. Generation of color component signals 2.7. International TV standards: Overview of different PAL standards, SECAM and NTSC, Problems of standards conversion **3. AM Transmitter** AM transmitter circuits and its modulation process **4. FM Transmitter** Basic FM transmitter circuits and its modulation process **5. AM Broadcasting** Actual set-up of devices/equipment used in AM broadcasting **6. FM Broadcasting** To know the actual set-up of devices/equipment used in FM broadcasting **7. TV Broadcasting** Actual set-up of devices/equipment used in TV broadcasting **8. CATV Broadcasting**

	Actual set-up of devices/equipment used in CATV broadcasting **9. Satellite Navigation and Global Positioning System:** 9.1. Radio and Satellite navigation 9.2. GPS position location principles 9.3. GPS receivers and Codes 9.4. Satellite signal acquisition 9.5. GPS navigation message 9.6. GPS signal levels 9.7. Timing accuracy 9.8. GPS receiver operation
Laboratory Equipment	Broadcast Training Modules to perform the experiments related to the topics included. **Practical:** 1. Field visit to broadcasting stations 2. Field visit to VSAT stations.

ANNEX IV – LABORATORY REQUIREMENTS

BS ELECTRONICS ENGINEERING

CHEMISTRY LABORATORY EXERCISES

Course Name	**CHEMISTRY FOR ENGINEERS (Laboratory)**
Course Description	A fundamental laboratory course designed to relate and apply the principles and theories in chemistry to engineering practices. It is a combination of experimental and calculation laboratory.
Number of Units for Lecture and Laboratory	1 laboratory unit
Number of Contact Hours per Week	3 hours per week
Prerequisites	None
Co-requisites	Chemistry for Engineers (Lecture)
Program Outcome/s Addressed by the Course	a-I, b-I, k-I
Course Outcomes	At the end of the course, the students must be able to: 1. Explicitly state experimental observation in relation to specific principles and fundamental concepts of chemistry 2. Interpret results clearly obtained from the experiments 3. Answer questions related to the performed experiment 4. Develop critical and technical communication skills 5. Explain the mechanics of alpha, beta and gamma decay as well as the correlation between the half-lives 6. Understand the natural environment and its relationships with human activities. 7. Design and evaluate strategies, technologies, and methods for sustainable management of environmental systems and for the remediation or restoration of degraded environments.
Course Outline	EXPERIMENTS: 1. Calorimetry 2. Heat of Combustion 3. Metals and Some Aspects of Corrosion 4. Mechanical Properties of Materials 5. Water: Its Properties and Purification 6. Determination of the Dissolved Oxygen Content of Water 7. Cigarette Smoking and Air Pollution ACTIVITIES: 1. Nuclear Reactions, Binding Energy and Rate of Decay 2. Crystal Lattices and Unit Cells 3. Community Immersion: Care for the Environment
Laboratory Equipment	Refer to Annex of Lab Requirements

SUGGESTED PHYSICS LABORATORY EXERCISES
(Pick 12 to relate with Covered Lecture Topics)

Exercise	Suggested Equipment
1. An exercise to illustrate the principles, use, and precision of the Vernier caliper and micrometer caliper	Ruler Vernier caliper Micrometer caliper Objects for measuring
2. An exercise to verify the graphical and analytical methods of determining resultant forces.	Force table Weight holder Masses Meter stick Protractor Alternate apparatus: Force frame Spring balance Weight holder Masses Ruler
3. An exercise to observe and verify the elements of motion along the straight line	Linear air track with blower and trolley Timer/stopwatch Meter stick Free fall apparatus Metal balls of different sizes Clamp Support rod Alternate apparatus: Spark timer/ticker timer Paper tape Stopwatch Plane board with stand Clamp Wooden cart Scissors Carbon paper Masking tape Meter stick
4. An exercise to observe and verify the elements of motion in two dimensions	Blackwood ballistic pendulum Metal ball Meter stick Carbon paper Inclined plane Protractor Alternate apparatus: Projectile apparatus Metal ball/plastic solid ball Photogate Timer/stopwatch Time of flight receptor pad Carbon paper White paper Meter-stick

