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

CHED MEMORANDUM ORDER
No. 92
Series of 2017

SUBJECT: POLICIES, STANDARDS AND GUIDELINES FOR THE BACHELOR OF SCIENCE IN CIVIL ENGINEERING (BSCE) 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 an outcomes-based quality assurance system as advocated under CMO 46 s. 2012 (Policy-Standard to Enhance Quality Assurance (QA) in Philippine Higher Education through an Outcomes-Based and Typology-Based Quality Assurance) and as addendum to CMO 37, s. 2012 (Establishment of an Outcomes-Based Educational System in Higher Education Institutions offering Engineering Programs), and by virtue of Commission en banc Resolution No. 788-2017 dated October 24, 2017 the following Policies, Standards and Guidelines (PSG) are hereby adopted and promulgated by the Commission.

ARTICLE I
INTRODUCTION

Section1. Rationale

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

ARTICLE II
AUTHORITY TO OPERATE

Section 2. Government Recognition

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

ARTICLE III
GENERAL PROVISIONS

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

Section 3. Minimum Standards

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

Using a learner-centered/outcomes-based approach, CHED provided a description of Outcomes-Based Teaching and Learning delivery method in Article V Section 13. A sample course syllabus is also given in Article V Section 14 as support to the outcomes-based delivery method.

Based on the curriculum and the means of its delivery, CHED determines the physical resource requirements for the library, laboratories and other facilities and the human resource requirements in terms of Administration and faculty. These are provided for in Article VI.

Section 4. Curriculum Design

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

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

ARTICLE IV
PROGRAM SPECIFICATIONS

Section 5. Program Description

5.1 Degree Name

The degree program described herein shall be called Bachelor of Science in Civil Engineering (BSCE)

5.2 Nature of the Field of Study

Civil Engineering is a profession that applies the basic principles of science in conjunction with mathematical and computational tools to solve problems associated with developing and sustaining civilized life on our planet. Civil Engineering works are generally one-of-a-kind projects; they are often grand in scale; and they usually require cooperation among professionals of many different disciplines. The completion of a civil engineering project involves the solution of technical problems in which information from numerous sources and myriad non-technical factors play a significant role. Some of the most common examples of civil engineering works include bridges, buildings, dams, airports and hangars, ports and harbors, highways and railways, tunnels, river and shore improvements, lighthouses, drydocks, irrigations, flood protection, drainage, water supply, and towers. Enumeration of any work in this section shall not be construed as excluding any other work requiring civil engineering knowledge and application.

Civil Engineering is one of the broadest engineering disciplines both in terms of the range of problems that fall within its purview and in the range of knowledge required to solve those problems.

5.3 Program Educational Objectives

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

5.4 Specific Professions/Careers/Occupations for Graduates

The scope of the practice of Civil Engineering is defined in the Civil Engineering Law of 1950 or R.A. 544 and embrace services

in the form of consultation, design, preparation of plans, specifications, estimates, erection, installation and supervision of the construction of streets, bridges, highways, railroads, airports and hangars, port works, canals, river and shore improvements, lighthouses, and dry docks; buildings, fixed structures for irrigation, flood protection, drainage, water supply and sewerage works; demolition of permanent structures; and tunnels. The enumeration of any work in this section shall not be construed as excluding any other work requiring civil engineering knowledge and application.

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

5.5 Allied Programs

The allied programs to BSCE are Architecture, Electrical Engineering, Electronics Engineering, Computer Engineering, Geodetic Engineering, Industrial Engineering, Management Engineering, Mechanical Engineering, and Sanitary Engineering.

Section 6. Institutional and Program Outcomes

The minimum standards for the BSCE program are expressed in the following minimum set of institutional and BSCE program outcomes. The Program Outcomes also conform to the Level 6 Descriptors as specified in the Philippine Qualifications Framework (PQF).

6.1 Institutional outcomes

a) Graduates of professional institutions must demonstrate a service orientation in one's profession,
b) Graduates of colleges must participate in various types of employment, development activities, and public discourses, particularly in response to the needs of the communities one serves
c) Graduates of universities, in addition must participate in the generation of new knowledge or in research and development projects
d) Graduates of State Universities and Colleges and Local Universities and Colleges must, in addition, have the competencies to support "national, regional and local development plans." (RA 7722).
e) Graduates of higher educational institutions must preserve and promote the Filipino historical and cultural heritage.

6.2. BSCE Program Outcomes

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

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

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

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

Section 7. Sample Performance Indicators/Criteria

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

Table 1. Sample Performance Indicators of a Program Outcome

PROGRAM OUTCOMES		PERFORMANCE INDICATORS	
e	Ability to identify, formulate, and solve complex civil engineering problems	1	Identify problem/s in a community that requires expertise in Civil Engineering based on needs assessment
		2	Formulate problem statement, objectives, scope and limitations and identify resources required to solve the problem/s
		3	Provide technical solution/s to the problem that is acceptable to the stakeholders. Use of appropriate modern tools to solve the problems must be demonstrated

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 Table 2.

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

Performance Indicators		Key Courses	Assessment Tools
1	Identify problem/s in a community that requires expertise in Civil Engineering based on needs assessment	CE Project	OBE Assessment Rubric
2	Formulate problem statement, objectives, scope and limitations and identify resources required to solve the problem/s	CE Project	OBE Assessment Rubric
3	Provide technical solution/s to the problem that is acceptable to the stakeholders. Use of appropriate modern tools to solve the problems must be demonstrated	CE Project	OBE Assessment Rubric

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

Key Courses	Assessment Tools	Targets and Standards
CE Project	OBE Assessment Rubric	70% of the students shall have a rating of at least 80%
CE Project	OBE Assessment Rubric	70% of the students shall have a rating of at least 80%
CE Project	OBE Assessment Rubric	70% of the students shall have a rating of at least 80%

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

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

Section 9. Continuous Quality Improvement

There shall 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 (CQI).

ARTICLE V
CURRICULUM

Section 10. Curriculum Description

The Civil Engineering curriculum is designed to prepare graduates to apply knowledge of mathematics, calculus-based physics, chemistry, and at least one additional area of basic science, consistent with the BSCE Program Educational Objectives; apply knowledge of technical areas appropriate to civil engineering; conduct civil engineering experiments and analyze and interpret the resulting data; design a system component, or process in more than one civil engineering context; explain basic concepts in management, business, public policy, and leadership; and explain the importance of professional licensure.

The CE curriculum has five (5) tracks of specialization. It is designed to prepare graduates in accordance with the institutional and program outcomes discussed in Article IV Section 6 in 5 Areas of Specialization of Civil Engineering courses.

The curriculum has a minimum total of 171 credit units, comprising of 121 units of technical courses. These technical courses include 15 units of mathematics, 10 units of natural/physical sciences, **23** units of basic engineering sciences, 6 units of allied courses, **49** units of professional courses (common), 15 units of professional courses (specialized) and 3 units On- the-Job-Training (OJT).

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

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

Section 11. Minimum Curriculum

11.1. Components:

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

Classification/ Field / Course	Minimum No. of Hours		Minimum Credit Units
	Lecture	Lab/Fldw/Comp	
I. TECHNICAL COURSES			
A. Mathematics			
Calculus 1	3	0	3
Calculus 2	3	0	3
Differential Equations	3	0	3
Engineering Data Analysis	3	0	3
Numerical Solutions to CE Problems	2	3	3
Sub-Total	**14**	**3**	**15**
B. Natural/Physical Sciences			
Chemistry for Engineers	3	3	4
Physics for Engineers (Calculus-based)	3	3	4
Geology for Civil Engineers	2	0	2
Sub-Total:	**8**	**6**	**10**
C. Basic Engineering Sciences			
Civil Engineering Orientation	2	0	2
Engineering Drawing and Plans	0	3	1
Computer Fundamentals and Programming	0	6	2
Computer-Aided Drafting	0	3	1
Statics of Rigid Bodies	3	0	3
Dynamics of Rigid Bodies	2	0	2
Mechanics of Deformable Bodies	4	0	4
Engineering Economics	3	0	3
Technopreneurship 101	3	0	3
Engineering Management	2	0	2
Sub-Total:	**19**	**12**	**23**
D. Allied Courses			
Engineering Utilities 1	3	0	3
Engineering Utilities 2	3	0	3
Sub-Total:	**6**	**0**	**6**
E. Professional Courses- Common			
Fundamentals of Surveying	3	3	4
Construction Materials and Testing	2	3	3
Structural Theory	3	3	4
Highway and Railroad Engineering	3	0	3
Building Systems Design	2	3	3
Principles of Steel Design	2	3	3
Principles of Reinforced/ Prestressed Concrete	3	3	4
Hydraulics	4	3	5
Hydrology	2	0	2
CE Law, Ethics and Contracts	2	0	2
Geotechnical Engineering 1 (Soil Mechanics)	3	3	4
Principles of Transportation Engineering	3	0	3
Quantity Surveying	1	3	2

Classification/ Field / Course	Minimum No. of Hours		Minimum Credit Units
	Lecture	Lab/Fldw/Comp	
Construction Methods and Project Management	3	0	3
CE Project 1	1	3	2
CE Project 2	1	3	2
Sub-Total:	**38**	**33**	**49**
F. Professional Courses – Specialized (HEI to offer at least four courses in each area of chosen specialization)			
Sub-Total:	**15**	**0**	**15**
G. On-the-Job Training (minimum of 240 hours)	2	3	3
Sub-Total:	**2**	**3**	**3**
TOTAL TECHNICAL COURSES	**102**	**57**	**121**
II. NON-TECHNICAL COURSES			
A. General Education (Please refer to CMO 20, s. 2013)			
Science, Technology, and Society	3	0	3
Readings in Philippine History	3	0	3
Mathematics in the Modern World	3	0	3
Contemporary World	3	0	3
Understanding the Self	3	0	3
Purposive Communication	3	0	3
Art Appreciation	3	0	3
Ethics	3	0	3
Sub-Total:	**24**	**0**	**24**
B. GEC Elective/Mandated Courses			
GE Elective	9	0	9
Life and Works of Rizal	3	0	3
Sub-Total:	**12**	**0**	**12**
C. Physical Education			
Physical Education 1, 2, 3 and 4	8	0	8
Sub-Total:	**8**	**0**	**8**
D. National Service Training Program			
NSTP 1 and 2	6	0	6
Sub-Total:	**6**	**0**	**6**
TOTAL NON-TECHNICAL COURSES	**50**	**0**	**50**
GRAND TOTAL	**152**	**57**	**171**

SUGGESTED PROFESSIONAL COURSES - SPECIALIZED:

A. CONSTRUCTION ENGINEERING AND MANAGEMENT

Project Construction and Management
Advanced Construction Methods & Equipment
Construction Cost Engineering
Database Management in Construction
Construction Occupational Safety and Health (COSH)

B. GEOTECHNICAL ENGINEERING

Geotechnical Engineering 2 (Rock Mechanics)
Foundation Engineering
Geotechnical Earthquake Engineering
Ground Improvement

C. STRUCTURAL ENGINEERING

Computer Softwares in Structural Analysis
Earthquake Engineering
Design of Steel Structures
Reinforced Concrete Design
Prestressed Concrete Design
Structural Design of Towers and Other Vert. Structures
Bridge Engineering
Foundation and Retaining Wall Design

D. TRANSPORTATION ENGINEERING

Transportation Systems Planning and Design
Highway Engineering
Airport Design
Ports and Harbors

E. WATER RESOURCES ENGINEERING

Water Resources Engineering
Flood Control and Drainage Design
Irrigation Engineering
Water Supply Planning and Development
Coastal Engineering
River Engineering
Ground Water Flow Modeling

Other Professional Courses- Specialized shall be offered and developed by the HEIs in accordance with their needs. The corresponding course description shall be likewise submitted to CHED.

The HEIs shall offer at least one track of professional courses - specialized. This specialization shall appear in the Transcript of Records and Diploma for example "Bachelor of Science in Civil Engineering (Geotechnical)"

SUMMARY OF THE BSCE CURRICULUM

Classification/ Field	Total No. of Hours		Total No. of Units
	Lecture	Lab/Fldw/Comp	
I. TECHNICAL COURSES			
A. Mathematics	14	3	15
B. Natural/Physical Sciences	8	6	10
C. Basic Engineering Sciences	19	12	23
D. Allied Courses	6	0	6
E. Professional Courses (Common)	38	33	49
F. Professional Courses- Specialized (minimum)	15	0	15
G. On-the-Job Training (minimum of 240 hrs)	2	3	3
Sub- Total	**102**	**57**	**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	0	8
D. National Service Training Program	6	0	6
Sub-Total	**50**	**0**	**50**
GRAND TOTAL	**152**	**57**	**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 pre-requisites and co-requisites are complied with.
The sample Program of Study listed below is meant for HEIs operating on a Semestral System. HEIs with CHED approved trimester or quarter term systems may adjust their courses and course specifications accordingly to fit their delivery system, as long as the minimum requirements are still satisfied.

The HEIs are also encouraged to include other courses to fulfill their institutional outcomes, as long as the total units for the whole program shall not be less than **171 units**, including P.E., and NSTP.

SAMPLE SEMESTRAL PROGRAM OF STUDY

FIRST YEAR

1st Year – First Semester

Courses	No. of Hours		Units	Prerequisite/Co-requisite
	Lecture	**Lab/Fldw/Comp**		
Science, Technology and Society	3	0	3	None
Mathematics in Modern World	3	0	3	None
Calculus 1	3	0	3	None
Chemistry for Engineers	3	3	4	None
Civil Engineering Orientation	2	0	2	None
Readings in Philippine History	3	0	3	None
PE 1			2	None
NSTP 1			3	None
TOTAL	**17**	**3**	**23**	

1st Year – Second Semester

Courses	No. of Hours		Units	Prerequisite/Co-requisite
	Lecture	**Lab/Fldw/Comp**		
Contemporary World	3	0	3	None
Understanding the Self	3	0	3	None
Calculus 2	3	0	3	Calculus 1
Physics for Engineers (Calculus Based)	3	3	4	Calculus 1/ Co-requisite of Calculus 2
Engineering Drawing and Plans	0	3	1	None
Computer Fundamentals and Programming	0	6	2	None
Life and Works of Rizal	3	0	3	None
PE 2			2	None
NSTP 2			3	None
TOTAL	**15**	**12**	**24**	

SECOND YEAR

2nd Year – First Semester

Courses	No. of Hours		Units	Prerequisite/Co-requisite
	Lecture	**Lab/Fldw/Comp**		
Differential Equations	3	0	3	Calculus 2
Computer-Aided Drafting	0	3	1	None
Statics of Rigid Bodies	3	0	3	Calculus 2, Physics for Engineers
Fundamentals of Surveying	3	3	4	Engineering Drawing and Plans
Engineering Economics	3	0	3	2nd Year Standing
Engineering Management	2	0	2	
Purposive Communication	3	0	3	None
GEC Free Elective-1 (please refer to CMO 20, s. 2013)	3	0	3	
PE 3			2	None
TOTAL	**20**	**6**	**24**	

2nd Year – Second Semester

Courses	No. of Hours		Units	Prerequisite/Co-requisite
	Lecture	**Lab/Fldw/Comp**		
Engineering Data Analysis	3	0	3	None
Geology for Civil Engineers	2	0	2	Chemistry for Engineers
Dynamics of Rigid Bodies	2	0	2	Statics of Rigid Bodies
Mechanics of Deformable Bodies	4	0	4	Statics of Rigid Bodies
Construction Materials & Testing	2	3	3	(Co-requisite) Mechanics of Deformable Bodies
Art Appreciation	3	0	3	None
GEC Free Elective-2 (please refer to CMO 20, s. 2013)	3	0	3	None
PE 4			2	None
TOTAL	**19**	**3**	**22**	

THIRD YEAR

3rd Year – First Semester

Courses	No. of Hours		Units	Prerequisite/Co-requisite
	Lecture	Lab/Fldw/Comp		
Structural Theory	3	3	4	Mechanics of Deformable Bodies
Highway and Railroad Engineering	3	0	3	Fundamentals of Surveying
Engineering Utilities 1	3	0	3	Physics for Engineers
Engineering Utilities 2	3	0	3	Physics for Engineers
Numerical Solutions to CE Problems	2	3	3	Differential Equations
Ethics	3	0	3	None
GEC Free Elective-3 (please refer to CMO 20, s. 2013)	3	0	3	None
TOTAL	**20**	**6**	**22**	

3rd Year – Second Semester

Courses	No. of Hours		Units	Prerequisite/Co-requisite
	Lecture	Lab/Fldw/Comp		
Technopreneurship 101	3	0	3	3rd Year Standing
Building Systems Design	2	3	3	Engineering Drawing and Plans
Principles of Steel Design	2	3	3	Structural Theory
Principles of Reinforced/Prestressed Concrete	3	3	4	Structural Theory
Hydrology	2	0	2	3rd Year Standing
Hydraulics	4	3	5	3rd Year Standing
CE Law, Ethics and Contracts	2	0	2	3rd Year Standing
TOTAL	**18**	**12**	**22**	

Summer

Courses	No. of Hours		Units	Prerequisite/Co-requisite
	Lecture	Lab/Fldw/Comp		
On-the-Job Training – 240 Hours	2	3	3	
TOTAL	**2**	**3**	**3**	

Note: OJT may be taken after the Third Year Level OR after the fourth year level

FOURTH YEAR

4th Year – First Semester

Courses	No. of Hours		Units	Prerequisite/Co-requisite
	Lecture	**Lab/Fldw/Comp**		
Geotechnical Engineering 1 (Soil Mechanics)	3	3	4	Geology for Civil Engineers, Mechanics of Deformable Bodies
Principles of Transportation Engineering	3	0	3	Highway and Railroad Engineering
CE Project 1	1	3	2	4th Year Standing
Professional Course- specialized 1	3	0	3	4th Year Standing
Professional Course- specialized 2	3	0	3	4th Year Standing
TOTAL	**13**	**6**	**15**	

Note: Other professional course- specialized can be added

4th Year – Second Semester

Courses	No. of Hours		Units	Prerequisite/Co-requisite
	Lecture	**Lab/Fldw/Comp**		
CE Project 2	1	3	2	CE Project 1
Quantity Surveying	1	3	2	Building Systems Design
Professional Course - specialized 3	3	0	3	4th Year Standing
Professional Course - specialized 4	3	0	3	4th Year Standing
Professional Course - specialized 5	3	0	3	4th Year Standing
Construction Methods and Project Management	3	0	3	4th Year Standing
TOTAL	**14**	**6**	**16**	

Note: Other professional course- specialized can be added

Grand Total = 171 Units

* The nth Year Standing means that the student must have completed at least 75% of the load requirements of the previous year level.

Section 12. Sample Curriculum Map

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

Section 13. Description of Outcomes-Based Teaching and Learning

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

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

A key component of a course design using OBTL is the constructive alignment of ILOs, TLAs, and ATs. This design methodology requires the Intended Learning Outcomes to be developed first, and then the Teaching / Learning Activities and Assessment Tasks are developed based on the ILOs. (Biggs, 1999)

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

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

Section 14. Course Syllabus and Course Specifications:

The Course Syllabus must contain at least the following components:

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

Refer to **Annex III** for Sample Course Specifications for the courses listed in the Sample Curriculum Map and **Annex V** for Sample Course Syllabus.

ARTICLE VI
REQUIRED RESOURCES

This article covers the specific required resources for the BSCE program.

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

Section 15. Administration

The administration of the college of engineering must provide academic governance and leadership to engineering programs by exerting efforts to achieve program educational objectives and program outcomes. As such, the college must have a full-time dean and full-time department or program chair who are adept in the principles of outcomes-based education and are trained to implement the elements of OBE and OBTL required by CMO 37 s. 2012.

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

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

a) shall be holder of baccalaureate degree and Master's degree in Civil Engineering;
b) shall be registered Civil Engineer with valid PRC license;
c) shall have a minimum teaching experience of not less than three (3) years and at least three (3) years of industry practice.

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

Section 16. Faculty

16.1 Requirements

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

There shall be adequate number of competent and qualified faculty to teach professional courses of BSCE program to effectively implement the minimum curricular requirements. The program shall not be dependent on one faculty handling professional courses.

In addition, by AY 2018-2019, all full-time faculty members teaching professional courses in BSCE shall be holder of Master's degree in Civil Engineering or Allied Programs.

16.2 Duties

The faculty shall be actively involved in the following areas of implementation of B.S.C.E program:

a. curriculum review, decision-making, and implementation of the academic program
b. program assessment and evaluation, and implementation of continuous improvement of the program
c. development, improvement, and achievement of course outcomes (COs)
d. enrichment of teaching/learning activities(TLAs)
e. development and improvement of assessment tasks, constructively aligned with COs and TLAs
f. student advising activities of the program
g. research and scholarly work
h. professional services offered by the program
i. linkage and extension work

Section 17. Library and Other Learning Resources

The library services and other learning resources are covered in Section 2.3 of CMO No. 86, s. 2017.

Section 18. Laboratory Equipment and Resources

18.1 Facilities

Facilities are covered in Section 2.4, 5.4 of CMO No. 86, s. 2017.

18.2 Laboratories for the BSCE Program

18.2.1. Laboratories for the BSCE Program

The program shall provide laboratories/fieldwork/drafting facilities for the following courses:

1. Chemistry for Engineers
2. Physics for Engineers
3. Hydraulics
4. Geotechnical Engineering 1 (Soil Mechanics)
5. Construction Materials and Testing
6. Engineering Drawing and Plans
7. Fundamentals of Surveying
8. Building Systems Design
9. Quantity Surveying

The program shall provide adequate computing facilities for courses in Computer Fundamentals and Programming, Computer-Aided Drafting, Design, Numerical Solutions for CE Problems and open computer laboratory for CE Projects.

Refer to **Annex IV** for the Laboratory equipment and resources required for the program,

18.2.2 Modern Tools in CE

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

18.3 Modernization of Equipment

Each CE Department of the college of engineering shall have a program for the continuing modernization and upgrading of its

instructional laboratories, facilities, and equipment. The said program shall have an adequate annual allocation in accordance with the financial capability of the school.

18.4 Calibration of Equipment

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

ARTICLE VII
COMPLIANCE OF HEIs

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

Before the start of AY 2018-2019, all HEIs offering BSCE program 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 BSCE program a Monitoring Workbook (CMO 37-MW-2017-HEI-BSCE) and Self-Assessment Rubric (SAR) (CMO-37-HEI-SAR-2017-BSCE).

The five-year BSCE. 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 to continue or start their BSCE 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 BSCE 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 BSIE program for AY 2018-2019.

19.3 Exemptions

HEIs with BSCE Programs of CODs/COEs status 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-BSCE). See Section 20. Those HEIs whose COD/COE applications were disapproved for AY 2018-2019 shall still comply with Sections 19.1 and 19.2.

Section 20. Application Workbook for AY 2018-2019

HEIs currently offering the BSCE program for AY 2018-2019 shall be made to complete a new Application Workbook (AW-2018- HEI-BSCE) 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 BSCE programs with COE or COD status submitting their completed Application Workbooks shall automatically receive certifications from CHED and shall be given approval to implement their programs beginning AY 2018-2019.

Other concerned HEIs which have submitted their CMO Monitoring Workbooks, Self-Assessment Rubrics, and Application Workbook shall be given conditional approval by CHED to start offering their new BSCE 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 the HEI with BSCE programs with weak implementation may be asked to submit developmental plans, which shall be subject to constant monitoring.

ARTICLE VIII
TRANSITORY, REPEALING and EFFECTIVITY PROVISIONS

Section 22. Transitory Provision

All private HEIs, state universities and colleges (SUCs) and local universities and colleges (LUCs) with existing authorization to operate the Bachelor of Science in Civil 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 of a Civil Engineer
Annex II – Minimum Program Outcomes and a Sample Curriculum Map
Annex III – Sample Course Specifications
Annex IV – Laboratory Equipment
A. Natural/Physical Courses
B. Professional Courses
Annex V – Sample Syllabus

ANNEX I - COMPETENCY STANDARDS, ATTRIBUTES AND COMPETENCIES OF A CIVIL ENGINEER

Civil Engineer (noun) – is a professional who provides services in the form of consultation, planning, design, preparation of plans, specifications, estimates, erection, installation, and supervision of construction of streets, bridges, highways, and railroads; airports and hangars; portworks, canals, river and shore improvements, light houses, and dry docks; buildings, towers, signages, sign boards, chimneys, silos containment structures, and solid waste disposal sites; fixed structures for irrigation, flood protection, drainage, water supply, and sewerages work; tunnels; and demolition of permanent structures.

ATTRIBUTES AND COMPETENCIES OF A CIVIL ENGINEER				
ATTRIBUTES		COMPETENCY LEVEL		
		NEW GRADUATE	1 - 7 YEARS ENGG. EXPERIENCE	GLOBALLY QUALIFIED ENGINEER (APEC/ASEAN)
1	Apply knowledge of mathematics, chemistry, physics, Information Technology and other engineering principles	Understand the principles of mathematics, chemistry, physics, natural and applied sciences including information technology. Determine relevant and appropriate applied science, engineering principles and techniques that can be used to address engineering concerns such as Construction Engineering and Management, Geotechnical and Geo-Environmental Engineering, Structural Engineering, Transportation Engineering, Water Resources Engineering.	Use relevant and appropriate applied science, engineering principles and techniques in the different Civil Engineering tracks to solve complex engineering problems. Develop simple computer programs to solve Civil engineering problems.	Propose innovations in design of structures, water resources system, highways, railroads, and foundation, and impart these to peers. Develop and continually upgrade proficiency in numerical and computational modeling in solving Civil engineering problems.

ATTRIBUTES AND COMPETENCIES OF A CIVIL ENGINEER				
ATTRIBUTES		COMPETENCY LEVEL		
		NEW GRADUATE	1 - 7 YEARS ENGG. EXPERIENCE	GLOBALLY QUALIFIED ENGINEER (APEC/ASEAN)
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 from research of literature and other technological advances in design of structures, water resources system, highways, railroads, and foundation reaching to substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences	Consolidate results of research and technical information in formulating solutions to Civil engineering design and adapt these into systems to achieve efficiency 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 and safety, cultural, societal, and environmental considerations.	Study, investigate and gather data related to complex engineering problems and propose solutions based on the fundamentals of engineering principles while incorporating ethics, safety and environmental considerations.	Study, investigate and gather data related to problems in design of structures, water resources system, highways, railroads, and foundation and prepare proposals to implement solutions while incorporating ethics, safety and environmental considerations. Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.	Consolidate studies made on problems in structures, water resources system, highways, railroads, and foundation and propose changes. Specialize in specific fields of practice in the Civil Engineering Professional and use the technical expertise in design of solutions to applicable complex engineering problems. Prepare project proposals, budget and reports related to the design of structures. Impart learnings to peers.

ATTRIBUTES AND COMPETENCIES OF A CIVIL ENGINEER				
ATTRIBUTES		COMPETENCY LEVEL		
		NEW GRADUATE	1 - 7 YEARS ENGG. EXPERIENCE	GLOBALLY QUALIFIED ENGINEER (APEC/ASEAN)
4	Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.	Conceptualize, formulate and implement design of experiments in a standard scientific manner in conducting investigations of complex engineering problems with consideration of cost, quality, security, and environmental impact.Recommend valid conclusions based on gathered information and results of investigation.	Use available database information, coordinate with other technical experts, plan and design experiments in conducting investigations of complex engineering problems, prepare reports and make presentations to concerned entities on the proposed solutions to the complex engineering problems.	Organize teams of experts, plan and design experiments in conducting investigations of complex engineering problems.Prepare feasibility, optimization reports, implementation plans and make presentations to the concerned entities on the proposed solutions to the complex engineering problems.
5	Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to solve complex engineering problems, with an understanding of the limitations.	Be familiar with the appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations. Recommend the applicable modern tools that can be used to solve complex engineering problems.	Be proficient in the use of 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.	Be familiar with applicable modern tools and techniques to solve complex engineering problems taking into consideration their limitations. Use civil engineering 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.

ATTRIBUTES AND COMPETENCIES OF A CIVIL ENGINEER				
ATTRIBUTES		COMPETENCY LEVEL		
		NEW GRADUATE	1 - 7 YEARS ENGG. EXPERIENCE	GLOBALLY QUALIFIED ENGINEER (APEC/ASEAN)
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 Civil Engineering Professional Practice.Make a personal commitment to societal, health, safety, legal and cultural issues recognising obligations to society, subordinates, and the environment.	Utilize relevant policies, laws, regulations and technical standards both locally and internationally in conjunction with the Civil Engineering Professional Practice.Prepare plans and designs while taking into consideration moral, ethical and environmental concerns.Impart learning to peers.	Employ relevant policies, laws, regulations and technical standards both locally and internationally in conjunction with the Civil Engineering Professional Practice.Be familiar with specific country regulations on professional engineering practice in implementing solutions to complex engineering problems.Prepare plans and designs 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 Civil engineering practice. Assess the effects of professional engineering work on design of structures. 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 Civil engineering practice. Use gained experience in civil engineering 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 Civil engineering practice. Use gained experience in civil engineering 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.

ATTRIBUTES AND COMPETENCIES OF A CIVIL ENGINEER				
ATTRIBUTES		COMPETENCY LEVEL		
		NEW GRADUATE	1 - 7 YEARS ENGG. EXPERIENCE	GLOBALLY QUALIFIED ENGINEER (APEC/ASEAN)
8	Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.	Be familiar with the Code of Ethics of Civil Engineers (PICE) and apply and behave according to this code in professional practice.Apply ethical principles in conjunction with engineering practice.	Be familiar with the Code of Ethics of Civil Engineers (PICE) and apply and behave according to this code in professional practice.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.	Practice the Code of Ethics of Civil Engineers and apply and behave according to this code in professional practice.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.

ATTRIBUTES AND COMPETENCIES OF A CIVIL ENGINEER				
ATTRIBUTES		COMPETENCY LEVEL		
		NEW GRADUATE	1 - 7 YEARS ENGG. EXPERIENCE	GLOBALLY QUALIFIED ENGINEER (APEC/ASEAN)
10	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	Prepare reports, presentations and other engineering documents in an organized way and relay information related to these effectively.Communicate clearly both verbally and in written form all instructions to peers, subordinates and superiors as may be deemed necessary.Organize, coordinate and implement activities or projects in a clear way.	Prepare reports, presentations and other engineering documents in an organized way and relay information related to these effectively.Prepare policies, procedures and other documents related to an activity or project and cascade to subordinates, peers and superiors effectively.Conduct trainings to subordinates and peers.Communicate clearly with legal entities/ authorities regarding engineering activities.	Consolidate reports and make presentations to peers and superiors on projects or on assigned endeavors .Conduct trainings to subordinates, peers and superiors.Communicate and coordinate clearly and act as liaison officer on matters concerning legal or regulatory issues.Prepare policies, rules, regulations, instructions, procedures and implements them.
11	Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	Plan, lead, organize and control small projects or tasks as may be deemed necessary in the practice of Civil engineering.	Plan, lead, organize and control small to medium-sized projects or tasks as may be deemed necessary in the practice of Civil 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 Civil engineering. Manage financial aspects of the project. Manage supervisors and peers. Prepare reports related to projects.

ATTRIBUTES AND COMPETENCIES OF A CIVIL ENGINEER				
ATTRIBUTES		COMPETENCY LEVEL		
		NEW GRADUATE	1 - 7 YEARS ENGG. EXPERIENCE	GLOBALLY QUALIFIED ENGINEER (APEC/ASEAN)
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 Civil engineering profession. Pursue graduate studies.	Attend trainings, seminars, conferences and participate in professional organizations that encourage continued learning in the Civil 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 Civil 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

Bachelor of Science in Civil Engineering

Program Outcomes

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

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

Sample Curriculum Map

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

I. TECHNICAL COURSES

A. Mathematics

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

B. Natural and Physical Sciences

COURSES	*Relationship to Program Outcomes*												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Chemistry for Engineers	I	I									I		
Physics for Engineers (Calculus-based)	I	I									I		
Geology for Civil Engineers					E	E		D	E	E	I		

C. Basic Engineering Sciences

COURSES	*Relationship to Program Outcomes*												
	a	b	c	d	e	f	g	h	i	j	k	L	m
Civil Engineering Orientation						I		I		I			
Engineering Drawing and Plans				E		I	I				E		
Computer Fundamentals and Programming	I										E		
Computer-Aided Drafting	I										D		
Statics of Rigid Bodies	I												
Dynamics of Rigid Bodies	I												
Mechanics of Deformable Bodies	E				D								
Engineering Economics	E										E		
Engineering Management							E		E			E	
Technopreneurship 101													

D. Allied Courses

COURSES	*Relationship to Program Outcomes*												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Engineering Utilities 1			E	E		E	E		E				
Engineering Utilities 2			E	E		E	E		E				

E. Professional Courses - Common

COURSES	*Relationship to Program Outcomes*												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Fundamentals of Surveying		D		E	I		E				E		
Construction Materials and Testing	E	D		E			E			E	E		
Structural Theory	E	I			E						I		
Highway and Railroad Engineering	E		E		E		E						
Building Systems Design			E	E	E	I	I	I		I	E		
Principles of Steel Design	E	I									E		
Principles of Reinforced/Prestressed Concrete	E	I									E		
Hydraulics	E	D		E	E		E						
Hydrology	E				E		E				E		
CE Law, Ethics and Contracts						D	E						
Geotechnical Engineering 1 (Soil Mechanics)	E	D		E	E		E			E	E		
Principles of Transportation Engineering	E		D			D							
Quantity Surveying	E			E		E	E		E		E	E	
Construction Methods and Project Management	E		D		E	E	D				D	E	
CE Project 1	E	D	D	D	D	D	D	D			D	D	
CE Project 2	E	D	D	D	D	D	D	D			D	D	

F. Professional Courses – Specialized (HEI to select five courses per track)

F.1 Construction Engineering and Management

COURSES	*Relationship to Program Outcomes*												
	a	b	c	d	e	f	g	h	l	j	k	l	m
Project Construction and Management							E		E	E	E	E	E
Advanced Construction Methods & Equipment							E		E	E	E	E	E
Construction Cost Engineering							E		E	E	E	E	E
Database Management in Construction							E			E	E	E	E
Construction Occupational Safety and Health (COSH)							E		E	E		E	E

F.2 Geotechnical Engineering

COURSES	*Relationship to Program Outcomes*												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Geotechnical Engg 2 (Rock Mechanics)	E		E		E		E	E			E		D
Foundation Engineering	E		D		E		E	E			D		D
Geotechnical Earthquake Engineering	E		D		E		E	E			D		D
Ground Improvement	E		D		E		E	E			D		D

F.3 Structural Engineering

COURSES	*Relationship to Program Outcomes*												
	a	b	c	d	E	f	g	h	i	j	k	l	m
Computer Softwares in Structural Analysis											D		D
Earthquake Engineering	E		E				E				E		D
Design of Steel Structures	E		E		E		E				E		D
Reinforced Concrete Design	E		E		E		E				E		D
Prestressed Concrete Design	E		E		E		E				E		D
Structural Design of Towers/Other Vert. Structures	E		E		E		E				E		D
Bridge Engineering	E		E		E		E				E		D
Foundation and Retaining Wall Design	E		E		E		E				E		D

F.4 Transportation Engineering

COURSES	*Relationship to Program Outcomes*												
	a	b	c	d	e	f	g	h	I	j	k	l	m
Transportation Systems Planning and Design	E		E		E		E			E	E		D
Highway Engineering	E		E		E		E		E	E	E		D
Airport Design	E		E		E		E	I	E	E			D
Ports and Harbors	E		E		E		E	I	E	E			D

F.5 Water Resources Engineering

COURSES	*Relationship to Program Outcomes*												
	a	b	c	d	e	f	g	h	I	j	k	l	m
Water Resources Engineering	D		D						E		E		D
Flood Control and Drainage Design	D				E		E				D		D
Irrigation Engineering	E				E		E				E		

Water Supply Planning and Development	D				E		E			E	D		D
Coastal Engineering	E		D		E		E						
River Engineering	E				E		E				E		D
Ground Water Modelling	E				E		E				D		D

G. On-the-job Training

COURSES	*Relationship to Program Outcomes*												
	a	b	c	d	e	f	g	h	i	j	k	l	m
On-the-job Training (minimum of 240 hours)				D		D	D	E	E	E	E	E	D

II. NON- TECHNICAL COURSES

A. General Education Courses

COURSES	*Relationship to Program Outcomes*												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Science, Technology, and Society				I			I	I	I				
Readings in Philippine History						I				I			
Mathematics in the Modern World	I				I								
Contemporary World								I	I	I			
Understanding the Self						I			I			I	
Purposive Communication							D						
Art Appreciation			I	I									
Ethics						I						I	

B. GEC Elective

COURSES	*Relationship to Program Outcomes*												
	a	b	c	d	e	f	g	h	i	j	k	l	m
GEC (3) Electives				I				I		I			

C. Mandated Courses

COURSES	*Relationship to Program Outcomes*												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Life and Works of Rizal				I		I			I				

ANNEX III – SAMPLE COURSE SPECIFICATIONS

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

1. TECHNICAL COURSES

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 unit lecture
Number of Contact Hours per Week	3 hours per week
Prerequisites	None
Program Outcome/s Addressed by the Course	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 curves 10. Applications of the Derivative 11. The Differential 12. Derivatives of Trigonometric Functions 13. Derivative of Inverse Trigonometric Functions 14. Derivative of Logarithmic and Exponential Functions 15. Derivative of the Hyperbolic Functions 16. Solutions of Equations 17. Transcendental Curve Tracing 18. Parametric Equations 19. Partial differentiation

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 t3ree-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 Addressed by the Course	a-l
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	**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 Addressed by the Course	a-l, k-l
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 1st 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 1st Order Differential Equations 3.1. Decomposition /Growth 3.2. Newton's Law of Cooling 3.3. Mixing (non-reacting fluids) 3.4. Electric Circuits 4. Linear Differential Equation of Order n 4.1. Introduction 4.1.1. 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)

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	Calculus 1
Program Outcome/s Addressed by the Course	a-I, b-I, k-I
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:	**NUMERICAL SOLUTIONS TO CE PROBLEMS**
Course Description	The course provides background on numerical analysis needed to solve civil engineering problems numerically when their analytical solution is either not available or difficult to obtain. MATLAB programming environment or its equivalent will be introduced and used in the course.
Number of Units for Lecture and Laboratory	3 units: 2 Units Lecture, 1 Unit Laboratory
Number of Contact Hours per week	2 hours Lecture 3 hours Laboratory
Prerequisite	Differential Equations
Co-Requisite	None
Program Outcome/s Addressed by the Course	a-E; e-D; g-E; i-E; j-E; k-D
Course Outcomes	After completing the course, the student must be able to: 1. Identify appropriate numerical/ mathematical tool or concepts suitable for the solution of the CE problem; 2. Analyze the CE problem to translate it to a numerical solution; 3. Use a computer software developing a solution to the problem. 4. Solve civil engineering problems numerically when their analytical solution is either not available or difficult to obtain.
Course Outline	**A. Lecture** 1. Review of the Mathematical Foundation - Physical Meaning of Derivatives and Integrals - Taylor Series Expansion - Definition of Matrix and Vector; Matrix Algebra - Summation, Subtraction and Multiplication of Matrices; Transpose, Determinant and Rank of a Matrix 2. Fundamentals of Computer aided mathematical calculations 3. Solving System of Linear Equations - Unique and Multiple Solutions, Trivial and Non-Trivial Solutions, No solution - Direct Methods - Gausss Elimination method - Gauss Elimination with Row Pivoting - Iterative Methods - Jacobi Method - Gauss-Seidel Method 3. Roots of Nonlinear Equations

	- Incremental Search Method - Bisection Method - Regula Falsi and Secant Methods - Newton-Raphson Method 4. Curve Fitting and Interpolation - Polynomial Interpolation – Lagrange and Newton's Polynomials - Cubic and Quadratic Spline Interpolation - Curve Fitting by Function Approximation - Least Squares Fit 5. Numerical Differentiation - Finite Difference Methods – Forward, Backward and Central Difference formulae - Derivatives for Noisy Data 7. Numerical Integration - Euler, Trapezoidal, Simpson and Gaussian Quadrature schemes. 8. Solution of Ordinary Differential Equations: Initial Value Problems - Euler's explicit method - Modified Euler's method, Midpoint method - Runge-Kutta methods (2^{nd}, 3^{rd} and 4^{th} order methods) - Modified Euler's Predictor-Corrector Method 9. Solution of Ordinary Differential Equations: Boundary-Value Problems - Shooting Method - Finite-Difference Method **Laboratory:** Faculty/ instructor shall develop applied CE problem exercises suitable for the various specialization of the program.
Laboratory Equipment	**Software** A program software suitable for numerical analysis calculations.
Suggested reference books	• Numerical Methods for Engineers and Scientists: An Introduction with Applications using MATLAB, Amos Gilat and Vish Subramaniam, John Wiley, First Edition 2007/2008 [Most but not all topics are covered in the text] • Applied Numerical Analysis - Using MATLAB, Laurene V. Fausett, Prentice Hall, 1999 [Good for computer codes but not so good for explanation]. • Applied Numerical Methods with MATLAB for Engineers and Scientists, Steven C. Chapra, McGraw Hill, 2^{nd} Edition 2007/2008

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	3 units lecture
Number of Contact Hours per Week	3 hours per week
Prerequisites	None
Co-requisites	Chemistry for Engineers Lab
Program Outcome/s Addressed by the Course	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

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-l, b-l, k-l
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 IV

Course Name	PHYSICS FOR ENGINEERS – CALCULUS BASED (Lecture)
	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	3 units lecture
Number of Contact Hours per Week	3 hours per week
Prerequisites	Calculus 1
Co-requisites	Calculus 2; Physics for Engineers Lab
Program Outcome/s Addressed by the Course	a-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	none

Course Name	**PHYSICS FOR ENGINEERS – CALCULUS BASED (Laboratory)**
Course Description	A fundamental laboratory course designed to relate and apply the principles and theories of physics.
Number of Units for Lecture and Laboratory	1 laboratory unit
Number of Contact Hours per Week	3 hours per week
Prerequisites	Calculus 1
Co-requisites	Calculus 2; Physics for Engineers (Lecture)
Program Outcome/s Addressed by the Course	a-l, b-l, k-l
Course Outcomes	At the end of the course, the students must be able to: 1. Perform experiments that relate and apply theories and principles of physics.