5. An exercise to verify the laws of motion	Atwood's machine Masses Stopwatch String Alternate apparatus: Frictionless dynamic track Smart pulley Stopwatch Weight holder String Clamp
6. An exercise to determine the coefficients of static and kinetic friction of various surfaces	Friction board with pulley Friction block with different surfaces Glass plate of size similar to friction board Platform/triple beam balance Weight holder Meter stick Slotted masses, 5-500g
7. An exercise to verify the work-energy theorem	Dynamic cart Frictionless dynamic track Masses Weight holder Clamp String Timer/stopwatch Platform/triple beam balance Support rod
8. An exercise to verify the principles of conservation of mechanical energy	Metal stand Clamp Metal ball String Meter stick Cutter blade Hanging mass Carbon paper White paper Masking tape
9. An exercise to verify the principles of conservation of momentum	Ramp/launcher Metal stand Clamp Metal balls of different sizes Meter stick Carbon paper White paper Masking tape

10. An exercise to verify the condition of the body in rotational equilibrium	Demonstration balance Vernier caliper Platform/triple beam balance Masses Meter stick
11. An exercise to verify the forces involved in uniform circular motion	Centripetal force apparatus Meter stick Mass with hook Platform/triple beam balance Stopwatch
12. An exercise to verify the principle of simple harmonic motion	Clamp Masses Weight holder Meter stick Support rod Spring Alternate apparatus: Hooke's Law apparatus
13. An exercise to measure specific gravity	Liquids: Hydrometer jar U-tube Inverted U-tube Beaker Masses Meter stick Vernier caliper Specimen of liquids Solids: Beam balance Hydrometer jar Beaker Thread Thermometer Specimen of solids Alternate apparatus: Mohr-Westpal Balance
14. An exercise to observe and verify the elements of transverse wave motion	Sonometer Weight holder Set of masses Tuning forks of three different frequencies Rubber hammer Meter stick
15. An exercise to determine the specific heats of solids by the methods of mixture	Calorimeter Stirrer for shot Specimen for shot Thermometer Platform/triple beam balance Beaker Ice Water

16. An exercise to measure the coefficient of linear expansion	Thermal expansion apparatus Steam generator Ohmmeter/VOM Connectors Basin/container Hot and cold water
17. An exercise to measure the mechanical equivalent of heat	Mechanical equivalent of heat apparatus Ohmmeter/VOM Mass (10 kg) Thermometer Vernier caliper Platform/triple beam balance
18. An exercise to observe and verify the elements of electric charge	Van de Graff generator Tissue paper Aluminum foil Metal conductor with insulated handle Fluorescent lamp Masking Tape Power Source Galvanometer Conducting paper Field mapper kit/mapping Apparatus Connectors
19. An exercise to illustrate Ohm's Law	Panel board/circuit board VOM or multitester DC power supply Bridging plugs/connecting wires Fixed resistor SPST switch SPDT switch Alternate apparatus: Bread board Jumper
20. An exercise to determine and compare the resistance of different conductors	1-m slide wire/ wheatstone bridge Power supply VOM or multitester Galvanometer Potentiometer Fixed resistor Unknown resistor SPST switch Connecting wires
21. An exercise to verify the principles of series and parallel connections	Panel board/circuit board VOM or multitester DC power supply Bridging plugs/connecting wires Fixed resistors Alternate apparatus: Bread board Jumper

22. An exercise to verify the relationship among the electromotive force, current, and resistance of cells in series and parallel	Dry cells Switch VOM or multitester Resistors Panel board/circuit board Bridging plugs/connecting wires Alternate apparatus: Bread board Jumper
23. An exercise to observe the applications of Kirchhoff's Law	Power supply Fixed resistors VOM or multitester Bridging plugs/connecting wires Panel board/circuit board Alternate apparatus: Bread board Jumper
24. An exercise to determine the electrical equivalent of heat	Electric calorimeter Thermometer Beam balance Masses Stop watch VOM or multitester Rheostat DC power source Connecting wires Switch
25. An exercise to observe the relationships between resistance and capacitance in the circuit	Power source Fixed capacitor (330 microfarad) Fixed Resistor (100 ohms) Connecting wires VOM or multitester Stopwatch
26. An exercise to observe the principle of magnetic field	Natural magnets Horseshoe magnets Bar magnets Ring Glass plate Iron fillings Frame for bar magnets Compass Mounted straight wire Coil Solenoid Battery Reversing switch Alternate apparatus: Tesla meter / tangent galvanometer