	2. Explicitly state experimental observation in relation to specific principles and fundamental concepts of physics. 3. Interpret results clearly obtained from the experiments. 4. Answer questions related to the performed experiment.
Course Outline	Pick 12 laboratory excises enumerated below to relate with covered lecture topics
Laboratory Equipment	Refer to Annex- IV

Course Name:	**GEOLOGY FOR CIVIL ENGINERS**
Course Description	Fundamentals of geology applied to civil engineering problems. Topics include rock and mineral types, soil properties, rock mechanics, geologic structures, active tectonics and earthquake hazards, slope stability and landslides, groundwater, rivers and flood hazards. Team projects include engineering geology case studies and site assessment investigations.
Number of Units for Lecture and Laboratory	2 units lecture
Number of Contact Hours per week	2 lecture hours per week
Prerequisite	Chemistry for Engineers
Co-Requisite	
Program Outcome/s Addressed by the Course	e-E, f-E, h-D, i-E, j-E
Course Outcomes	At the end of the course, the student must be able to: 1. Describe and explain the role of geology in the design and construction process of underground openings in rock 2. Apply geologic concepts and approaches on civil engineering projects. 3. Identify and classify rock using basic geologic classification systems. 4. Use the geologic literature to establish the geotechnical framework needed to properly design and construct heavy civil works rock projects.

	5. Utilize backgrounds in engineering and earth science to provide solutions to engineering problems within the context of the natural world.
Course Outline	I GENERAL GEOLOGY Geology in Civil Engineering - Branches of geology - Earth Structure and Composition - Elementary knowledge on continental drift and plate tectonics. Earth processes - Weathering - Work of rivers, wind and sea and their engineering importance – origin, occurrence of earthquake- Mode of occurrence - prospecting –Ground water - Importance in civil engineering. II MINERALOGY Elementary knowledge on symmetry elements of crystallographic systems - physical properties of minerals - study of the following rock forming minerals - Quartz family. Feldspar family, Augite, Hornblende, Biotite, Muscovite, Calcite, Garnet - properties, process of formation of all minerals - Coal and Petroleum - Their origin and occurence in India. III PETROLOGY Classification of rocks - Distinction between Igneous, Sedimentary and Metamorphic rocks. Description – occurrence, properties and distribution of following rocks. Igneous rocks - Granite, Syenite, Diorite, Gabbro, Pegmatite, Dolerite and Basalt. Sedimentary rocks - sandstone, Limestone, Shale, Conglomerate and breccia. Metamorphic rocks - Quartzite, Marble, Slate, Gniess and Schist. IV STRUCTURAL GEOLOGY AND ROCK MECHANICS Attitude of beds - Outcrops - Geological maps - study of structures - Folds, Faults and Joints - Their bearing on Engineering Construction - Rock mechanics - physical properties and mechanical properties of rocks – porosity – permeability - density – strength – hardness – elasticity – plasticity - dynamic property of rocks - types of wave theory – factors influencing wave velocity - static and dynamics moduli of elasticity – grouting. V GEOLOGICAL AND GEOPHYSICAL INVESTIGATION IN CIVIL ENGINEERING Site investigations - Geological methods - Exploration techniques - geophysical methods – Seismic and electrical methods – direct penetration – core boring – logging of cores – geological condition necessary for construction of dams – tunnels – building – Road cutting

Laboratory Equipment	None
Suggested reference books	Parbin Singh, "Engineering and General Geology ", Katson Publication House. P. C. Varghese, "Engineering Geology for Civil Engineers". PHI Learning Pvt. Ltd., Legeet, " Geology and Engineering ", McGraw Hill Book Company, 1998. 2. Blyth, " Geology for Engineers ", ELBS, 1995.

C. BASIC ENGINEERING SCIENCES

Course Name:	**CIVIL ENGINEERING ORIENTATION**
Course Description	Introduction to various tracks of specialization of civil engineering, emphasis on ethics, responsibility and professionalism.
Number of Units for Lecture and Laboratory	2 Units Lecture
Number of Contact Hours per week	2 Lecture hours per week
Prerequisite	High school algebra, geometry, and trigonometry.
Co-Requisite	
Program Outcome/s Addressed by the Course	f-I, h-I, j-I
Course Outcomes	After completing this course, the student must be able to: 1. Understand the history of Civil Engineering and the profession 2. Familiarize with the practices of Civil Engineers in relation to their interaction with society 3. Know the trend of Civil Engineering development 4. Understand the relationship of Civil Engineering to Environmental Science

Course Outline	1. History of Civil Engineering 2. Civil Engineering and Society and Other Professions 3. Current Fields/Careers of Civil Engineering a) Structural Engineering b) Construction Engineering and Management c) Geotechnical Engineering d) Water Resources Engineering e) Transportation Engineering f) Environment and Energy 4. Civil Engineering, Sustainability and the Future 5. Civil Engineering and Environmental Science
Laboratory Equipment	N/A
Suggested reference books	Donaldson, K., *The Engineering Student Survival Guide*, McGraw-Hill

Course Name:	**ENGINEERING DRAWINGS AND PLANS**
Course Description	This laboratory course is designed to develop abilities needed to develop, accurately locate and interpret dimensions on and read engineering drawings.
Number of Units for Lecture and Laboratory	1 Unit Laboratory
Number of Contact Hours per week	3 Laboratory hours per week
Prerequisite	
Co-Requisite	
Program Outcome/s Addressed by the Course	d-E; f-I; g-I; k-E
Course Outcomes	After completing this course, the student must be able to: • Be familiar with engineerings drawings. • Understand the concept of drafting. • Recognize the types of engineering drawings. • Properly utilize the scale within a given drawing. • Locate and recognize the revision of a given print. • Recognize which type of view, or views, appear on a drawing. • Identify the types of lines that appear on a drawing. • Understand dimensions and their respective tolerances.

Course Outline	Laboratory Faculty/ instructor shall develop student exercises that shall demonstrate the concepts enumerated herewith I. Introduction to the design process ▪ Drawing Instrument & their use. ▪ Types of lines & letters. ▪ Scales ▪ Dimensions & their Types. ▪ Planning of a Sheet. ▪ Types of Engineering Drawings. ▪ Geometric Constructions & Engineering Curves, Parabola, Ellipse & Hyperbola. A. Professional roles B. Documentation II. Use of the architectural and engineering scale A. Measuring components of working drawings B. Preparing sketches III. Freehand sketching and lettering techniques A. Use of tools B. Professional standards IV. Theory of orthographic projections A. 3-view drawings B. Elevations C. Sections V. Symbols and conventions used in architectural and engineering working drawings VI. Interpreting working drawings by type and relationships Building Drawings. ▪ Building symbols. ▪ Types of building drawings, proposed drawing, submission drawing, Working drawing & completion drawing. A. Site Plan B. Floor Plan C. Foundation and Floor Framing Plan D. Roof Framing Plan E. Sections F. Details G. Exterior and Interior Elevations H. Utility Plans VII. Working drawing content by drawing type A. Structural B. Electrical C. Mechanical and plumbing VIII. Common Code requirements A. Relationship to plan check documents B. Relationship to documents and drawings IX. Common specification information A. Organization

	B. Division content C. Description of materials X. Coordination of architectural drawings with structural, electrical, mechanical, and plumbing plans. XI. Introduction to Bridge Drawings XII Introduction to Building Information Modeling
Laboratory Equipment	Drafting Tables Computers Visualization Software for drawings
Suggested reference books	

Course Name	**COMPUTER FUNDAMENTALS AND PROGRAMMING**
Course Description	Basic information technology concepts; fundamentals of algorithm development; high-level language and programming applications; computer solutions of engineering problems.
Number of Units for Lecture and Laboratory	2 units laboratory
Number of Contact Hours per Week	6 hours laboratory
Prerequisite	Second Year Standing
Program Outcome/s Addressed by the Course	a-I, k-E
Course Outcomes	After completing this course, the student must be able to: 1. Explain basic information technology concepts and concepts 0f programming languages 2. Use application software and the Internet properly; 3. Use high-level programming languages by demonstrating proficiency in algorithm development; 4. Use the computer as a tool in engineering practice.

Course Outline	1. Introduction to Computers 1.1. Computer Organization 1.2. Number Systems and Data Representation 1.3. Application Software: Word Processing and Spreadsheet 1.4. The Internet 2. Programming 2.1. Algorithm Development 2.2. Programming Fundamentals
Laboratory Equipment	1. Personal computer with: 1.1. Operating system 1.2. Word processing software 1.3. Spreadsheet software 1.4. High-level programming language 1.5. Internet browser and Internet connection
Suggested References	Caputo, Tony C., *Build Your Own Server*, McGraw-Hill, 2003. Kruse, Robert L., Bruce P. Leung and Clovis L. Tondo. *Data Structures and Program Design in C*, 2nd ed. Prentice Hall, Inc., 1996. Press, Barry and Marcia Press. *PC Upgrade and Repair Bible*, Desktop Edition. John Wiley & Sons, Inc., 2004. Sebesta, Robert W. *Concepts of Programming Languages*, 4th ed. Addison-Wesley Publishing Co., 1999.

Course Name	**COMPUTER-AIDED DRAFTING**
Course Description	Concepts of computer-aided drafting (CAD); introduction to the CAD environment; terminologies; and the general operating procedures and techniques in entering and executing basic CAD commands.
Number of Units for Lecture and Laboratory	1 unit laboratory
Number of Contact Hours per Week	3 hours laboratory
Prerequisite	Third Year Standing
Program Outcome/s Addressed by the Course	a-l, k-D

Course Outcomes	After completing this course, the student must be able to: 1.. Identify the techniques and skills in computer-aided drafting that are necessary for engineering practice 2. Create electronic drawings (e-drawing) using CAD; and
Course Outline	1. Introduction to CAD Software 2. CAD Drawing 3. Snapping, Construction Elements 4. Dimensioning 5. Plotting, Inputting Images 6. 3D and Navigating in 3D 7. Rendering
Laboratory Equipment	1. Personal computer with: 1.1. Operating system 1.2. CAD software 2. Printer or plotter
Suggested References	*CAD Software User's Manual.*

Course Name	**STATICS OF RIGID BODIES**
Course Description	A basic engineering science course of solid mechanicsdealing with bodies that are or remain at rest.It is designed to provide fundamental concepts about forces, moments and couples and their systems. The concept of resultants and equilibrium of forces and moments is utilized to enable solution of statically determinate problems.
Number of Units for Lecture	3 units lecture
Number of Contact Hours per Week	3 hours
Prerequisites	Physics for Engineers, Calculus 2
Co-requisites	None
Program Outcome/s Addressed by the Course	a-E,
Course Outcomes	At the end of the course, the students must be able to: 1. Understand the concepts of forces and moments of forces; 2. Apply the principles of static equilibrium from the knowledge of resultants

	of forces and moments. 3. Relate the course to other engineering situations that involve the concepts of forces and moments of forces.
Course Outline	1 Fundamental Concepts 1.1 Force and their characteristics 1.2 External and internal effects of forces 1.3 Force systems; concurrent, non-concurrent, parallel, non-concurrent, non-parallel; coplanar and spatial force systems 1.4 Components of a force; resolution of forces into planar and spatial components 1.5 Moment of a force 1.6 Vector analysis; addition, subtraction and multiplication of vectors 2 Resultants of force systems **2.1** Resultant of coplanar force systems **2.2** The couple and its characteristics **2.3** Resultant of spatial force systems 3 Equilibrium **3.1** Free-body diagrams **3.2** Equations of equilibrium for a coplanar concurrent force system **3.3** Equilibrium of bodies acted upon my two to three forces **3.4** Equilibrium of bodies acted upon by coplanar non-concurrent force system **3.5** Equilibrium of bodies acted upon by spatial concurrent force system **3.6** Equilibrium of bodies acted upon by spatial parallel force system **3.7** Equilibrium of bodies acted upon by spatial non-concurrent force system 4 Analysis of Structures **4.1** Types of elementary structures **4.2** Nature of supports and their reactions **4.3** Structural stability/instability **4.4** Static indeterminacy of structures – external and internal **4.5** Analysis of plane trusses; method of joints, method of sections **4.6** Analysis of pin-jointed frames -- method of members 5 Friction **5.1** Dry friction and coefficient of friction **5.2** Angle of friction **5.3** Application of friction in machine elements – wedges, square-threaded screws, belt-friction **5.4** Equilibrium of forces involving friction 6 Centroids and Centers of Gravity **6.1** Center of gravity of a two-dimensional body; flat plate **6.2** Determination of centroids by integration **6.3** Centroids of composite bodies -- approximation 7 Moment of Inertia; Product of inertia **7.1** Moment of inertia **7.2** Area moment of inertia by integration

	7.3 Transfer formula for moment of inertia **7.4** Polar moment of inertia **7.5** Radius of gyration **7.6** Moment of inertia for composite sections **7.7** Product of inertia **7.8** Transfer formula for product of inertia
Laboratory Equipment	None
Reference Books	1. Singer, Ferdinand L., *Engineering Mechanics*, Statics and Dynamics, Harper and Row, latest edition 2. Breer, Ferdinand P. and Johnston, E. Russel Jr., *Mechanics for Engineers*, McGraw Hill, latest edition 3. Hibbeler, R.C., *Engineering Mechanics*, Statics, , Amazon, 14th Edition

Course Name	**DYNAMICS OF RIGID BODIES**
Course Description	Kinetics and kinematics of a particle; kinetics and kinematics of rigid bodies; work energy method; and impulse and momentum.
Number of Units for Lecture and Laboratory	2 units lecture
Number of Contact Hours per Week	2 hours lecture
Prerequisite	Statics of Rigid Bodies
Co-requisite	Mechanics of Deformable Bodies
Program Outcome/s Addressed by the Course	a-l
Course Outcomes	After completing this course, the student must be able to: 1. Discuss the principles governing the motion of particles, velocity and acceleration; 2. Discuss the principles of Newton's Second Law and its applications; 3.. Explain kinematics of rigid bodies, its energy and momentum.
Course Outline	1. Introduction to Dynamics 2. Position, Velocity, and Acceleration 3. Determination of the Motion of the Particles 4. Uniform Rectilinear Motion 5. Uniformly Accelerated Rectilinear Motion 6. Position Vector, Velocity, and Acceleration

	7. Derivatives of Vector Functions 8. Rectangular Components of Velocity and Acceleration 9. Flight of Projectile 10. Tangential and Normal Components of Acceleration 11. Kinetics of Particles: Newton's Second Law 12. Dynamic Equilibrium 13. Kinematics of Rigid Bodies 13.1. Translation 13.2. Rotation About a Fixed Axis 13.3. Equations Defining the Rotation of a Rigid Body About a Fixed Axis 13.4. General Plane Motion 13.5. Absolute and Relative Velocity in Plane Motion 13.6. Instantaneous Center of Rotation in Plane Motion 13.7. Absolute and Relative Acceleration 13.8. Rate of Change of a Vector with Respect to a Rotating Frame 13.9. Plane Motion of a Particle Relative to a Rotating Frame; Coriolis Acceleration 13.10. Motion About a Fixed Point 13.11. General Motion 14. Plane Motion of Rigid Bodies: Forces and Accelerations 14.1. Equation of Motions 14.2. Angular Momentum of a Rigid Body in Plane Motion 14.3. Plane Motion of a Rigid Body. D' Alembert's Principle 14.4. Solution of Problems involving the Motion of a Rigid Bodies 14.5. Systems of Rigid Bodies 14.6. Constrained Plane Motion 15. Plane Motion of Rigid Bodies: Energy and Momentum Methods 15.1. Principle of Work and Energy for a Rigid Body 15.2. Work of Forces Acting on a Rigid Body 15.3. Kinetic Energy of a Rigid Body in Plane Motion 15.4 Systems of Rigid Bodies 15.5 Conservation of Energy 15.6 Principle of Impulse and Momentum 15.7 Conservation of Angular Momentum 15.8 Impulsive Motion 15.9 Eccentric Impact
Laboratory Equipment	None
Suggested Reference	Beer and Johnston. *Vector Mechanics for Engineers: Dynamics*, 7th SI ed. McGraw-Hill, 2003.

Course Name	MECHANICS OF DEFORMABLE BODIES
Course Description	Axial stress and strain; stresses for torsion and bending; combined stresses; beam deflections; indeterminate beams; and elastic instability.
Number of Units for Lecture and Laboratory	4 units lecture
Number of Contact Hours per Week	4 hours lecture
Prerequisite	Statics of Rigid Bodies
Co-requisite	Dynamics of Rigid Bodies
Program Outcome/s Addressed by the Course	a-E, e-E
Course Outcomes	After completing this course, the student must be able to: 1. Explain the concepts of stress and strain; 2. Compute stresses due to bending, shears, and torsion under plain and combined loading; 3. Analyze statically determinate and indeterminate structures; and 4. Determine the elastic stability of columns.
Course Outline	1. Load Classification 2. Concept of Stress, Normal and Shear Stress 3. Stresses under Centric Loading 4. Stress Concentration 5. Plane Stress 6. Principal Stresses for Plane Stress 7. Mohr's Circle for Plane Stress 8. Deformations, Normal and Shear Strains 9. Material Properties 10. Working Stresses 11. Deformation in a System of Axially Loaded Members 12. Temperature Effects on Axially Loaded Members 13. Statically Indeterminate Members 14. Thin-Walled Pressure Vessel 15. Torsional Stresses; Elastic Torsion Formula 16. Torsional Deformation; Power Transmission 17. Flexural Stresses by the Elastic Curve 18. Moment Equation Using Singularity Function 19. Beam Deflection by the Double Integration Method

	20. Area Moment Theorems 21. Moment Diagram by Parts 22. Beam Deflection by Area Moment Method 23. Statically Indeterminate Beams 24. Buckling of Long Straight Columns 25. Combined Loadings 26. Analysis of Riveted Connections by the Uniform Shear Method 27. Welded Connections
Laboratory Equipment	None
Suggested References	Hibbeler, Russell C. *Mechanics of Materials*, 5th ed. Prentice Hall, Inc., 2002. Higdon, Archie, et al. *Mechanics of Deformable Bodies*, 4th ed. John Wiley & Sons, 1989. McGill, David and Wilton M. King. *Engineering Mechanics, An Introduction to Dynamics*, 3rd ed. PWS Publishing Co., 1995.

Course Name	**ENGINEERING ECONOMICS**
Course Description	Concepts of the time value of money and equivalence; basic economy study methods; decisions under certainty; decisions recognizing risk; and decisions admitting uncertainty.
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours lecture
Prerequisite	Second Year Standing
Program Outcome/s Addressed by the Course	e-E, k-E
Course Outcomes	After completing this course, the student must be able to: 1. Solve problems involving interest and the time value of money; 2. Evaluate project alternatives by applying engineering economic principles and methods and select the most economically efficient one; and 3. Deal with risk and uncertainty in project outcomes by applying the basic economic decision making concepts.