27. An exercise to demonstrate the Faraday's law of electromagnetic induction	Coils Galvanometer VOM or multitester AC power supply Bar magnets Connecting wires
28. An exercise to verify the law of reflection and refraction	Optics bench Light source, sodium/mercury lamps Ray table and base Component holder Slit plate Slit mask Ray optics mirror Cylindrical lens
29. An exercise to investigate and study the image formation in mirror and lenses	Optic bench Light source Ray table and base Component holder Parallel ray lens Slit plate Ray optics mirror 5 cm focal length spherical mirror -15cm focal length concave lens 10cm/7.5 cm focal length convex lens 15 cm focal length convex lens Viewing screen Crossed arrow target

CIRCUITS 1 LAB

Laboratory Equipment	DC Training Module that can perform the following experiments: 1. Familiarization with DC Equipment 2. Parallel & Series connection of linear resistors 3. Delta-Wye transformation of resistive networks 4. DC power measurement 5. Kirchhoff's Law 6. Superposition Law 7. Thevenin's Theorem 8. Bridge circuits 9. RC/RL Time constant curve 10. Maximum Power Transfer

CIRCUITS 2 LAB

Laboratory Equipment	AC Training Module that can perform the following experiments: 1. Familiarization with AC instruments 2. Impedance of RC circuits 3. Impedance of RLC circuits 4. Power dissipation in AC circuits 5. Measurement of Power Factor 6. Three Phase circuit 7. Power in 3-phase balanced load 8. Transformer 9. Frequency response of RL and RC 10. Maximum Power transfer

SIGNALS, SPECTRA & SIGNAL PROCESSING

Laboratory Equipment	Training module in signal processing or equivalent to perform the following experiments: 1. Periodic Signals 2. Non-periodic Signals 3. Computation of Transforms 4. Sampling and Quantization 5. Measurements on Filter Response 6. FIR Filter Analysis and Design 7. IIR Filter Analysis and Design Software requirement: Signal Processing

ELECTRONICS 1 LAB

Laboratory Equipment	Electronics Training Module or set of equipment and components that can perform the following experiments: 1. Solid state Diode familiarization 2. Diode Applications 3. Power Supply 3. Transistor familiarization 4. Transistor applications 5. JFET familiarization and characteristic curves 6. BJT familiarization and characteristic curves 7. Pre-amplifiers Recommended List of Equipment: 1. Power Supplies 2. Signal Generator 3. Oscilloscope 4. Curve Tracer 5. Digital Multimeter

ELECTRONICS 2

Laboratory Equipment	Electronics Training Module or set of equipment and components that can perform the following experiments: 1. Frequency response of a transistor amplifier 2. Cascaded transistor amplifier 3. The differential amplifier 4. The operational amplifier 5. The transistor as a switch 6. Familiarization with digital circuits 7. Filters
	Recommended List of Equipment: 1. Power Supplies 2. Signal Generators 3. Oscilloscope 4. Digital Multimeter 5. Spectrum Analyzer 6. Logic Analyzer

ELECTRONICS 3

Laboratory Equipment	Electronics Training Module or set of equipment and components that can perform the following experiments: 1. SCRs, UJT, PUT 2. TRIAC, DIAC and other Thyristors 3. Optoelectonic Devices and Sensors 4. Transducers 5. Interfacing techniques 6. Programmable Logic Controllers Plus design of at least (2) systems applications included in the outline.
	Recommended List of Equipment: 1. Power Supplies 2. Signal Generators 3. Oscilloscope 4. Digital Multimeter 5. Spectrum Analyzer 6. Logic Analyzer 7. PLCs

COMMUNICATIONS 1: PRINCIPLES OF COMMUNICATION SYSTEMS

Laboratory Equipment	Training modules in Analog Communications or equivalent to perform the following experiments: 1. Passive, Active Filters, Tuned Circuits 2. AM Transmitter 3. Frequency Modulation 4. Pulse Amplitude Modulation 5. Diode Detection 6. Time Division Multiplexing 7. Frequency Division Multiplexing Suggested *Project* : superheterodyne receiver

COMMUNICATIONS 2: MODULATION AND CODING TECHNIQUES

Laboratory Equipment	Digital Training Modules or equivalent to perform the following experiments. 1. PAM 2. Noise 3. FSK 4. ASK 5. PSK 6. PCM 7. Error Detection and Correction *Suggested Project*: A hardware or a computer simulation to illustrate the application of modulation and coding techniques.