Course Outline	1. Introduction 1.1. Definitions 1.2. Principles of Engineering Economics 1.3. Engineering Economics and the Design Process 1.4. Cost Concepts for Decision Making 1.5. Present Economic Studies 2. Money-Time Relationships and Equivalence 2.1. Interest and the Time Value of Money 2.2. The Concept of Equivalence 2.3. Cash Flows 3. Economic Study Methods 3.1. The Minimum Attractive Rate of Return 3.2. Basic Economic Study Methods: Present Worth, Future Worth, Annual Worth, Internal Rate of Return, External Rate of Return 3.3. Other Methods: Discounted Payback Period, Benefit/Cost Ratio 4. Decisions Under Certainty 4.1. Evaluation of Mutually Exclusive Alternatives 4.2. Evaluation of Independent Projects 4.3. Effects of Inflation 4.4. Depreciation and After-Tax Economic Analysis 4.5. Replacement Studies 5. Decisions Recognizing Risk 5.1. Expected Monetary Value of Alternatives 5.2. Discounted Decision Tree Analysis 6. Decisions Admitting Uncertainty 6.1. Sensitivity Analysis 6.2. Decision Analysis Models

D. ALLIED COURSES

Course Name:	**ENGINEERING UTILITIES 1**
Course Description	The course focuses on the environmental systems in buildings. Lecture discussions include building electrical systems, natural and artificial lighting, and building telecommunications. Reducing operational loads and integrating high performance energy systems into buildings offers solutions towards achieving a sustainable and secure energy future. Engineers must understand the interrelationship between a building and its subsystems, and need sufficient knowledge of building systems and design alternatives to recommend appropriate

	solutions that suit the site, climate, building type, and occupants. They must coordinate the work of the engineering disciplines that carry the sustainability concept forward through building design, construction, commissioning, operation and, ultimately, demolition, recycling and reuse.
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per week	3 lecture hours per week
Prerequisite	Physics for Engineers
Co-Requisite	
Program Outcome/s Addressed by the Course	**c-E, d-E, f-E, g-E, l-E**
Course Outcomes	Following are the course competencies: **1. Building Electrical Systems** a. Name and define common electrical terminology (i.e. voltage, amperage, resistance, voltage drop, ampacity, etc.) and relate voltage, amperage, resistance, energy, and power. b. Calculate energy and cost of operation of electrical equipment. c. Name, describe and distinguish between types of electrical circuits and compute circuit loads. d. Identify, describe and distinguish between types of branch circuit components. e. Name, describe and distinguish between types building system voltage (e.g., 120/240V, 277/480V, etc.) and buildings in which they are used. f. Identify, describe and distinguish between types of building distribution equipment. g. Compute the minimum required size of branch circuit components. h. Interpret design information of building electrical system components. **2. Artificial Illumination and Daylighting.** a. Name, describe and distinguish between types of artificial and natural lighting sources. b. Identify the influence of color rendition. c. Identify appropriate lighting levels for a specific occupancy. d. Perform basic lighting analysis (single point, zonal cavity, and natural lighting methods)

	e. Interpret design and detailing information on artificial and natural lighting. **3. Building Telecommunication Systems** a. Name, describe and distinguish between types of networks. b. Identify types of transmission media. c. Name and describe standards, devices, equipment and space requirements for a structured cabling and wireless systems. d. Interpret design and detailing information on building telecommunication systems. a. Identify, describe and distinguish between types of renewable power systems (e.g., PV, wind, hydropower, etc.). b. Interpret design and detailing information for renewable power systems.
Course Outline	Course Introduction Electrical Theory Electrical Materials Electrical Systems Electrical Design Principles Sustainable/Future Systems Light Architectural Lamps Lighting Design Principles Architectural Lighting Design Building Telecommunication Systems
Suggested reference books	**Textbook:** Mechanical and Electrical Systems in Architecture, Engineering and Construction. 5th edition. Joseph B. Wujek and Frank Dagostino. Pearson Education/Prentice Hall. 2010. (Hardcopy recommended) **Optional Readings**: The following books are optional supplementary reading for this course: 1. Mechanical and Electrical Equipment for Buildings, 11th edition. Walter T. Grondzik, Alison G. Kwok, Benjamin Stein, John S. Reynolds. John Wiley. 2. Mechanical and Electrical Systems in Buildings, 5th edition. William K. Y. Tao, and Richard R. Janis.• Pearson Education/Prentice Hall. 3. Pertinent Codes (Most recent edition): National Electrical Code. Energy Conservation Code, International Code Council.

Course Name:	Engineering Utilities 2
Course Description	The course focuses on the mechanical systems, fire protection systems, sanitary/ plumbing systems, and acoustics in buildings. Lecture discussions include HVAC systems, acoustics, vertical transportation and fire protection. Reducing operational loads and integrating high performance energy systems into buildings offers solutions towards achieving a sustainable and secure energy future. Engineers must understand the interrelationship between a building and its subsystems, and need sufficient knowledge of building systems and design alternatives to recommend appropriate solutions that suit the site, climate, building type, and occupants. They must coordinate the work of the engineering disciplines that carry the sustainability concept forward through building design, construction, commissioning, operation and, ultimately, demolition, recycling and reuse.
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per week	3 lecture hours per week
Prerequisite	Physics for Engineers
Program Outcome/s Addressed by the Course	c-E, d-E, f-E, g-E, l-E
Course Outcomes	Following are the course competencies: **1. Building Plumbing Systems.** a. Name, describe and distinguish between sources of potable water. b. Name, describe and distinguish between key types of and components in a plumbing supply/distribution system. c. Identify, describe and distinguish between types of and uses for water heaters. d. Name and explain basic properties of fluid flow of a building plumbing system (i.e. flow rate, velocity, pressure, pressure drop, etc.). e. Calculate maximum probable flow rate of a building plumbing system.

	f. Calculate pressure drop in lines of a building plumbing system. g. Compute the minimum required size of distribution lines of a building plumbing system. h. Name, describe and distinguish between methods of waste disposal in buildings. i. Identify, describe and distinguish between key components of a drain, west and vent (DWV) system. j. Compute the minimum required size of drainage and vent lines of a building plumbing system. k. Interpret plumbing supply and DWV system design and detailing information. **2. Life Safety Systems** a. Identify, describe, distinguish between passive and active fire protection. b. Identify, describe, distinguish and interpret fire resistance and spread fire ratings. c. Name, describe and distinguish between types and key components of building fire extinguishing, sprinkler, and standpipe systems, fire detection systems, and fire alarm systems. d. Interpret building fire protection system design and detailing information. **3. Conveying Systems** a. Identify, describe and distinguish between types of conveying systems that move people and freight vertically and horizontally (escalators, elevators, ramps, lifts, walkways). b. Describe applications for building conveying systems that move people and freight. c. Interpret conveying system design and detailing information. **4. Acoustical Control Systems** a. Identify, describe, and interpret ratings related to acoustical control (STC, NRC). b. Interpret acoustical control design and detailing information.
Course Outline	1. Course Introduction 2. Basic Principles of Sanitary/ Plumbing Design 3. Plumbing Materials, Fittings, Fixtures 4. Building Water System and Design 5. Domestic Water Heating 6. Sanitary Drainage Systems 7. OSST/Alternative Waste Systems 8. Plumbing/Water Systems Review 9. Life Safety Systems in Buildings 10. Acoustical Control in Buildings 11. Basic Principles in Building Conveying Systems
Suggested	**Textbook**: Mechanical and Electrical Systems in Architecture,

reference books	Engineering and Construction. 5th edition. Joseph B. Wujek and Frank Dagostino. Pearson Education/Prentice Hall. 2010. (Hardcopy recommended) **Optional Readings**: The following books are optional supplementary reading for this course: 1. Mechanical and Electrical Equipment for Buildings, 11th edition. Walter T. Grondzik, Alison G. Kwok,• Benjamin Stein, John S. Reynolds. John Wiley. 2. Mechanical and Electrical Systems in Buildings, 5th edition. William K. Y. Tao, and Richard R. Janis.• Pearson Education/Prentice Hall. 3. Pertinent Codes (Most recent edition): National Fire Protection Association.• International Fire Code, International Code Council.• Plumbing Code, International Code Council.• Mechanical Code, International Code Council.•

E. PROFESSIONAL COURSES – COMMON

Course Name:	**FUNDAMENTALS OF SURVEYING**
Course Description	This course deals with: Measurement of distance and distance corrections, the use of surveying instruments, area computations, balancing the traverse, elevation determination, and leveling..Stadia surveying, topographic surveying, triangulation and trilateration, missing data, irregular boundaries, and global positioning system
Number of Units for Lecture and Laboratory	3 Units Lecture
Number of Contact Hours per week	3 hours Lecture
Prerequisite	Engineering Drawings and Plans
Co-Requisite	Fundamentals of Surveying (Fieldwork)
Program Outcome/s Addressed by the Course	b-D, d-E, e-I, g-E, k-E
Course Outcomes	After completing this course, the student must be able to: 1. Apply the basic surveying concepts, principles and theories on distance and angular measurements as well as area computation.

	2. Solve for distances, elevations and areas from a provided set of survey data. 3. Apply the basic surveying concepts, principles and theories on determining horizontal and vertical distances using stadia. 4. Compute for the missing data from an incomplete traverse data. 5. Acquire a working knowledge in design and lay-out of horizontal or vertical curves in highway or railway 6. Determine and use the appropriate methodology in calculating earthworks in various civil engineering constructions.
Course Outline	1. Introduction of the Surveying, 2. Types of Surveying 3. Measurement of Distance, Errors in measurement 4. Pacing 5. Measurement of Directions and Angles 6. Bearing and Azimuth 7. Magnetic Declination 8. Balancing the Traverse 9. Area Computation; 10. Curvature and Refraction; Elevation Determination 11. Leveling, 12. The Stadia Theory; Measurement by Stadia for Horizontal Distance 13. Measurement by Stadia for Inclined Distance; Sources of Error in stadia work 14. Stadia Interval Factor 15. Triangulation and Trilateralization 16. Topographic Surveying 17. General Characteristics of Contours 18. Horizontal Curves 19. Missing Data 20. Earthwork Operations 21. Global Positioning System
Laboratory Equipment	
Suggested reference books	1. Surveying: Theory and Practice by James M. Anderson and Edward M. Mikhail, (7th Edition), 2002 2. Kavanagh, Barry F., Surveying: Principles and Applications (9th Edition), 2014 3. Kavanagh, Barry F., Surveying with Construction Applications (8th Edition), 2015 4. Ghilani, C.D., and Wolf, P.R., Elementary Surveying: An Introduction to Geomatics (13th Edition), 2011 5. Schofield W. and M. Breach, Engineering Surveying, (6th Edition), 2007 6. La Putt, J.P., Elementary Surveying (3rd Edition) 2013 Reprint

	7. La Putt, J.P., Higher Surveying (2nd Edition) 2013 Reprint

Course Name:	**FUNDAMENTALS OF SURVEYING (Fieldwork)**
Course Description	Proper handling and utilization of surveying instrument will be taken. Students will learn how to perform measurement of distance and apply distance corrections, use and proper handling of surveying instruments, and perform calculations related to area computations, latitude and departure computations, DMD and DPD methods of land area determination, balancing the traverse, elevation determination, and leveling. Perform stadia surveying, topographic surveying, triangulation and trilateralization, missing data computation, and subdivision of lots. Laying out of horizontal curves, compound curve, reversed curve, spiral curve and mass diagramming.
Number of Units for Lecture and Laboratory	1 Unit Fieldwork
Number of Contact Hours per week	3 Fieldwork hours per week
Prerequisite	Engineering Drawings and Plans
Co-Requisite	Fundamentals of Surveying (Lecture)
Program Outcome/s Addressed by the Course	d-E, b-D, e-I, g-E, k-E
Course Outcomes	After completing this course, the student must be able to: 1. Apply the basic surveying concepts, principles and theories on distance and angular measurements as well as area computation. 2. Conduct fieldwork exercises to measure distances and angles/direction leading towards the determination of areas and elevations and report the results in an organized manner. 3. Recognize the importance of various team member's roles and cite examples of team behaviors that are helpful in the implementation of the fieldwork exercise. 4. Write a neat and orderly field report detailing the results and analyses of the fieldwork activity. 5. Apply the basic surveying concepts, principles and theories on stadia

	and topographic surveying as well as subdivision of lots. 6. Utilize modern surveying equipment such as the total station and handheld GPS in obtaining vertical and horizontal distances, angles and coordinates 7. Conduct fieldwork exercises in laying out horizontal curves and report the results in an organized manner. 8. Utilize modern surveying equipment and software such as the total station and surveying calculator software in obtaining vertical and horizontal distances, angles and coordinates
Course Outline	Introduction of the Survey Lab, Taping (and Pace Factor Determination) Direction Measurement and Angle Measurement Balancing the Traverse Area Computation Leveling Stadia Interval Factor Inclined Stadia Sights Trilateration and Triangulation Missing Data : Non-Adjacent Sides Locating lots using GPS Boundary mapping using GPS Subdivision of lots Laying Out a Simple Horizontal Curve: Chord-Deflection Method, Tangent Offset Method, Sub-chord-Deflection Method, Moving-Up on the Curve, When the Point of Intersection is Inaccessible, Using Two Total Stations, and When an Obstacle Intervenes on the Curve Laying Out a Compound Curve, Reversed Curve and Spiral Curve/Laying Out a Vertical Curve Mass Diagramming
Laboratory Equipment	Steel Tape, Compass, Theodolite, GPS, Total Station
Suggested reference books	8. Surveying: Theory and Practice by James M. Anderson and Edward M. Mikhail, (7th Edition), 2002 9. Kavanagh, Barry F., Surveying: Principles and Applications (9th Edition), 2014 10. Kavanagh, Barry F., Surveying with Construction Applications (8th Edition), 2015 11. Ghilani, C.D., and Wolf, P.R., Elementary Surveying: An Introduction to Geomatics (13th Edition), 2011 12. Schofield W. and M. Breach, Engineering Surveying, (6th Edition), 2007 13. La Putt, J.P., Elementary Surveying (3rd Edition) 2013 Reprint 14. La Putt, J.P., Higher Surveying (2nd Edition) 2013 Reprint

Course Name:	CONSTRUCTION MATERIALS AND TESTING
Course Description	The course deals with the physical properties of common construction materials primarily metals, plastics, wood, concrete, coarse and fine aggregates, asphalt and synthetic materials; examination of material properties with respect to design and use of end product, design and control of aggregates, concrete and asphalt mixtures, principle of testing; characteristics of test; properties of materials and materials testing equipment.
Number of Units for Lecture, Laboratory, Fieldwork and Tutorial	Lecture – 2 units Laboratory – 1 unit
Number of Contact Hours per week	Lecture – 2 hours Laboratory – 3 hours
Prerequisite	Mechanics of Deformable Bodies
Co-requisite	Construction Materials and Testing (Laboratory)
Program Outcome/s Addressed by the Course	a-E, b-D, d-E, g-E, j-E, k-E
Course Outcomes	After completing this course, the student must be able to: 1. Explain relevant properties of common construction materials; 2. Conduct experiments on common construction materials according to international standards such as the American Society for Testing and Materials (ASTM); 3. Evaluate the results of the test of common construction materials

Course Outline	1. Introduction to Construction Materials & Testing; 2. Familiarization with apparatus & equipment used in testing of materials; 3. General Properties of Materials; 4. Specific Weight, Water Absorption, Abrasion, Density and Uniformity of Aggregates; 5. Preparation and Curing of Concrete Test Specimens; 6. Determination of Setting Time of Hydraulic Cement; 7. Familiarization with the Parts and Functions of the Universal Testing Machine; 8. Testing of Wood: Samples for Bending, Compression, Shear, Tension, and Water Content; 9. Determine the Compressive Strength of Concrete Hollow Blocks; 10. Determining the Time of Setting of Portland Cement 11. Testing the Tensile Strength of Steel Bars 12. Field Tests of Construction Materials
Laboratory Equipment	See Annex IV
Suggested References	1. Basic Construction Materials 2002, Theodore W. Marotta 2. Civil Engineering Materials 1992 Davis, Troxell & Hawck 3. Construction Materials, Smith 4. Materials of Construction 4Ed 1990 Chandigarah 5. Testing of Engineering Materials 1982 Gildey, Murphy & Bragman 6. Materials Testing Blackowski & Ripling 7. Strength & Structure of Engineering Materials

Course Name	**STRUCTURAL THEORY (Lecture)**
Course Description	A professional course common to all civil engineering students designed to provide fundamental concepts, principles, and theories in the theory of structures and structural analysis for internal actions in a structure and its defomations under load.
Number of Units for Lecture and Laboratory	3 lecture units,
Number of Contact Hours per Week	3 hours lecture
Prerequisites	Mechanics of Deformable Bodies
Co-requisites	Structural Theory (Computation)
Program Outcome/s Addressed by the Course	a-E, b-I, e-E, k-I
Course	At the end of the course, the students must be able to:

Outcomes	1. Identify and classify various types of planar and spatial; structural systems and the manner by which these are supported for stability; 2. Determine the state of static and kinematic determinacy and stability of structural systems, externally and internally; 3. Apply the methods of structural analysis for external and internal actions on various types of structural systems due to static and moving loads; 4. Develop intuition on deflected shapes of structures under loading.
Course Outline	1. Introduction 1.1 Introduction to structural engineering; the analysis and design process; structural forms, nature of loads; building materials 1.2 Types of supports; support reactions, degrees of static and kinematic indeterminacy for planar and spatial structures; degrees of freedom of joint translation and rotation; conditions for instability, stability, and redundancy of structures; 1.3 Concept of axial, shear, torsional, flexural rigidities and stiffness of structural members 2 Analysis for external reactions and internal stress resultants of statically determinate structures 2.1 Beams 2.2 Plane and space trusses 2.3 Cables and arches 2.4 Plane frames 2.5 Influence lines for reactions and internal stress resultants due to moving loads 3 Classical methods of structural analysis for translations (deflections) and rotations of statically determinate structures 3.1 Double-integration method for beams 3.2 Area-moment method for beams and plane frames 3.3 Conjugate beam method 3.4 Castigliano's first theorem 3.5 Unit-load method/virtual work 3.6 Partial derivative method 4 Classical methods of structural analysis for statically indeterminate structures **4.1** Double-integration method for beams **4.2** Area-moment method **4.3** Conjugate beam method **4.4** Castigliano's second theorem **4.5** Unit-load method/virtual work method **4.6** Partial derivative method **4.7** Moment-distribution method **4.8** Three-moment equation for beams **4.9** Method of consistent deformation/superposition 4.10 Slope-deflection method; matrix analysis 5 Approximate methods of structural analysis for statically indeterminate

	plane frames 5.1 Portal method 5.2 Cantilever method 5.3 Faotor method 6 Influence lines for external reactions and internal stress resultants of indeterminate structures
Laboratory Equipment	None
Reference Books	1 Hibbler, R.C., *Structural Analysis*, 9th Ed., Prentice Hall 2 Rajan. S.D., Introduction to Structural Analysis and Design, John Wiley & Sons, 2001 3 Utku, Senol, Norris C.H. and Wilbur, J.B., *Elementary Structural Analysis,* 4th Ed., McGraw-Hill, Inc. 1991

Course Name	**STRUCTURAL THEORY (Computation)**
Course Description	A professional course common to all civil engineering students designed to provide fundamental concepts, principles, and theories in the theory of structures and structural analysis for internal actions in a structure and its defomations under load.
Number of Units for Lecture and Laboratory	1 unit computation
Number of Contact Hours per Week	3 hours computation
Prerequisite	Mechanics of Deformable Bodies
Co-requisite	Structural Theory (Lecture)
Program Outcome/s Addressed by the Course	a-E, b-I, e-E, k-I
Course Outcomes	At the end of the course, the students must be able to: • Demonstrate by numerical calculations and other methods the concepts, principles and theories obtained from the lecture portion of the course.
Course Outline	1.Introduction 1.3 Introduction to structural engineering; the analysis and design

	process; structural forms, nature of loads; building materials 1.2 Types of supports; degrees of static and kinematic indeterminacy for planar and spatial structures; degrees of freedom of joint translation and rotation 1.4 Concept of axial, shear, torsional, flexural rigidities and stiffness 2 Analysis for external reactions and internal stress resultants of statically determinate structures 2.1 Beams 2.2 Plane and space trusses 2.3 Cables and arches 2.4 Plane frames 2.5 Influence lines for reactions and internal stress resultants due to moving loads 3 Classical methods of structural analysis for translations (deflections) and rotations of statically determinate structures 3.1 Double-integration method for beams 3.2 Area-moment method for beams and plane frames 3.3 Conjugate beam method 3.4 Castigliano's first theorem 3.5 Unit-load method/virtual work 3.6 Partial derivative method 4 Classical methods of structural analysis for statically indeterminate structures **4.10** Double-integration method for beams **4.11** Area-moment method **4.12** Conjugate beam method **4.13** Castigliano's second theorem **4.14** Unit-load method/virtual work method **4.15** Partial derivative method **4.16** Moment-distribution method **4.17** Three-moment equation for beams **4.18** Method of consistent deformation/superposition 4.10 Slope-deflection method; matrix analysis 5 Approximate methods of structural analysis for statically indeterminate plane frames 5.1 Portal method 5.2 Cantilever method 5.3 Faotor method 6 Influence lines for external reactions and internal stress resultants of indeterminate structures
Laboratory Equipment	None
Reference Books	4 Hibbler, R.C., *Structural Analysis*, 9th Ed., Prentice Hall 5 Rajan. S.D., Introduction to Structural Analysis and Design, John Wiley & Sons, 2001 6 Utku, Senol, Norris C.H. and Wilbur, J.B., *Elementary Structural*

	Analysis, 4th Ed., McGraw-Hill, Inc. 1991

Course Name	**HIGHWAY AND RAILROAD ENGINEERING**
Course Description	Presents the methods and underlying principles for the design and control of the elements of road and railroad infrastructure. Students also become familiar with transportation system terminology, flow analysis, driver, vehicle and road characteristics, and aspects of road geometrics, road construction, drainage, pavements and maintenance.
Number of Units for Lecture and Laboratory	3 lecture units
Number of Contact Hours per Week	3 hours lecture per week
Prerequisites	Fundamentals of Surveying
Co-requisites	None
Program Outcome/s Addressed by the Course	a-E, c-E, e-E, g-E
Course Outcomes	At the end of the course, the students must be able to: 1. Define the basic concepts of highway and railroad transportation and present how to apply them in civil engineering practice 2. Recognize the concepts associated with the geometric and structural design of highway and railway engineering systems. 3. Explain the basic service requirements of highway and detail the procedure to conduct level of service analysis. 4. Develop basic traffic stream parameters and models, traffic flow models, and apply the queuing theory
Course Outline	1. Importance of transportation, different modes of transportation, characteristics of road transport, scope of highway and traffic engineering 2. Highway development and planning: Importance, classification of roads, road patterns, planning surveys; highway alignment and surveys 3. Design criteria for highways and railways 4. Geometric design for highways and railways, including cross sections, horizontal and vertical alignments, super-elevation and earthworks. 5. Structural design of railways and pavements 6. Failures, maintenance and rehabilitation of transportation infrastructure.

	7. Traffic Engineering: Traffic characteristics - Traffic studies-speed, volume, speed and delay, origin-destination, parking and accident studies; capacity of urban roads and highways; traffic operations regulation and control; design of intersections- at grade and grade separated 8. Traffic flow and analysis of roads including queuing analysis and level of service assessment. 9. Pavement Materials and Design: Specifications and tests on pavement materials, pavement design factors, design of flexible and rigid pavements as per IRC
Laboratory Equipment	None
Reference Books	1. Mannering Fred, Washburn Scott,Kilaresky Walter. 2004. Principles of Highway Engineering & TrafficAnalysis. Muze Inc. 2. Wright, Paul H. 2003. Highway Engineering.Wiley & Sons. 3. Garber, Nicholas; &Hoel, Lester. 2001.Highway and Traffic Engineering. Brookes/Cole Publishing. 4. Fajardo, Max Jr. B., Elements of Roads and Highways, Second Edition, 5138 Merchandising Publisher, Manila,1998. 5. Department of Public Works and Highways.1995. Standard Specification for Public Works and Highways(Volume II – Standard Specification for Highways, Bridges and Airports), DPWH, Office of the Secretary, Bonifacio Drive, Port Area, Manila 6. Hay, W. W. 1982. Railroad Engineering, 2nd Edition. Wiley. 7. Armstrong J. H. 2008. The Railroad: What It Is, What It Does, 5th Edition.

Course Name:	**BUILDING SYSTEMS DESIGN**
Course Description	Building construction is examined from the standpoints of life safety (including fire safety and zoning constraints on site planning); architectural and building service systems (plumbing, electrical, vertical transportation, security, fire protection); materials, sustainability, and life-cycle analysis; accessibility; technical documentation and outline specifications; building enclosure systems; and interior finish systems. The lecture course will focus on developing knowledge of building systems, including architectural design building materials and construction techniques, and will foster the skills required to adopt a building systems approach compliant to the National Building Code and its referral codes. The students' developed knowledge of building systems will also include understanding of different types and applications of building materials and diverse construction techniques. Sustainability principles' impact on the property lifecycle, and how these will integrate and apply to skills and knowledge to industry based case studies will also be examined. The course will include at least one site visit to an operating building in the locality. The laboratory class will focus on the tools and techniques to create a computer generated building model, and applied tools for working with computer model exploring output and simulation. Students will develop techniques looking at both realistic and schematic representation, and the

	integration of building systems modeling as a tool to inform and enhance the design process.
Number of Units for Lecture and Laboratory	2 Units Lecture 1 Unit Laboratory
Number of Contact Hours per week	2 lecture hours per week 3 laboratory hours per week
Prerequisite	Engineering Drawings and Plans
Program Outcome/s Addressed by the Course	c-E; d-E; e-E; f-I; g-I; h-I; j-I; k-E
Course Outcomes	At the end of the course, the students must be able to: 1. Identify appropriate provisions of the National Building Code and its referral codes as these apply to buildings; 2. Codes and Regulations: Ability to design sites, facilities, and systems that are responsive to relevant codes and regulations, and include the principles of lifesafety and accessibility standards; 3. Technical Documentation: Ability to make technically clear drawings, prepare outline specifications, and construct models illustrating and identifying the assembly of materials, systems, and components appropriate for a building design; 4. Building Envelope Systems and Assemblies: Understanding of the basic principles involved in the appropriate selection and application of building envelope systems relative to fundamental performance, aesthetics, moisture transfer, durability, and energy and material resources; 5. Building Materials and Assemblies: Understanding of the basic principles used in the appropriate selection of interior and exterior construction materials, finishes, products, components, and assemblies based on their inherent performance, including environmental impact and reuse; 6. Building Service Systems: Understanding of the basic principles and appropriate application and performance of building service systems, including lighting, mechanical, plumbing, electrical, communication, vertical transportation, security, and fire protection systems; 7. Financial Considerations Understanding of the fundamentals of building costs, which must include life-cycle costs.
Course Outline	**Lecture** I. Codes and Regulations: National Building Code of the Philippines Architectural Code National Structural Code of the Philippines

	Electrical Code of the Philippines Fire Code National Plumbing Code Sanitation Code of the Philippines II. Technical Documentation: Space planning Calculations Specifications Quantity Survey and Cost Estimates Building Permit III. Building Envelope Systems and Assemblies: Fundamentals of performance Aesthetics Moisture transfer Durability Energy and material resources; IV. Building Materials and Assemblies: Appropriate selection of interior and exterior construction materials Finishes, Products, Components, and Environmental Impact and Reuse of Materials V. Building Service Systems: Lighting; Mechanical Systems in Buildings including Vertical Transportation; Plumbing Systems in Buildings; Electrical, Communication, and Security; Fire Protection Systems. VI. Financial Considerations: Fundamentals of Building Costs; Life-cycle Costs. **Laboratory Exercises to be designed as appropriate by Faculty/ Instructor**
Laboratory Equipment	Computers Visualization Softwares
Suggested reference books	Codes and Standards National Building Code of the Philippines Architectural Code National Structural Code of the Philippines Electrical Code of the Philippines Fire Code National Plumbing Code Sanitation Code of the Philippine Other References: Edward Allen, Fundamentals of Building Construction, 6th

	edition, John Wiley & Sons, New York, 2013

Course Name	**PRINCIPLES OF STEEL DESIGN (Lecture)**
Course Description	A professional course common to all civil engineering students designed to provide fundamental concepts, principles, and theories in the structural strength analysis and design of steel elements in a structure
Number of Units for Lecture and Laboratory	2 lecture units
Number of Contact Hours per Week	2 hours lecture
Prerequisites	Mechanics of Deformable Bodies, Structural Theory
Co-requisites	Principles of Steel Design (Computation)
Program Outcome/s Addressed by the Course	a-E, b-I, k-E
Course Outcomes	At the end of the course, the students must be able to: 1. Understand the stress-strain characteristics of steel in both elastic and plastic stages of deformation; 2. Be able to determine the strength of structural steel members in axial loading, bending, shear, and torsion for various cross-sectional shapes in both elastic and plastic conditions 3. Be able to apply allowable strength and load-and-resistance factor design methods of steel design 4. Be able to determine the strength of bolted/riveted and welded connections
Course Outline	1. Introduction the course 1.1 Identification of civil engineering structures for which the use of structural steel is applicable for use 1.2 Typical stress-strain characteristics of steel in simple tension and the evaluation of its mechanical properties 1.3 Availability of steel grades available in the country and elsewhere 2. Familiarization of various structural shapes 2.1 Rolled sections, built-up sections 2.2 Determination of the cross-sectional properties of structural shapes 2.3 Introduction to available manuals, charts, and tables already available 3. Analysis and design for axial tension 3.1 Reference codes of practice –AISC, NSCP C101 3.2 Factors affecting the allowable tensile stress 3.3 Gross area, net area, effective net area for bolted/riveted connections

	3.4 Limiting slenderness of tension members 3.5 Allowable tensile strength, ultimate tensile strength 3.6 Allowable strength design (ASD) and load-and-resistance factor design (LRFD) methods 4. Analysis and design for axial compression 4.1 Euler's critical load, critical stress 4.2 End conditions and slenderness ratio 4.3 Factors affecting the allowable compressive stress 4.4 Code provisions for allowable compressive stress 4.5 Evaluation of allowable axial compressive load for any structural shape and slenderness 4.6 Use of available tables in manuals for allowable concentric loads 4.7 Column built-up sections, evaluation of allowable concentric load 4.8 ASD and LRFD of axially-loaded compression members 5. Analysis and design of members for bending 5.1 Factors affecting the allowable bending stress 5.2 Compact, non-compact, slender sections in bending 5.3 Lateral unbraced length of flexural members 5.4 Moment-resisting capacity of beams 5.5 Nominal bending, plastic bending strength 5.6 ASD and LRFD for bending 6. Shear strength of structural members 6.1 Allowable shear stress, allowable shear strength 6.2 Nominal shear strength 6.3 ASD and LRFD of structural elements for shear 7. Combined axial and flexural loading 7.1 Investigation of column adequacy under combined loading 7.2 Conversion of moments to equivalent axial loads 7.3 Design of columns under combined loading 8 Connections 8.1 Welded connections 8.2 Types of welds 8.3 Allowable strength of welds 8.4 Allowable strength of welded connections 8.5 Bolted/riveted connections, allowable strength of bolts/rivets 8.6 Allowable strength of bolts, rivets
Reference Books	1. American Institute of Steel Construction (AISC), *Manual of Steel Construction*, latest edition 2. Association of Structural Engineers of the Philippines (ASEP), *National Structural Code for Buildings and Other Vertical Structures* (NSCP C101. 7th Ed.), 2016 3. Spiegel, Leonard and Limbrunner, George F, *Applied Structural Steel Design*, 3rd Ed., McGraw Hill, Inc., 1997

Course Name	**PRINCIPLES OF STEEL DESIGN (Computation)**
Course Description	A professional course common to all civil engineering students designed to provide fundamental concepts, principles, and theories in the structural strength analysis and design of steel elements in a structure
Number of Units for Lecture and Laboratory	1 unit computation
Number of Contact Hours per Week	3 computation hours
Prerequisite	Mechanics of Deformable Bodies, Structural Theory
Co-requisite	Principles of Steel Design (Lecture)
Program Outcome/s Addressed by the Course	a-E, b-I, k-E
Course Outcomes	At the end of the course, the students must be able to: Demonstrate by numerical calculations and other methods the concepts, principles and theories obtained from the lecture portion of the course.
Course Outline	1. Introduction the course 1.1 Identification of civil engineering structures for which the use of structural steel is applicable for use 1.2 Typical stress-strain characteristics of steel in simple tension and the evaluation of its mechanical properties 1.3 Availability of steel grades available in the country and elsewhere 2. Familiarization of various structural shapes 2.1 Rolled sections, built-up sections 2.2 Determination of the cross-sectional properties of structural shapes 2.3 Introduction to available manuals, charts, and tables already available 3. Analysis and design for axial tension 3.1 Reference codes of practice –AISC, NSCP C101 3.2 Factors affecting the allowable tensile stress 3.3 Gross area, net area, effective net area for bolted/riveted connections 3.4 Limiting slenderness of tension members 3.5 Allowable tensile strength, ultimate tensile strength 3.6 Allowable strength design (ASD) and load-and-resistance factor design (LRFD) methods 4. Analysis and design for axial compression 4.1 Euler's critical load, critical stress 4.2 End conditions and slenderness ratio 4.3 Factors affecting the allowable compressive stress

	4.4 Code provisions for allowable compressive stress 4.5 Evaluation of allowable axial compressive load for any structural shape and slenderness 4.6 Use of available tables in manuals for allowable concentric loads 4.7 Column built-up sections, evaluation of allowable concentric load 4.8 ASD and LRFD of axially-loaded compression members 5. Analysis and design of members for bending 5.1 Factors affecting the allowable bending stress 5.2 Compact, non-compact, slender sections in bending 5.3 Lateral unbraced length of flexural members 5.4 Moment-resisting capacity of beams 5.5 Nominal bending, plastic bending strength 5.6 ASD and LRFD for bending 6. Shear strength of structural members 6.1 Allowable shear stress, allowable shear strength 6.2 Nominal shear strength 6.3 ASD and LRFD of structural elements for shear 7. Combined axial and flexural loading 7.1 Investigation of column adequacy under combined loading 7.2 Conversion of moments to equivalent axial loads 7.3 Design of columns under combined loading 8 Connections 8.1 Welded connections 8.2 Types of welds 8.3 Allowable strength of welds 8.4 Allowable strength of welded connections 8.5 Bolted/riveted connections, allowable strength of bolts/rivets 8.6 Allowable strength of bolts, rivets
Laboratory Equipment	Computers
Reference Books	4. American Institute of Steel Construction (AISC), *Manual of Steel Construction*, latest edition 5. Association of Structural Engineers of the Philippines (ASEP), *National Structural Code for Buildings and Other Vertical Structures* (NSCP C101. 7th Ed.), 2016 6. Spiegel, Leonard and Limbrunner, George F, *Applied Structural Steel Design*, 3rd Ed., McGraw Hill, Inc., 1997

Course Name	**PRINCIPLES OF REINFORCED/PRESTRESSED CONCRETE (Lecture)**
Course Description	A professional course common to all civil engineering students designed to provide fundamental concepts, principles, and theories in the structural strength analysis and design of plain, reinforced, and prestressed concrete elements in a structure
Number of Units for	3 lecture units

Lecture and Laboratory	
Number of Contact Hours per Week	3 hours lecture
Prerequisites	, Structural Theory
Co-requisites	Principles of Reinforced/Prestressed Concrete (Computation)
Program Outcome/s Addressed by the Course	a-E, b-I, k-E
Course Outcomes	At the end of the course, the students must be able to: 1. Understand the in-depth stress-strain characteristics of concrete for all stages of loading. 2. Evaluate the strength of structural plain, reinforced, or prestressed concrete elements in axial loading, bending, shear, and torsion under pseudo-elastic and inelastic stages of loading 3. Apply allowable strength and load-and-resistance factor design methods for reinforced and prestressed concrete
Course Outline	1 Properties of concrete as a construction material 1.1 Identification of structures for which the use of reinforced or prestressed concrete is applicable 1.2 Typical stress-strain characteristics of concrete in simple compression 1.3 Mechanical properties of concrete; modulus of elasticity 1.4 Properties of reinforcing steel; Grades of steel available 1.5 Reference code of practice (NSCP C101, ACI 318 Publications) 2 Analysis for flexural strength of reinforced concrete 2.1 Mechanics of bending 2.2 Flexural strength of plain concrete beam sections 2.3 Singly-reinforced rectangular beam sections under elastic, elasto-plastic, and ultimate bending; allowable bending strength, nominal and design bending strengths 2.4 Doubly-reinforced rectangular beam sections under elastic, elasto-plastic, and ultimate bending; allowable bending strength, nominal and design bending strengths 2.5 Singly-reinforced T- beam sections under elastic, elasto-plastic, and ultimate bending; allowable bending strength, nominal and design bending strengths 2.6 Doubly-reinforced T- beam sections under elastic, elasto-plastic, and ultimate bending; allowable bending strength, nominal and design bending strengths 2.7 Rectangular and T- beam sections with web longitudinal reinforcement under elastic, elasto- plastic, and ultimate bending; allowable bending strength, nominal and design bending strengths 3 Design for flexural strength of reinforced concrete 3.1 Singly-reinforced rectangular beam sections 3.2 Doubly-reinforced rectangular beam sections 3.3 Singly-reinforced rectangular T-beam sections 3.4 Doubly-reinforced rectangular T-beam sections

	4 Analysis and design for shear 4.1 Mechanics of shear 4.2 Types of shear reinforcement 4.3 Allowable and nominal shear stress of concrete in reinforced sections 4.4 Allowable and nominal shear strength of reinforced webs 4.5 Allowable stress design and strength design for shear 5 Analysis and design for torsion 5.1 Mechanics of torsion 5.2 Allowable and nominal torsion stress of concrete in reinforced sections 5.3 Nominal torsion strength of reinforced webs 5.4 Strength design for torsion 5.5 Strength design for shear and torsion 6 Analysis and design for compression members 6.1 Short RC columns under concentric loading 6.2 Allowable strength analysis 6.3 Nominal strength, design strength analysis 6.4 Short RC columns under uniaxial bending 6.5 Balanced loading, compression failure, tension failure 6.6 Nominal strength, design strength 6.7 Strength interaction between axial load and uniaxial bending moment 6.8 Nominal and design strength of columns under biaxial bending 6.9 Slenderness effects for columns 6.10 Strength design of eccentrically-loaded columns for longitudinal reinforcement under unaxial and under biaxial bending 6.11 Transverse reinforcement design for columns 7 Prestressed concrete 7.1 Sources of prestressing force 7.2 Prestressing wires, cables, and tendons 7.3 General equations for flexural design 7.4 Cable profiles 7.5 Losses in prestressing 7.6 Nominal bending strength, design bending strength 7.7 Shear and diagonal tension
Reference Books	1. Association of Structural Engineers of the Philippines, *National Structural Code of the Philippines (NSCP C101,Vol. I Builings and Other Vertical Structures)*, 7th Ed., 2016 2. American Concrete Institute, *ACI 318 Building Code Requirements for Reinforced Concrete*, latest edition 3. McCormac, Jack C, *Design of Reinforced Concrete, 7th Ed., 2005,* John Wiley & Sons 4. Nilson, Arthur H. and Winter, George et. Al, *Design of Concrete Structures*, 13th Ed., 2000, Mc-Graw Hill, Inc. 5. Wang. Chu Kia and Salmon, Charles C, *Reinforced Concrete Design,*6th Ed., 1998, Addison-Wesley