COMMUNICATIONS 3: DATA COMMUNICATIONS

Laboratory Equipment	Training modules in two wire and four wire circuits, modems, SDH, SONET Suggested design project in data communication system design and networking

COMMUNICATIONS 4: TRANSMISSION MEDIA, ANTENNA SYSTEM AND DESIGN

Laboratory Equipment	Training Modules in Transmission lines, antennas, microwave and Optical Fibre Communications Systems to perform the following laboratory exercises: 1. Transmission Lines 2. Antennas 3. Measurement of Frequency, Wavelength, Phase Velocity in Waveguides 4. Generation of Microwaves 5. Detection of Microwaves 6. Attenuation measurement 7. Optical Fibre System: numerical aperture, attenuation, modal theory

DIGITAL ELECTRONICS 1: LOGIC CIRCUITS AND SWITCHING THEORY

Laboratory Equipment	Training modules or equivalent to perform the following experiments: 1. Diode digital logic gates 2. Transistor digital logic gates 3. Integrated digital logic gates 4. Flip Flops 5. Registers 6. Counters (binary, ripple, decade, etc...) Logic Circuit Project Design, construction and testing

DIGITAL ELECTRONICS 2: MICROPROCESSOR & MICROCONTROLLER SYSTEMS AND DESIGN

Laboratory Equipment	Experiment topics include: 1. assembly language programming topics, 2. interfacing with input and output devices, 3. data transfer between micro controller-based circuits and the PC via the serial port and parallel port Microcontroller/microprocessor trainers or equivalent, emulators, personal computers if not provided by trainer, include the following: 1. Assembler, cross-compiler, debugger 2. Seven-segment or LCD displays 3. Switches and keypads 4. Motors with TTL-input drivers Suggested Project: An embedded system using a microcontroller demonstrating integration with I/O devices and communication with a PC.

ECE ELECTIVE LABORATORY

HEIs shall provide necessary and adequate laboratory equipment to the specialized elective courses included in the curriculum covering the topics included in the minimum course description and outline.

Annex V – SAMPLE COURSE SYLLABUS

BS ELECTRONICS ENGINEERING

Course Name	**ELECTRONIC DEVICES AND CIRCUITS (LECTURE)**
Course Description	Introduction to quantum mechanics of solid state electronics; diode and transistor characteristics and models (BJT and FET); diode circuit analysis and applications; transistor biasing; small signal analysis; large signal analysis; transistor amplifiers; Boolean logic; transistor switch.
Number of Units	3 units
Number of Contact Hours per week	3 hours
Prerequisite	Physics 2; Integral Calculus
Course Outcomes	Upon completion of the course, the student must be able to: 1. Explain the basic concept of atomic theory and relate it to the characteristics of materials **(POa, POe, POi)** 2. Discuss the construction, basic operation, characteristics and configurations of semiconductor diodes **(POa, POb, POe, POi)** 3. Analyze the function of semiconductor diode in some practical applications **(POa, POb, POe, POi)** 4. Discuss the basic structure, operation and characteristics of Bipolar Junction Transistors (BJT) **(POa, POb, POe, POi)** 5. Discuss the different configurations, DC Biasing and some practical applications of BJT **(POa, POb, POe, POi)** 6. Discuss the basic structure, operation and characteristics of Field Effect Transistors (FET) **(POa, POb, POe, POi)** 7. Discuss the different configurations, DC Biasing and some practical applications of FET **(POa, POb, POe, POi)**
Course Outline	1. Introduction of Semiconductors • Discuss the concept of atomic theory, and the subatomic particles of the atom. (CO1) • Identify and differentiate conductors, semiconductors and insulators. (CO1) • Discuss the crystal structure of the common semiconductor materials and ions formed from covalent bonding. (CO1) • Explain the general characteristics of three important semiconductor materials: Ge, Si and GaAs. (CO2) • Explain the concept of conduction in semiconductors using electron and hole theory. (CO2) • Differentiate the difference between n – type and p – type materials. (CO2) 2. Diode Equivalent Circuits • Explain what happens in a diode during no bias, forward bias, and reverse bias conditions. (CO2) • Identify the three equivalent model of the diode and plot its corresponding characteristic curves. (CO2) • Calculate current and voltage for circuits with diode connected in series, parallel or series–parallel using the different equivalent diode models. (CO2)