Course Name	**PRINCIPLES OF REINFORCED/PRESTRESSED CONCRETE (Computation)**
Course Description	A professional course common to all civil engineering students designed to provide fundamental concepts, principles, and theories in the structural strength analysis and design of plain, reinforced, and prestressed concrete elements in a structure
Number of Units for Lecture and Laboratory	1 unit computation
Number of Contact Hours per Week	3 hours computation
Prerequisites	Mechanics of Deformable Bodies, Structural Theory
Co-requisites	Principles of Reinforced/Prestressed Concrete (Lecture)
Program Outcome/s Addressed by the Course	a-E, b-I, k-E
Course Outcomes	At the end of the course, the students must be able to: Demonstrate by numerical calculations and other methods the concepts, principles and theories obtained from the lecture portion of the course.
Course Outline	1. Properties of concrete as a construction material a. Identification of structures for which the use of reinforced or prestressed concrete is applicable b. Typical stress-strain characteristics of concrete in simple compression c. Mechanical properties of concrete; modulus of elasticity d. Properties of reinforcing steel; Grades of steel available e. Reference code of practice (NSCP C101, ACI 318 Publications) 2. Analysis for flexural strength of reinforced concrete a. Mechanics of bending b. Flexural strength of plain concrete beam sections c. Singly-reinforced rectangular beam sections under elastic, elasto-plastic, and ultimate bending; allowable bending strength, nominal and design bending strengths d. Doubly-reinforced rectangular beam sections under elastic, elasto-plastic, and ultimate bending; allowable bending strength, nominal and design bending strengths e. Singly-reinforced T- beam sections under elastic, elasto-plastic, and ultimate bending; allowable bending strength, nominal and

	design bending strengths f. Doubly-reinforced T- beam sections under elastic, elasto-plastic, and ultimate bending; allowable bending strength, nominal and design bending strengths 3. Rectangular and T- beam sections with web longitudinal reinforcement under elastic, elasto- plastic, and ultimate bending; allowable bending strength, nominal and design bending strengths 4. Design for flexural strength of reinforced concrete a. Singly-reinforced rectangular beam sections b. Doubly-reinforced rectangular beam sections c. Singly-reinforced rectangular T-beam sections d. Doubly-reinforced rectangular T-beam sections 5. Analysis and design for shear a. Mechanics of shear b. Types of shear reinforcement c. Allowable and nominal shear stress of concrete in reinforced sections d. Allowable and nominal shear strength of reinforced webs e. Allowable stress design and strength design for shear 6. Analysis and design for torsion a. Mechanics of torsion b. Allowable and nominal torsion stress of concrete in reinforced sections c. Nominal torsion strength of reinforced webs d. Strength design for torsion e. Strength design for shear and torsion 7. Analysis and design for compression members a. Short RC columns under concentric loading b. Allowable strength analysis c. Nominal strength, design strength analysis d. Short RC columns under uniaxial bending e. Balanced loading, compression failure, tension failure f. Nominal strength, design strength g. Strength interaction between axial load and uniaxial bending moment h. Nominal and design strength of columns under biaxial bending i. Slenderness effects for columns j. Strength design of eccentrically-loaded columns for longitudinal reinforcement under unaxial and under biaxial bending k. Transverse reinforcement design for columns 7 Prestressed concrete a. Sources of prestressing force b. Prestressing wires, cables, and tendons c. General equations for flexural design d. Cable profiles e. Losses in prestressing

	f. Nominal bending strength, design bending strength g. Shear and diagonal tension
Laboratory Equipment	Computers
Reference Books	1. Association of Structural Engineers of the Philippines, *National Structural Code of the Philippines (C101-16, 7th Ed.. 2016)* 2. American Conrete Instiute, *ACI 318 Building Code Requirements for Reinforced Concrete*, latest edition 3. McCormac, Jack C, Design of Reinforced Concrete, 7th Ed., 2005, John Wiley & Sons 4. Nilson, Arthur H. and Winter, George et. Al, Design of Concrete Structures, 13th Ed., 2000, Mc-Graw Hill, Inc. 5. Wang. Chu Kia and Salmon, Charles C, Reinforced Concrete Design,6th Ed., 1998, Addison-Wesley

Course Name	**HYDRAULICS (Lecture)**
Course Description	The course emphasizes the continuity equation, energy equation, and momentum equation. Familiarization of the properties of common liquids in the study of hydraulics. Application of fundamental principles to solve problems involving liquid pressure and corresponding forces resulting from this pressure. Applications of appropriate equations in performing calculations involving flow velocity, flow rate and forces exerted by moving liquids in closed conduits and open channels. Familiarization and applications of flow measuring devices such as orifice, weirs, pitot tube,
Number of Units for Lecture and Laboratory	4 units of lecture
Number of Contact Hours per Week	4 hours a week
Prerequisites	Dynamics of Rigid Bodies, Mechanics of Deformable Bodies
Co-requisite	Hydraulics Laboratory
Program Outcome/s Addressed by the Course	a-E, b-D, e-E, g-E
Course Outcomes	At the end of the course, the students must be able to: 1. Discuss the different liquid properties that are involved in the determination of pressure, forces, and flow. 2. Discuss the Continuity Equation with reference to the conservation of

	mass, Energy Equation with reference to the Euler equation, and Momentum Equation with reference to the 2nd Law of Newton on motion. 3. Perform calculations related to (2.a) fluid pressure and forces with the liquid is at rest, (2.b) flow velocity, flow rate, pressure, and forces when liquid is flowing in pipes and open channels, (2.c) flow velocity and flow rates in conjunction with different flow measuring devices. 4. Design laboratory experimental procedure, perform the procedure, and interpret the result
Course Outline	1) Common liquid properties 2) Hydrostatic pressure and forces 3) Fluid's flow equations: 4) Volume flow rate 5) Mass flow rate 6) Weight Flow rate 7) Continuity equation 8) Energy Equation 9) Momentum equation 10) Flow in closed Conduits 11) Resistance formula: Hagen-Poiseuille equation, Darcy-Weisbach formula, Colebrook –White 12) Minor losses in pipes 13) Losses due to friction 14) Pipe connecting two reservoirs 15) Reservoir problems 16) Pipe in series 17) Parallel pipes 18) Pipe Networks 19) Water Hammer 20) Open channel 21) Uniform flow 22) Flow resistance formula 23) Efficient section 24) Specific Energy 25) Rapidly Varied Flow (Hydraulic Jump) 26) Gradually Varied Flow 27) Flow measurements 28) Orifice 29) Venturi meter 30) Weirs
Reference Books	Author, Title, Publisher, Place of Publication, Date of Publication 1. C.T. Crowe, J. A. Roberson and D.F. Elger, "Engineering Fluid Mechanics" 9th Edition ", Copyright 2005 by John Wiley & Sons, Inc. 2. J.F. Cruise, M.M. Sheriff, V.J Singh, "Elementary Hydraulics" International Student Edition, Copyright 2007, Thopmson, Canada

	3. A. Chadwick and J. Morfett, "Hydraulics in Civil and Environmental Engineering" , Copyright 1993 by F&FN Spon. 4. R.E. Featherstone and C. Nalluri, "Civil Engineering Hydraulics" 3rd Edition ", Copyright 1995 by Blackwell Science Ltd.

Course Name	**HYDRAULICS (LABORATORY)**
Course Description	The course emphasizes the continuity equation, energy equation, and momentum equation. Familiarization of the properties of common liquids in the study of hydraulics. Application of fundamental principles to solve problems involving liquid pressure and corresponding forces resulting from this pressure. Applications of appropriate equations in performing calculations involving flow velocity, flow rate and forces exerted by moving liquids in closed conduits and open channels. Familiarization and applications of flow measuring devices such as orifice, weirs, pitot tube,
Number of Units for Lecture and Laboratory	1 unit of laboratory
Number of Contact Hours per Week	3 hours laboratory
Prerequisites	Dynamics of Rigid Bodies, Mechanics of Deformable Bodies
Co-requisite	Hydraulics (Lecture)
Program Outcome/s Addressed by the Course	a-E, b-D, d-E, e-E, g-E
Course Outcomes	At the end of the course, the students must be able to: 1. Discuss the different liquid properties that are involved in the determination of pressure, forces, and flow. 2. Discuss the Continuity Equation with reference to the conservation of mass, Energy Equation with reference to the Euler equation, and Momentum Equation with reference to the 2nd Law of Newton on motion. 3. Perform calculations related to (2.a) fluid pressure and forces with the liquid is at rest, (2.b) flow velocity, flow rate, pressure, and forces when liquid is flowing in pipes and open channels, (2.c) flow velocity and flow rates in conjunction with different flow measuring devices. 4. Design laboratory experimental procedure, perform the procedure, and interpret the result

Course Outline	1. Determination of density of common liquid (oil, water, glycerine) 2. Determination of liquid viscosity (oil, water, glycrine) 3. Calibration of pressure gage using the Dead weight apparatus 4. Hydrostatic force on submerged and Semi-submerged rectangular area 5. Buoyancy and Stability of floating object 6. Energy equation experiment using the Bernoulli apparatus 7. Laminar and turbulent flow experiments 8. Water jet impinging on fixed blade 9. Experimentation on major and minor losses in pipes 10. Pipes in Series and parallel 11. Discharge measurements (Orifice, weir, Venture meter, Pitot tube) 12. Hydraulic jump
Reference Books	Author, Title, Publisher, Place of Publication, Date of Publication 1. C.T. Crowe, J. A. Roberson and D.F. Elger, "Engineering Fluid Mechanics" 9th Edition ", Copyright 2005 by John Wiley & Sons, Inc. 2. J.F. Cruise, M.M. Sheriff, V.J Singh, "Elementary Hydraulics" International Student Edition, Copyright 2007, Thopmson, Canada 3. A. Chadwick and J. Morfett, "Hydraulics in Civil and Environmental Engineering" , Copyright 1993 by F&FN Spon. 4. R.E. Featherstone and C. Nalluri, "Civil Engineering Hydraulics" 3rd Edition ", Copyright 1995 by Blackwell Science Ltd.

Course Name	**HYDROLOGY**
Course Description	The course deals on the hydrologic cycle and the different processes such as precipitation, evaporation, infiltration, overland flow, groundwater flow and surface runoff generation.
Number of Units for Lecture and Laboratory	2 units lecture
Number of Contact Hours per Week	2 hours lecture
Prerequisites	Integral calculus
Program Outcome/s Addressed by the Course	a-E, e-E, g-E, k-E

Course Outcomes	At the end of the course, the students must be able to: 1. Discuss with appropriate diagrams the hydrologic cycle and the different processes and storages within the cycle. 2. Perform calculation related to measurements, movement, and storages in the different processes of the hydrologic cycle.
Course Outline	1. Definition of Hydrology 2. The Hydrologic Cycle 3. Precipitation • Formation of Precipitation • Different Types of Precipitation • Rainfall characteristics (Depth, Duration, Intensity, Hyetograph) • Point Rainfall Measurements • Different Types of Raingauges • Estimation of Missing rainfall data • Conversion of Point rainfall to areal rainfall • Double Mass Analysis 4. Infiltration • Definition of infiltration • Factors affecting infiltration, and infiltration measurements • Horton Model and Phillip's equation, • Green-Ampt model • Ponding time • Fitting infiltration models to infiltration data using Excel 5. Evaporation (Here only discussions of basic concepts are introduced. The detailed calculations will be dealt in Irrigation Engineering) • Physics of evaporation • Factors affecting evaporation • Measurements of different factors for evaporation • Available methods/procedures for estimating evaporation from open water 6. Basic Subsurface flow (Steady State condition) • Law of Darcy, confined and unconfined Aquifers • Ground water flow in Confined Aquifer • Groundwater flow in unconfined aquifer • Radial ground water flow in Confined Aquifer • Radial Ground water flow in unconfined aquifer • Travel time of ground water in confined aquifer 7. Rainfall-Runoff relation • Definition of hydrograph • Hydrograph Separation • Unit Hydrograph • Estimation of discharge using unit hydrograph • Rational Formula • SCS Curve Method
Reference Books	Author, Title, Publisher, Place of Publication, Date of Publication

	1. Bedient, P.B., Huber W.C. and Vieux, B.E. Hydrology and Floodplain Analysis, Pearson 4th Ed., Philippine edition copyright 2010 2. David Chin, Water Resources Engineering, 3rd Ed., Pearson , 2013 3. McCuen, R.H., Hydrologic Analysis and Design, Prentice Hall, 1989 4. Linsley, R.K., M.A. Kohler and J.L.H. Paulhus, Hydrology for Engineers by; McGraw-Hill, 1988 5. Applied Hydrology by VenTe Chow, David Maidment and Larry Mays; McGRAW-HILL International Editions; 1988 6. Handbook of Hydrology David maidment, 1993

Course Name:	**CIVIL ENGINEERING LAW, ETHICS AND CONTRACTS**
Course Description	This course deals on the principles and fundamentals of the laws on obligations, contracts, and professional ethics that are applicable to the civil engineering profession. It is designed to prepare civil engineering students for professional practice. Topics on the perspective of the student as future practitioners, contractors, and employees in the field are also given emphasis. They include the study of code of ethics, legal procedure in the practice of civil engineering in the Philippines, ethical relations of an engineer with fellow professionals, clients, and general public, elements of contracts, obligations, Civil Engineering Law (RA 544) National Building Code, labor laws, E-Procurement Law, and the Manual of Professional Practice for Civil Engineers.
Number of Units for Lecture, Laboratory, Fieldwork and Tutorial	Lecture – 2 units
Number of Contact Hours per week	Lecture – 2 hours
Prerequisite/Co-requisite	4th Year Standing
Program Outcome/s Addressed by the Course	f-D, g-E
Course Outcomes	At the end of the course, the students must be able to: 1. Explain the Civil Engineering Code of Ethics which includes the fundamental principles and canon; 2. Explain the laws governing the practice of civil engineering profession in the Philippines 3. Give examples of standard contract documents 4. Appraise the civil engineering fundamental principles and canons in oral presentations

Course Outline	1. *Introduction to General Ethics and Ethical Values.* 2. *Civil Engineering Code of Ethics:* Fundamental Principles. Fundamental Canons. Guidelines to Practice under the Fundamental Canons of Ethics. 3. *The Practice of Civil Engineering:* Professional Responsibility. Client-Civil Engineer Relationships. Civil Engineering Services. Specialization of a Civil Engineer. Selection of a Civil Engineer. Prime Professional Practice. Employment. Design Competition. Contingency Basis of Employment. Professional Practice of Foreign Civil Engineers. 4. *Classification of Engineering Services:* Consultations, Research Investigations and Reports. Design Services for Construction Projects. Construction Services. Special Services for Construction Projects. Engineering Support Services. Academic Services. Services as Employee. 5. *The Selection of the Civil Engineer:* Basis for Selection. Client's Selection Committee. Qualifications-Based Selection (QBS) Procedure. Selection Procedure for "Level of Effort Contracts. 6. *Charging for Civil Engineering Services:* Salary Cost * Multiplier + Direct Non-Salary Expense. Hourly Billing Rate. Per Diem. 7. *Charging for Civil Engineering Services:* Cost Plus Fixed Fee. Fixed Price. Percentage of Construction Cost. Schedule of Minimum Fees. 8. *Total Project Cost:* Professional Engineering Costs. Construction Costs. 9. *Total Project Cost:* Legal, Land, Administration, Stuffing, and Financial Costs. Contingency Allowance. 10. *RA 544:* An Act to Regulate the Practice of Civil Engineering in the Philippines. 11. R.A. 9184: The Government Procurement Reform Act. Implementing Rules and Regulations on the Procurement of Consulting Services for Government Projects. 12. PD 1594 and its Implementing Rules and Regulations as Amended. 13. CIAP Document 102: Uniform General Conditions of Contract for Private Construction. 14. Extracts from the New Civil Code: Obligations and Contracts. 15. The Civil Engineering Professional Licensure Examination. 16. PD 1096: The National Building Code and its Implementing Rukles and regulations. 17. Seminar: Trends and Issues Concerning Civil Engineering Practice.
Laboratory Equipment	None

Suggested References	1. Philippine Institute of Civil Engineers, Inc. 2003. *Manual of Professional Practice for Civil Engineers, 2nd Edition. Manila:* Philippine Institute of Civil Engineers, Inc. 2. Hinze, Jimmie. 2001. *Construction Contracts, 2nd Edition.* Boston, USA : Mc Graw-Hill. 3. Central Book Supply. 2000. *Engineering Laws in the Philippines and Related Laws.* Manila: Central Book Supply. 4. Sajorda, Q.A., 1996 *Construction MASTER SPECIFICATIONS,* Elastomark Corporation, Philippines 5. Mead, Mead, and Akerman. 1992. *Contracts, Specifications and Engineering Relation.* USA: McGraw-Hill Book Company. 6. Nolledo, Jose. 1989. *The Civil Code of the Philippines.* Manila: National Book Store. 7. Philippine Bidding Documents for Government Contracts.

Course Name:	**GEOTECHNICAL ENGINEERING 1 (Soil Mechanics)**
Course Description	Soil formation and identification. Engineering properties of soils. Fundamental aspects of soil characterization and response, including soil mineralogy, soil-water movement, effective stress, consolidation, soil strength, and soil compaction. Use of soils and geosynsynthetics in geotechnical and geo-environmental applications. Introduction to site investigation techniques. Laboratory testing and evaluation of soil composition and properties.
Number of Units for Lecture and Laboratory	3 units lecture 1 unit laboratory
Number of Contact Hours per week	3 lecture hours per week 3 laboratory hours per week
Prerequisite	Geology for Civil Engineers, Mechanics of Deformable Bodies
Program Outcome/s Addressed by the Course	a-E; b-D; d-E; e-E; g-E; j-E; k-E
Course Outcomes	At the end of the course, the students must be able to: 1. apply basic mathematics, science and engineering principles to solve engineering problems, 2. calculate the stresses transferred to underlying soils applied by the superstructural loads, 3. deal with the estimation of compressibility and settlement properties of soils for shallow foundation footings design,

	4. design and conduct experiments, as well as to analyze and interpret data, 5. be familiar with soil mechanics tests and determine which test is needed in designing civil engineering projects and/or solving engineering problems, 6. use word processors in writing and finishing lab report, 7. use soil laboratory equipment properly, 8. demonstrate the ability to work in groups.
Course Outline	**Lecture** 1. **Soil Formation** ▪ Soil and its constituents, weathering of rocks and types of soils. Description and Identification of soil (Visual-Manual Procedure), Mineralogy of soil solids. 2. **Physical Properties** ▪ Water content, void ratio, porosity, degree of saturation, specific gravity, unit Weight and their determination, Atterberg limits, sieve analysis, hydrometer and Pipette analysis, Stoke's law, grain size distribution. 3. **Soil Classification** Grain size classification, Bureau of soils,. M.I.T., Unified, AASHTO and ASTM Classification systems. Textural Classification by triangular chart, united soil classification system, AASHTO soil classifications. 4. **Permeability and Seepage** ▪ Definition, Hydraulic gradient, Darcy's Law, Factors affecting permeability, Permeability of stratified soils, Laboratory and field determination of coefficient of permeability. ▪ Seepage force, quick sand condition, flow nets, boundary conditions, graphical method of flow net construction, determination of quantity of seepage, two dimensional flow, Laplace Equation, seepage through earth dams, design of filters 5. **Compaction** ▪ Definition, Compaction fundamentals, Moisture density relationships, ▪ Standard Proctor test and modified AASHO test for compaction, Factors affecting compaction, Compaction equipment, properties and structure of compacted soils, Specifications, field control and measurement of in-situ density, CBR test. 6. **Vertical stresses in soils** ▪ Definition, stresses caused by self weight of soil, Geostatic stresses, stresses caused by point loads and uniformly distributed loads: Boussinesq and Westerqaard theories, Pressure bulb, stress distribution diagram on horizontal and vertical planes; stress at a point outside loaded area, Newmark's charts and 2:1 Method 7. **Soil Exploration** ▪ Importance of soil exploration, soil exploration methods; probing, test trenches and pits, auger boring, wash boring,

	rotary drilling, Percussion drilling and geophysical methods, soil samples, Disturbed and undisturbed samples, In-situ tests (SPT, CPT and PLT) 8. **Geosynsynthetics in geotechnical and geoenvironmental engineering** 9. **Introduction of related Software** **Laboratory** 1. Identification of Soil (Visual Manual Procedure) 2. Determination of Moisture content of soil 3. Determination of specific gravity of soil 4. Determination of liquid limit of soil 5. Grain-size analysis of soil (including both mechanical and hydrometer analysis) 6. Determination of Plastic limit and Plasticity Index of soil 7. Determination of shrinkage limit of soil 8. Classification of soil according to AASHTO and USCS 9. Modified/Proctor Compaction Test 10. Constant Head Permeability test (Granular Soil) 11. Falling Head Permeability (Granular and Fine grained soils)
Laboratory Equipment	Refer to Annex IV
Suggested reference books	

Course Name	**PRINCIPLES OF TRANSPORTATION ENGINEERING**
Course Description	The course gives emphasis on urban transportation planning, design and operation using statistical and modeling techniques and computer methods. It also covers capacity and level of service of air, rail and highway. It also includes safety, environmental impacts and mitigation, transportation policy fundamentals and case studies.
Number of Units for Lecture and Laboratory	3 lecture units
Number of Contact Hours per Week	3 hours lecture
Prerequisites	Highway and Railroad Engineering
Co-requisites	None
Program	a-E, c-D, f-D

Outcome/s Addressed by the Course	
Course Outcomes	At the end of the course, the students must be able to: 1. Define concepts of transportation systems analysis and planning 2. Apply travel demand forecasting computation and analysis 3. Prepare traffic impact assessment reports 4. Recognize current transportation issues and policies, economic, safety and environmental concerns
Course Outline	1. Introduction to Transportation Planning & Engineering 2. Transportation as a System & 2. Philippine Transportation System 3. Urban Transportation Planning Concepts 4. Introduction to Travel Demand Forecasting (Classic Four-Step Forecasting Model) 4.1. Trip Generation 4.2. Trip Distribution 4.3. Modal Split 4.4. Route/Traffic Assignment 5. Traffic Impact Assessment 6. Transportation Safety & Economics 7. Transportation Policy Analysis and Planning/Technical Tour
Reference Books	1. Mannering Fred, Washburn Scott, Kilaresky Walter. 2004. Principles of Highway Engineering & Traffic Analysis. Muze Inc. 2. Garber, Nicholas; &Hoel, Lester. 2001. Highway and Traffic Engineering. Brookes/Cole Publishing. 3. Ortuzar, J. D. And Willumsen, L.G. 2011. Modelling Transport, John Wiley & Sons, Ltd., West Sussex, UK.