	• Explain the diagram of a basic power supply and determine the waveform produced by each block. (CO3)
Course Outline	3. Wave Shaping Circuits • Explain the process of rectification using diodes to establish a pulsating dc from a sinusoid ac input. (CO3) • Calculate and determine the output waveform of half-wave and full-wave rectified signal. (CO3) • Calculate and determine the resulting output waveform of a bridge type, transformer-coupled and center-tapped transformer rectifier. (CO3) • Design a clipper circuit given an output and an input. (CO3) • Analyze the output response of a clipper circuit. (CO3) • Design a clamper circuit given an output and an input. (CO3) • Analyze the output response of a clamper circuit. (CO3) 4. Special Diode Application • Interpret the characteristic curves of a zener diode. (CO2) • Draw the equivalent circuit of a zener diode. (CO2) • Explain how a zener diode produces a constant level of dc voltage during reverse bias condition. (CO2) • Solve circuits with zener diodes. (CO2) • Discuss the basic characteristics and operation of LED's, photodiodes, Schottky, varactor, pin, step recovery, tunnel, and laser diodes. (CO2) 5. Power Supply And Voltage Regulation • Discuss how a voltage input is amplified with the use of capacitors and diodes. (CO3) • Compute the ripple voltage produced by filtering a rectified output with the use of a capacitor. (CO3) • Discuss how a ripple is produced. (CO3) 6. Bipolar Junction Transistor • Describe the basic structure of the BJT. • Explain how a BJT is biased and discuss the transistor currents and their relationships. (CO4) • Discuss transistor parameters and characteristics and use this to analyze a transistor circuit. (CO4)

	• Identify and differentiate the schematic symbol and construction of an npn and pnp transistor. (CO4) • Discuss how a transistor amplifies an input voltage/ current. (CO5) • Discuss the operation of a transistor in cut-off and saturation region. (CO4) • Discuss the operation of a transistor in common configuration: common base, common collector, and common emitter. (CO5) • Measure the important voltage levels of a BJT configuration and use them to determine whether the network is operating properly. (CO4) • Analyze the saturation and cut-off conditions of a BJT network and the expected voltage and current levels established by each condition. (CO4) • Apply proper biasing of a transistor to ensure proper operation in the active region. (CO5) • Perform dc analysis of BJT using different biasing configurations. (CO5) 7. Small- Signal Analysis (BJT) • Use BJT in an application where its amplification and switching capabilities are used. (CO5) 8. Field Effect Transistor • Describe the basic structure of the JFET. (CO6) • Explain how a JFET is biased and discuss the transistor currents and their relationships. (CO6) • Discuss transistor parameters and characteristics and use this to analyze a transistor circuit. (CO6) • Identify and differentiate the schematic symbol and construction of a p – channel and an n- channel JFET. (CO6) • Sketch the transfer characteristics from drain characteristics of a JFET. (CO6) • Discuss the characteristics and operation of a D-MOSFET. (CO6) • Discuss the characteristics and operation of an E-MOSFET. (CO6) • Discuss the differences between the dc analyses of the various types of FET's. (CO7) • Apply proper biasing of a FET to ensure proper operation in the desired region. (CO7) • Perform dc analysis of JFET, MOSFET, and MESFET using different biasing configurations. (CO7) 9. Small-Signal and Large Analysis (FET) • Solve combination of FET's in a single network (CO7) • Use JFET in an application where its transfer characteristics are used. (CO7)