Course Name:	**QUANTITY SURVEYING**
Course Description	This course provides a basic understanding of the methods used to prepare 1. a building and/or bridge construction cost estimate, 2. earthwork costs. The students learn to do quantity takeoff utilizing plans and specifications.
Number of Units for Lecture and Laboratory	1 unit lecture 1 unit computation
Number of Contact Hours per week	1 hour lecture 3 hours computation
Prerequisite	Building Systems Design

Program Outcome/s Addressed by the Course	a-E, d-E, f-E, g-E, i-E, k-E, l-E
Course Outcomes	Upon completion of this course the student should be able to: 1. Determine quantity of various building materials 2. Develop bid costs for materials, labor and equipment for several construction project elements. 3. Evaluate total cost of engineering projects, including labor fringes, taxes, bonding fees, insurance, overhead and profit.
Course Outline	Lecture I. Review of Specifications and Plans/ Details a. Invitation to bid b. General conditions c. Special conditions d. Bid form II. Detailed Quantity Survey a. Concrete b. Masonry c. Steel d. Electrical System e. Sanitary/ Plumbing System f. Mechanical System g. Earthworks III. Unit Cost Derivation a. Labor b. Material c. Equipment d. Subcontractor IV. Summary of Total Project Costs a. Labor, material, equipment and subcontractor costs b. Labor fringes, taxes and insurance costs c. Material and equipment taxes d. Bond and insurance costs e. Overhead and profit Laboratory Exercise 1 Preparation of review comments of construction documents Exercise 2 Quantity takeoff a. Earthworks b. Concrete Elements c. Masonry d. Structural Steel e. Electrical Systems

	f. Sanitary/ Plumbing Systems g. Mechanical System Exercise 3 Unit Cost Derivation based on Method of Construction a. Labor b. Material c. Equipment d. Subcontractor Exercise 4 Preparation of Program of Work Exercise 5 Preparation of Summary of Total Project Cost Exercise 6 Preparation of Bid Document/ Bid Forms Exercise 7 Bid Analysis and Unbalanced Bids
Laboratory Equipment	Computers
Suggested reference books	Peurifoy, Robert L., Oberlender, Garold D. (2002). Estimating Construction Costs w/ CD-ROM, 5th (or current) edition. McGraw-Hill

Course Name:	**CONSTRUCTION METHODS AND PROJECT MANAGEMENT**
Course Description	The course deals with the principles of construction methods and equipment, management and their applications. It covers project planning, scheduling, monitoring and control. It also includes concepts on organization, safety, information systems and computer applications. Students are given opportunities to visit actual project sites and observe the application of these theories in construction projects.
Number of Units for Lecture, Laboratory, Fieldwork and Tutorial	Lecture – 3 units Fieldwork – 1 unit
Number of Contact Hours per week	Lecture – 3 hours Fieldwork – 3 hours
Prerequisite/Co-requisite	4th Year Standing
Program Outcome/s Addressed by the Course	a-E, c-D, e-E, f-E, g-D, k-D, l-E
Course Objectives	After completing this course, the student must be able to: 1. Understand the construction project cycle from inception, planning, execution, testing and certification. 2. Understand construction project requirements such as permits and

	licenses, clearance, and compliance to all applicable laws and ordinances, etc; 3. Read and interpret construction plans, working drawings, and revise contract documents, estimates and technical specifications; 4. Understand the components of the Terms of Reference (TOR) for professional services and bidding/tendering processes, award and acceptance; 5. Prepare and update construction schedule and work programs; 6. Understand construction methods, equipment, materials and manpower control; 7. Understand temporary facilities requirements of a construction project; 8. Understand the existing local labor laws and regulations
Course Outline	1. Contracts and Specifications; 2. Construction Project Organization; 3. Planning and Scheduling (PERT/CPM); 4. Construction Estimates and Values Engineering 5. Construction Methods and Operations; 6. Construction Equipment Operations and Maintenance 7. Construction Manpower Safety; 8. Computer Applications in Construction Management; 9. Construction Reports 10. Construction Fieldwork 11. Construction Disputes 12. Fieldwork: Observation of construction projects
Laboratory Equipment	None
Suggested References	1. Construction Planning Equipment & Methods by R.L. Peurifoy, latest edition 2. Project Management for Engineering and Construction, latest edition 3. Construction Management Handbook, CMDF 4. Constructors Performance Evaluation System (CPES) Implementing Guidelines, CIAP

Course Name:	**CE PROJECT 1**
Course Description	Development of a capstone project proposal containing a clear set of objectives, methodology, project implementation plan/schedule and resource requirements.
Number of Units for Lecture and Laboratory	1 unit lecture, 1 unit laboratory
Number of Contact Hours per week	1 hour lecture, 3 hours laboratory

Prerequisite	4th year standing
Program Outcome/s Addressed by the Course	a-E, b-D, c-D, d-D, e-D, f-D, g-D, h-D, k-D
Course Outcomes	After completing this course, the student must be able to: 1. Review and/or apply design concepts, design codes and engineering tools learned in previous courses and work on a real-world capstone design project in a team setting 2. Solve an engineering problem with technical or non-technical project constraints through the actual engineering design process 3. Collaborate with other students and function in a multidisciplinary group 4. Develop and enhance interpersonal skills 5. Develop and enhance ethical and professional responsibility 6. Apply project management skills to finish the project according to schedule 7. Practice effective communication skills through the preparation of a project proposal, engineering reports and oral project presentations
Course Outline	1. Introduction of CE Project Course 2. Project Team Composition (members must come from various fields of specialization) 3. Identification and/or assignment of candidate Design Projects 4. Weekly progress meeting reports/consultations with adviser • Independent study (guided by the adviser) to define and refine the objectives, methodology, project implementation plan/schedule, and resource requirements • Design Project Proposal Preparation/Development 5. Design Project Proposal Presentation and approval
Laboratory Equipment	Depends on the topic chosen, Computers
Suggested reference books	AASHTO ASEP, National Structural Code of the Philippines Vol. 1, 2001 Edition ASTM American Concrete Institute, ACI 318 Building Code Requirements for Reinforced Concrete Department Administrative Order (DAO) issuances of DENR National Building Code of the Philippines

	Pritchard, Harris & Rabins, Engineering Ethics: Concepts and Cases Philippine Institute of Civil Engineering (PICE), PICE Manual of Practice

Course Name:	**CE PROJECT 2**
Course Description	Implementation of a capstone project based on an approved proposal.
Number of Units for Lecture and Laboratory	1 unit lecture, 1 unit laboratory
Number of Contact Hours per week	1 hour lecture, 3 hours laboratory
Prerequisite	CE PROJECT 1
Program Outcome/s Addressed by the Course	a-E, b-D, c-D, d-D, e-D, f-D, g-D, h-D, k-D
Course Outcomes	After completing this course, the student must be able to: 1. Apply design concepts, design codes and engineering tools learned in previous courses and work on a real-world capstone design project in a team setting 2. Solve an engineering problem with technical or non-technical project constraints through the actual engineering design process 3. Collaborate with other students and function in a multidisciplinary group 4. Develop and enhance interpersonal skills 5. Develop and enhance ethical and professional responsibility 6. Apply project management skills to finish the project according to schedule 7. Practice effective communication skills through the preparation of a project proposal, engineering reports and oral project presentations
Course Outline	1. Review of the objectives/aims of the CE Project Course 2. Implementation of the approved CE Project Proposals • Weekly progress meeting reports/consultations with adviser • Independent study, as needed (guided by the adviser)

	3. Design Project Mid-term Presentation 4. Continuation of the implementation of the approved CE Project Proposals • Weekly progress meeting reports/consultations with adviser • Independent study, as needed (guided by the adviser) 5. Design Project Documentation 6. Design Project Final Presentation and approval 7. Submission of an Engineering Report (Project Documentation)
Laboratory Equipment	Depends on the topic chosen, Computers
Suggested reference books	AASHTO ASEP, National Structural Code of the Philippines Vol. 1, 2001 Edition ASTM American Concrete Institute, ACI 318 Building Code Requirements for Reinforced Concrete Department Administrative Order (DAO) issuances of DENR National Building Code of the Philippines Pritchard, Harris & Rabins, Engineering Ethics: Concepts and Cases Philippine Institute of Civil Engineering (PICE), PICE Manual of Practice

F. PROFESSIONAL COURSES – Specialized

F.1 CONSTRUCTION ENGINEERING AND MANAGEMENT

Course Name:	**PROJECT CONSTRUCTION & MANAGEMENT**
Course Description	The course seeks to introduce the student to the basic theories and tools of management and decision-making. It tackles in detail the functions of management in managing the following aspects of a corporation: production, service operations, marketing and finance functions. This course will enable the students to acquire and develop the skills in defining, planning and monitoring engineering projects using basic engineering management tools and techniques.

Number of Units for Lecture and Laboratory	3 units Lecture
Number of Contact Hours per week	3 hours Lecture
Prerequisite	None
Co-Requisite	None
Program Outcome/s Addressed by the Course	g-E, i-E, j-E, k-E, l-E, m-E
Course Outcomes	After completing this course, the student must be able to: 9. Describe the management process and explain the different functions of management 10. Craft a personal mission and vision statement 11. Perform a SWOT analysis 12. Identify the types of organizational structures. 13. Identify management practices applied in civil engineering
Course Outline	Course Syllabus; Introduction to Engineering Management Management and Organization; Levels of Management Responsibility per Management Function Functional Management Skills; Planning Process Workshop 1: Visioning and Crafting a Mission Statement Workshop 2: Hollow-Square Experiment Workshop 3: SWOT Analysis Workshop 3: SWOT Analysis Organizing and Staffing Leading and Influencing; Motivating and Communicating; Controlling Organizational Structure & Design Workshop 4: Organizational Structure Analysis Exercise Problem-solving Methodology; Problem Solving Tools and Techniques LONG QUIZ 1 Location, Facilities and Capacity Planning Layout Strategy Material Management Inventory Management Designing Work Standards and Manpower Planning Film Showing

	Market Planning, Business Development, Financial Management Quality Management: Quality Control and Inspection, Quality Assurance Total Quality Management Project Management; Project Scheduling: Network Analysis - Arrow Diagram and Scheduling Computation Network Analysis - Precedence Diagram and Scheduling Computation
Laboratory Equipment	N/A
Suggested reference books	1. Atienza, R. V. (2010). Engineering Management. De La Salle University. 2. Manalang, A. S. (2010). Engineering Management Workbook. De La Salle University. 3. Ivancevich, J., Konopaske, R. and Matteson, M. (2007). Organizational Behaviour and Management, 8th edition. 4. Additional readings and lecture notes provided 5. George, S. and Weimerskirch, A. (1992). Total Quality Management. The Portable MBA Series. John Wiley & Sons, Inc. 6. Heizer, J. and Render, B. (2008). Operations Management. 9th Edition. Prentice Hall. 7. Oberlender, G. (2000). Project Management for Engineering and Construction. 2nd Edition. McGraw Hill. 8. Pearce, J. A. and Robinson, R. (2003). Strategic Management. Formulation, Implementation and Control. 8th Edition. McGraw Hill Irwin. 9. Robbins, S. P. and Couter, M.(2007). Management.9th edition. Pearson 10. Radosavljevic, M., Bennett, J. (2012). Construction Management Strategies: A Theory of Construction Management, John Wiley & Sons. 11. A discussion about value management in civil engineering, Liu, Y.H. 12. Hu, G.L., and Wang, Q.L., Scopus, 2013. 13. Dynamic Project Management: An Application of System Dynamics in Construction Engineering and Management, Han, S. , Lee, S., Park, M., Optimization and Control Methods in Industrial Engineering and Construction. 2014, p219-231.

Course Name:	**ADVANCED CONSTRUCTION METHODS & EQUIPMENT**
Course Description	Deals with the principles of construction methods and equipment, management and their applications. It covers analytical techniques for project planning, scheduling, monitoring and control. It also includes concepts on organization, quality control and assurance, quality management, safety, information systems and computer applications and softwares. Students are

	given opportunities to visit actual sites and observe the application of these theories and concepts in construction projects.
Number of Units for Lecture and Laboratory	3 Units Lecture
Number of Contact Hours per week	3 hours Lecture
Prerequisite	None
Co-Requisite	None
Program Outcome/s Addressed by the Course	g-E, i-E, j-E, k-E, l-E, m-E
Course Outcomes	After completing this course, the student must be able to: 1. Draw a network diagram using Activity on Arrow (AOA) and Activity on Node (AON) methods. 2. Prepare and update construction estimates, schedule, material and manpower report. 3. Calculate labor and equipment productivity. 4. Read and interpret construction plans, working drawings, contract documents and technical specifications in the preparation of a complete bid for a construction project. 5. Identify and present a traditional and new method/theory/practice applied in construction projects. 6. Investigate, report and propose a solution to a safety or quality issue in a construction project.
Course Outline	Introduction, Construction Project Cycle, Preparing a Bid Package, Bidding Process and Requirements Issues during Construction Phase, Contracts and Specifications, Construction Contracts Construction Project Organization, Legal Structure, Construction Project Requirements Planning and Scheduling: Network Analysis – Activity on Arrow (AOA) and scheduling computation, Network Analysis – Activity on Node (AON) and scheduling computation Time-Cost Trade-off Program Evaluation and Review Technique (PERT) Estimating, Quantity Surveying, Quantity Take-off Estimating, Quantity Surveying, Quantity Take-off

	Construction Equipment Operations, Productivity and Maintenance Construction Methods and Techniques – Group Report 1 Resource Management, Resource Leveling, Construction Labor, Manpower planning, control and monitoring Material Management Quality Management (quality planning, quality assurance and quality control), Construction Safety Construction Disputes
Laboratory Equipment	N/A
Suggested reference books	1. Halpin, Daniel W. and Woodhead, Ronald W., Construction Management, 4th Edition, Wiley, Hoboken, NJ, 2012. 2. Evans, James R., Quality, management, organization, and strategy, 6th Edition, Cengage Learning, Australia : South-Western, 2011. 3. Lewis, James P., Project planning, scheduling & control : the ultimate hands-on guide to bringing projects in on time and on budget, 5th Edition, McGraw-Hill, New York, 2011 4. Peurifoy, Robert et.al., Construction Planning, Equipment and Methods, 8th Edition, McGraw-Hill, New York, 2011. 5. Plotnick, Fredric L. and Bockrath, Joseph T., Contracts and the legal environment for engineers & architects, 7th Edition, McGraw-Hill, New York, 2011. 6. Pratt, David J., Fundamentals of Construction Estimating, 3rd Edition, Delmar Cengage Learning, Clifton Park, N.Y., 2011. 7. Nunnally, Stephens W., Construction Methods and Management, 6th Edition, Pearson Prentice Hall, Upper Saddle River, N.J., c2004. 8. Rowlinson, Steve, Construction Safety Management Systems, Spon Press/Taylor & Francis Group, London, 2004. 9. Keoki, Sears S. et.al., Construction project management : a practical guide to field construction management, 5th Edition, Wiley, Hoboken, NJ, 2008. 10. Gould, Frederic E. and Joyce, Nancy E., Construction Project Management, 2nd Edition, Prentice Hall, Upper Saddle River, N.J., 2003. 11. Oberlender, Garold D., Project Management for Engineering and Construction, 2nd Edition, McGraw-Hill, Boston, 2000. 12. Primavera Project Management Reference Manual, available online. 13. Fajardo, Max B., Simplified Construction Estimate, 5138 Trading, 2000. 14. Fajardo, Max B., Project Construction Management, 5138 Trading, 2000. 15. Fajardo, Max B., Specifications and Contract, 5138 Trading, 1999.

Course Name:	CONSTRUCTION COST ENGINEERING
Course Description	The course deals primarily with cost engineering and accounting systems in construction projects. Discussion covers data to be collected, information to be produced, procedures and policies in system implementation and typical forms used. Relevant topics in financing and purchasing are also discussed. Computer applications will be considered as well as practical insights on the cost control systems of on-going construction projects.
Number of Units for Lecture and Laboratory	3 Units Lecture
Number of Contact Hours per week	3 Lecture hours per week
Prerequisite	None
Co-Requisite	None
Program Outcome/s Addressed by the Course	g-E, i-E, j-E, k-E, l-E, m-E
Course Outcomes	After completing this course, the student must be able to: 1. Apply the project management information system, cost engineering and accounting concepts in construction projects 2. To analyze and design an improved cost engineering and accounting system for a construction project.
Course Outline	Introduction and Orientation The Project Management Information System - System Information Systems - The PMIS, Objectives, Design - Components of PMIS - Values of PMIS - Challenges to implementation of PMIS Introduction to Construction Cost Types of Construction Cost: Preliminary Estimates; Cost per sqm Stipulated sum/Unit Price; Cost plus; Estimating formats Work Breakdown Structure (WBS)

	CSI Master Format Cost Estimating components Quantities Direct cost: Unit Cost Theory and Practice Materials, labor, equipment Equipment Cost of owning and operating Sub-con cost Project Overhead Cost Contingencies/ taxes Profit /mark-up Site Visit Cost Planning Flowchart- Project scheduling Flowchart- Materials cost scheduling Flowchart- Manpower scheduling Flowchart- Subcon cost Scheduling Flowchart- Equipment cost scheduling Preparing Cash flow projections Cash flow assumptions: Cash receipts, Capital investment, Loans, Interest payment, Pre-operating and admin cost Site Visit Cost Accounting Preparing Income Statements Preparing Balance Sheets General Financial Control Over the Business Accounting ratios Horizontal and vertical analysis of financial statements Audits
Laboratory Equipment	N/A
Suggested reference books	3. Spain, Bryan, Spon's First Stage Estimating Handbook, 3rd Edition, Taylor and Francis, Londong and New York, 2010 4. Mubarak, Saleh, Construction Planning and Control, 2nd Edition, John Wiley & Sons, Inc. 2010 5. O'Brien, James J. and Zilly, Robert G., 'Contractor's Management Handbook,' 2nd Edition, Mac-Graw Hill, 1991 6. Halpin, Daniel, and Senior, Bolivar, Construction Management, 4th Edition, Wiley, 2012. 7. Myers, Danny, Construction Economics: A New Approach, 3rd Edition, London: Routledge, 2013 8. Mislick, Gregory, and Nussbaum, Daniel, Cost Estimation: Methods and

	Tools, Wiley, 2015 9. Del Pico, Wayne, Project Control: Integrating Cost and Schedule in Construction, Wiley, 2013 10. Towey, Donald, Cost Management of Construction Projects, Wiley, 2013

Course Name:	**DATABASE MANAGEMENT IN CONSTRUCTION**
Course Description	The course covers Civil Engineering Information Systems, Information Engineering and Architectures, Information Strategy, Enterprise-wide Information Strategy Planning, Case Tools, Relational Database, Modeling and Normalization, Zachman's Framework, Object Oriented Modeling and Design, Data Warehousing and Data Mining.
Number of Units for Lecture and Laboratory	3 Units Lecture
Number of Contact Hours per week	3 Lecture hours per week
Prerequisite	None
Co-Requisite	None
Program Outcome/s Addressed by the Course	g-E, j-E,k-E, l-E, m-E
Course Outcomes	After completing this course, the student must be able to: 1. Identify Project Information System 2. Recognize structures and functions of project components 3. Write and present reports in the proper format and in correct English using word processor, spread sheets, Develop teamwork and cooperative learning through group exercises. 4. Model existing information system in the construction industry 5. Design and propose a new database management system in an existing information system in the construction industry

Course Outline	Introduction Civil Engineering Information Systems Grouping of students and identify a non-construction company for Report #1 Information Engineering and Architecture Anticipated inputs from company for Report #1 Information Strategy Planning List down processes needed for Report #1 Report #1 Enterprise – Wide Information Strategy Planning: Top-down approaches, Analysis of goals and problems, Critical success factor analysis, Technology impact analysis, Strategic systems vision Grouping of students and identify a construction company for Report #2 Case tools: Matrices, Hierarchies, Process Modeling Relationship Framework Anticipated inputs from company for Report #2 Relational Database Modeling and Normalization List down processes needed for Report #2 Zachman's Framework Observe actual processes needed for Report #2 Object Oriented Modeling and Design Model proposed process for improvement for Report#2 Report # 2 Database Management Systems: use of software Use computer softwares in preparation for the Term Project Automating information discovery: Data warehousing and Data Mining Use computer softwares in preparation for the Term Project
Laboratory Equipment	N/A
Suggested reference books	11. Paulson, Computer Application in Construction, MC Graw Hill, 1995 12. Rumbaugh, et al., Object Oriented Modeling and Design, Prentice Hall, 1991 13. Date, An Introduction to Database Systems, Addison Wasley, 1990

	14. Martin, Information Engineering, Books II and III, Prentice Hall, 1990 15. Mubarak, Construction Project Scheduling and Control, 2nd Edition, 2010 16. Kung, Object-Oriented Software Engineering: An Agile Unified Methodology, 1st Edition, McGraw-Hill, 2014 17. Elmasri&Navathe, Fundamentals of Database Systems, 6th Edition, Addison-Wesley, 2011 18. Abraham Silberschatz and Henry Korth and S. Sudarshan, Database Systems Concepts, 6th Edition, McGraw-Hill, 2011 19. Mark Gillenson, Fundamentals of Database Management Systems, 2nd Edition, Wiley, 2012

Course Name:	**CONSTRUCTION OCCUPATIONAL SAFETY AND HEALTH**
Course Description	This is an introductory course on occupational safety and health management that follows a risk management approach based on international standards and best practices by organizations such as the International Labour Organization and the Institution of Occupational Safety and Health. Topics include the relationship of health and safety, identification and control of workplace hazards and risks, and practical workplace assessment with an emphasis to personal safety. Finally, this course focuses on management principles rather than techniques and methods.
Number of Units for Lecture and Laboratory	3 Units Lecture
Number of Contact Hours per week	3 Lecture hours per week
Prerequisite	None
Co-Requisite	None
Program Outcome/s Addressed by the Course	g-E, i-E, j-E, l-E, m-E
Course Outcomes	After completing this course, the student must be able to: 1. Discuss and explain the importance and value of safety. 2. Describe the different health and hazards and their prevention. 3. Apply the concepts and principles of safety in engineering practice

	4. Explain "Safety as the engineer's professional and moral responsibility"
Course Outline	- Global and National Situation in OSH - OSH Foundations and its Benefits - International OSH Standards by the International Labour Organization - Philippine Legislation - OSH Policy and Safety Statement - Responsibilities of Employers' and Employees' - Organizational Structure - Risk Assessment - Hazard Checklist (Qualitative) - Risk Assessment Reporting - Principles of Control and Prevention - Safe Systems of Work - Job Safety Analysis - Movement of People and Vehicles – Hazards and Control - Manual and Mechanical Handling Hazards and Control - Work Equipment Hazards and Control - Construction Activities Hazards and Control - Electrical Hazards and Control - Fire Hazards and Control - Chemical and Biological Health Hazards and Control - Physical and Psychosocial Hazards and Control - Discussion of the Term Project - Safety Inspection Observation Sheet - Safety Inspection Report
Laboratory Equipment	N/A
Suggested reference books	1. International Health and Safety at Work for the NEBOSH International General Certificate, by Hughes and Ferrett 2013 2. Occupational Safety and Health Standards, Department of Labor and Employment, Philippines 3. International Labour Standards on Occupational Safety and Health, International Labour Organization

F.2 GEOTECHNICAL ENGINEERING

Course Name:	**GEOTECHNICAL ENGINEERING (ROCK MECHANICS)**
Course Description	This course provides an introduction to the theory of rock mechanics and its applications in mine construction and operation. Students are presented with the fundamental concepts of stress and strain in isotropic and anisotropic rocks and conduct stress analyses using data collected in the laboratory and

	the field. Rock mass structures and classification schemes are introduced, and students learn how these govern rock slope stability and underground rock excavation methods in a given stress environment. Rock control and support systems utilized in underground and surface excavations and their related safety requirements are discussed. Rock mechanics topics surrounding blasting and the stability of impoundment dams and tailings dumps are also presented. In-class exercises focus on introducing rock engineering properties through laboratory testing, as well as building a foundation in geotechnical data collection, data presentation, and core logging.
Number of Units for Lecture and Laboratory	3 Units Lecture
Number of Contact Hours per week	3 lecture hours per week
Prerequisite	Geotechnical Engineering 1
Co-Requisite	
Program Outcome/s Addressed by the Course	a-E, c-E, e-E, g-E, h-E, k-E, m-D
Course Outcomes	Upon successful completion of this course the student will be able to: 1. identify the objectives of geotechnical data collection and rock mass classification methods, and successfully collect and analyze a range of geotechnical datasets for design purposes 2. describe the theory and analysis of in situ and induced stresses in a rock mass and structurally controlled failure 3. apply the principles of rock mechanics and excavation design to develop excavation proposals for given geologic environments (e.g. stratified, massive, blocky, or faulted lithologies) 4. explain the principles and techniques of reinforcement design for the primary failure modes in underground rock excavations, and apply these principles and techniques to inform design for tunnels and large excavations 5. describe the theory, analysis, and control of rock and soil slope stability and rockfall hazards. 6. calculate the Factor of Safety of rock slopes and underground excavations 7. describe the mechanical implications of various blast types and patterns for a rock mass, and characterize blasting control systems

	for surface and underground excavations.
Course Outline	1 Stress and strain: force and stress; stress transformations; principal stresses and stress invariants; plane problems and biaxial stress; displacement and strain; geomechanics conventions. 2 Rock mass structure and characterization: types of structural features; geomechanical properties of discontinuities; structural data collection and presentation; rock mass classification. 3 Rock strength and deformability: concepts and definitions; isotropic and anisotropic rock behaviour (uniaxial and multiaxial); behaviour of discontinuous rock masses. 4 Pre-mining state of stress: factors influencing the in situ state of stress; in situ stress determination and presentation of results. 5 Methods of stress analysis: principles of classical stress analysis; closed-form solutions for simple excavation shapes; boundary element, finite element, distinct element, and finite difference analysis methods for continuous rock. 6 Excavation design in massive elastic rock: general principles of excavation design; zone of influence; excavation shape and boundary stresses; delineation of rock failure zones. 7 Excavation design in (1) stratified rock: design factors; rock mass response to mining; roof bed deformation mechanics; roof beam deflection; and (2) blocky rock: design factors; Block Theory; triangular roof prisms; tetrahedral block roofs; stope wall design. 8 Energy, mine stability, mine seismicity, and rockbursts: mechanical relevance of energy changes; energy transmission in rock; characterization of seismic events; instability due to fault slip. 9 Rock support and reinforcement: support and reinforcement principles and design; rock-support interaction analysis; materials and techniques. 10 Underground mining methods and related rock mechanics considerations: rock mass response to stoping activity; pillar-supported methods; artificial support techniques; longwall and caving methods. 11 Surface mining methods and related rock mechanics

	considerations: rock slope failure; bench analysis for failure geometries; methods for bench face angle prediction; rock fabric data reduction. 12 Mining-induced surface subsidence: types and effects; chimney caving; sinkholes; discontinuous subsidence with caving methods; continuous subsidence with tabular orebodies. 13 Blasting mechanics: explosive types; elastic models for explosive-rock interaction; nature of rock breakage; perimeter blasting; transient ground motion; evaluation of blast performance. 14 Soil mechanics: soil index properties and United Soil Classification System; soil tests; creep; slope stability
Laboratory Equipment	None
Suggested references	Brady BHG, Brown ET. 2004. Rock mechanics for underground mining. 3rd ed. AZ Dordrecht, The Netherlands: Kluwer Academic Publishers. 626 p. Darling P. 2011. SME Mining Engineering Handbook. 3rd. ed. United States of America: Society for Mining, Metallurgy, and Exploration, Inc. 1839 p.

Course Name:	**FOUNDATION ENGINEERING**
Course Description	Review of fundamental concepts – index and classification properties, water flow, effective stress concept, consolidation behavior, shear strength of soils – undrained and drained conditions. Subsurface exploration – main sampling/characterization methods and reporting, variability. Lateral loads (at-rest, active and passive pressures). Earth retaining structures – walls (gravity/cantilever, mechanically-stabilized earth, sheet-piled, anchored), braced cuts, dewatering and drainage. Performance requirements, applied loads based on codes, and selection of foundations. Shallow foundation design – types (spread, strip, and mat/raft), bearing capacity and settlements (elastic/initial, consolidation, allowable/tolerable), testing and evaluation. Deep foundation design – types (methods, configuration, materials), bearing capacity (axial and lateral) and settlements, testing and evaluation.
Number of Units for Lecture and Laboratory	3 Units Lecture
Number of Contact Hours per	3 lecture hours

week	
Prerequisite	
Co-Requisite	
Program Outcome/s Addressed by the Course	a-E, c-D, e-E, g-E, h-E, k-D, m-D
Course Outcomes	After completing this course, the students will be able to: 1. Plan a subsurface exploration, and select appropriate drilling, sampling and field property measurement tools for different soil profiles. 2. Create an idealized soil profile for analysis and design from collected soil properties. 3. Evaluate laboratory and field data to select appropriate parameters to use in foundation analysis. 4. Determine the lateral loads from soils. 5. Design earth retaining structures. 6. Apply shallow and deep bearing capacity and settlement equations for design with applicable correction factors with a consideration of water effects and layering.
Course Outline	1. Review of fundamental concepts – index and classification properties, water flow, effective stress concept, consolidation behavior, shear strength of soils – undrained and drained conditions. 2. Subsurface exploration – sampling/characterization methods and reporting, variability. 3. Lateral loads (at-rest, active and passive pressures). 4. Earth retaining structures and excavations – walls (gravity/cantilever, mechanically-stabilized, sheet-piled, anchored) braced cuts, drainage/dewatering. 5. Performance requirements, applied loads based on codes, and

	selection of foundations. 6. Shallow foundation design – types (spread, strip, and mat/raft), bearing capacity and settlements (elastic/initial, consolidation, allowable/tolerable), testing and evaluation. 7. Deep foundation design – types (methods, configuration, materials), bearing capacity (axial and lateral) and settlements, testing and evaluation.
Laboratory Equipment	None
Suggested reference books	1. Principles of Foundation Engineering - SI Edition – 8 th Ed. (2016) by B. M. Das – Cengage Learning 2. Additional hand-outs will be given in class as deemed necessary. 3. Foundation Design: Principles and Practices – 3 rd Edition (2016) by D. P. Coduto, W. A. Kitch, M. R. Yeung – Pearson 4. Canadian Foundation Engineering Manual – 4 th Edition (2006) by The Canadian Geotechnical Society – BiTech Publishers 5. Soil Mechanics and Foundations – 3 rd Edition (2010) by M. Budhu – Wiley 6. Foundation Design and Construction – 7 th Edition (2001) by M. J. Tomlinson – Pearson 7. Analysis and Design of Shallow and Deep Foundations (2005) by L. C. Reese, W. M. Isenhower, S-T. Wang – Wiley 8. Geotechnical Engineering: Foundation Design – 1 st Edition (1994) by J. N. Cernica – Wiley 9. Soil Strength and Slope Stability – 2 nd Edition (2014) by J. M. Duncan, S. G. Wright, T. L. Brandon – Wiley 8) Geotechnical Engineering Design – 1 st Edition (2016) by M. Xiao – Wiley

Course Name:	**GEOTECHNICAL EARTHQUAKE ENGINEERING**
Course Description	This course on Geotechnical Earthquake Engineering introduces the fundamental concepts of earthquake engineering related to geotechnical problems, principles of earthquake, wave propagation, dynamic soil properties, liquefaction and seismic design of various geotechnical structures. This course focuses on seismic hazard analysis which includes both Probabilistic Seismic Hazard Analysis (PSHA) and Deterministic Seismic Hazard Analysis (DSHA), followed by site response analysis. Also, behavior of various geotechnical structures such as shallow and deep foundations, retaining structures, slopes, ground anchors, waterfront retaining structures,

	reinforced soil-wall, tailing dam due to earthquake loading are discussed with reference to codal provisions.
Number of Units for Lecture and Laboratory	3 Units Lecture
Number of Contact Hours per week	3 lecture hours per week
Prerequisite	
Co-Requisite	
Program Outcome/s Addressed by the Course	a-E, c-D, e-E, g-E, h-E, k-D, m-D
Course Outcomes	After successful completion of the course, the student shall be able to: 1. Classify and evaluate earthquake sources/loads, and associated geotechnical earthquake hazards. 2. Explain key concepts in the seismic assessment of engineering structures. 3. Interpret the behavior of soils and geotechnical structures during earthquakes. 4. Apply simplified design-oriented methods for liquefaction analysis, and seismic analysis and design of retaining walls, embankments, bridge and building foundations. 5. Analyze the response of sites, earth structures and soil-structure systems under earthquake loads
Course Outline	1. Introduction to Geotechnical Earthquake Engineering Scope and objective; Nature and types of earthquake loading; Importance of Geotechnical Earthquake Engineering 2. Basics of Vibration theory Concept of dynamic load, Earthquake load, Single degree of freedom system, Multiple degree of freedom system, Free and forced vibrations, Damped and undamped systems, Equation of Motion, Response spectra. 3. Engineering Seismology Basic Seismology, Earthquake, List of major earthquakes, Causes of earthquakes, Sources of earthquake data, Elastic rebound Theory, Faults, Plate tectonics, Seismograph and Seismogram, Prediction of Earthquakes, Protection against earthquake

	damage, Origin of Universe, Layers of Earth, Theory of Continental Drift, Hazards due to Earthquakes. 4. Strong Ground Motion Size of Earthquake: Magnitude and Intensity of Earthquake, Modified Mercalli Intensity Scale, Measuring of Earthquake, Earthquake Magnitude Local (Richter) magnitude, surface wave magnitude, Moment magnitude, Seismic energy, Correlations. Spectral Parameters: Peak Acceleration, Peak Velocity, Peak Displacement, Frequency Content and duration, Spatial Variability of Ground Motion, Attenuation Relationships, Fourier Amplitude Spectra, Arias Intensity. 5. Wave Propagation Elastic response of continua (one, two and three dimensional wave equations); Waves in unbound media; Waves in semi-infinite media; Waves in layered media, Mohorovicic Discontinuity and Gutenberg Discontinuity, Seismic Travel Time Curve, Three Circle Method for locating an Earthquake's Epicenter. 6. Dynamic Soil Properties Stiffness, damping and plasticity parameters of soil and their determination (laboratory testing, intrusive and non intrusive in-situ testing); Correlations of different soil parameters; Liquefaction (basics, evaluation and effects), Liquefaction hazard map, Lateral Spreading. 7. Seismic Hazard Analysis Magnitude Indicators, Segmentation, Deterministic Seismic Hazard Analysis (DSHA),Probabilistic Seismic Hazard Analysis (PSHA),Earthquake Source Characterization, Gutenberg-Richter recurrence law, Predictive relationships, temporal uncertainty, Probability computations, Seismic Hazard Curve, Logic tree methods. 8. Site Response Analysis Ground Response Analysis, Transfer Function, Non-linear approach. Site Classification. 9. Seismic Analysis and Design of Various Geotechnical Structures Pseudo-static method, Pseudo dynamic method, other dynamic methods, Seismic analysis of retaining wall, Seismic slope stability analysis, Behavior of reinforced soil under seismic conditions, Seismic design of retaining structures, Seismic analysis of Tailings Dam, Seismic displacement based analysis, seismic design of shallow foundations, seismic design of pile foundations, seismic uplift capacity of ground anchors, seismic design of Municipal Solid Waste (MSW) landfills. Codal provisions/guidelines for seismic 10. design of geotechnical structures.
Laboratory Equipment	
Suggested reference books	References: 1. Shamsher Prakash,"Soil Dynamics", McGraw-Hill Book Company.

	2. Steven L.Kramer,"Geotechnical Earthquake Engineering",Prentice Hall Inc. 3. Robert W. Day,"Geotechnical Earthquake Engineering Handbook", McGraw Hill, New York. 4. Ikuo Towhata,"Geotechnical Earthquake Engineering",Springer-Verlag Heidelberg. 5. Kenji Ishihara,"Soil Behaviour in Earthquake Geotechnics", Oxford University Press, USA. 6. Milutin Srbulov,"Geotechnical Earthquake Engineering:Simplified Analyses with Case Studies and Examples",Springer-Verlag. 7. D. D.Barkan,"Dynamics of Bases and Foundations", McGraw-Hill Book Company.

Course Name:	**GROUND IMPROVEMENT**
Course Description	As more engineering structures are built, it becomes increasingly difficult to find a site with suitable soil properties. The properties at many sites must be improved by the use of some form of soil improvement methods. The objective of this course is for students to understand common ground improvement methods, including densification and compaction, preloading consolidation by prefabricated vertical drains, vacuum and electro-osmotic consolidation, physical and chemical stabilization, soil reinforcement and seepage and dewatering. The focus of discussion will be on understanding scientific principles and appropriate applications; the degree to which soil properties may be improved; advantages and limitations. Case studies will be presented as part of learning process throughout the lectures.
Number of Units for Lecture and Laboratory	3 Units Lecture
Number of Contact Hours per week	3 lecture hours per week
Prerequisite	Geotechnical Engineering 1
Co-Requisite	
Program Outcome/s Addressed by the	a-E, c-D, e-E, g-E, h-E, k-D, m-D

Course	
Course Outcomes	Upon successful completion of this course the student will be able to: 1. design and analyze foundations on difficult soils; 2. design and analyze embankments and earth dams; 3. design and analyze earth retaining structures; 4. develop methodologies for seepage control, dewatering and other ground improvement projects with consideration of enhancing the benefit and reducing the cost.
Course Outline	I Densification and Compaction 1. Shallow and deep compaction 2. Dynamic compaction 3. Compaction quality control and assessment II Consolidation 1. Prefabricated vertical drains (PVDs) 2. Vacuum preloading 3. Electro-osmosis III Physical and chemical stabilization 1. Chemical admixtures 2. Grouting 3. Thermal treatment 4. Ground freezing 5. Electro-cementation IV Reinforcement by inclusions 1. Reinforced earth structures 2. Ground anchors, nails and micro-piles V Seepage control and dewatering

	1. Drainage methods 2. Seepage control 3. Design considerations
Laboratory Equipment	
Suggested reference books	Hausmann, M. R. (1990), Engineering Principles of Ground Modification, McGraw Hill, NY.

F.3 STRUCTURAL ENGINEERING

Course Name	**COMPUTER SOFTWARES IN STRUCTURAL ANALYSIS**
Course Description	A specialized professional course for civil engineering students in structural engineering aimed at introducing to them the state-of-the-art computer tools in structural analysis that are available in the market.
Number of Units for Lecture and Laboratory	3 lecture units
Number of Contact Hours per Week	3 hours' lecture
Prerequisites	Structural Theory
Co-requisites	None
Program Outcome/s Addressed by the Course	k-D, m-D
Course Outcome	At the end of the course, the student must be able to become familiar with the computer software commercially available for structural analysis and knowledgeable in their use and application.
Course Outline	Hands on seminar-workshop on the use of the computer softwares.
Laboratory Equipment	Computer laboratory
Reference Books	Computer software users' manual.

Course Name	EARTHQUAKE ENGINEERING
Course Description	A specialized professional course for civil engineering students in structural engineering designed to understand the theoretical, practical, and computational aspects of the earthquake excitation in relation to structural design.
Number of Units for Lecture and Laboratory	3 lecture units
Number of Contact Hours per Week	3 hours lecture
Prerequisites	Structural Theory
Co-requisites	None
Program Outcome/s Addressed by the Course	a-E, c-E, g-E, k-E, m-D
Course Outcomes	At the end of the course, the students must be able to: 1. Understand the occurrence and origin of earthquakes; 2. Understand structural dynamics and appreciate the response of structures to seismic excitation; 3. Apply the latest developments in earthquake and seismic design relevance to the National Structural Code of the Philippines.
Course Outline	1. Causes of earthquakes and faulting; tectonic plates 2. Faulting and seismic zones of the Philippines 3. Measurement of earthquakes; magnitude v. intensity 4. Dynamics of vibration; attenuation 5. Time history 6. Elastic and inelastic response spectra 7. Effects of soils on ground motion; liquefaction 8. Earthquake effects and design of structures 9. National Structural Code of the Philippines in relation to earthquake-resistant structural design
Laboratory Equipment	None
Reference Books	1. Association of Structural Engineers of the Philippines (ASEP), *National Structural Code of the Philippines (NSCP) C101, Vol. I, Buildings and Other Vertical Structures* (7th Ed., 2016 2. Chen, W.F. and Lui, E.M., *Earthquake Engineering for Structural Design,*

	CRC Press, 2005 3. Hu, Y-X and Liu, S-C., *Earthquake Engineering*, CRC Press, 1996 4. Williams, Martin, *Structural Dynamics*, CRC Press, 2016

Course Name	**DESIGN OF STEEL STRUCTURES**
Course Description	A specialized professional course for civil engineering students in structural engineering designed to enable the design of steel structures.
Number of Units for Lecture and Laboratory	3 lecture units
Number of Contact Hours per Week	3 hours lecture
Prerequisites	Structural Theory
Co-requisites	None
Program Outcome/s Addressed by the Course	a-E, c-E, e-E, g-E, k-E, m-D
Course Outcomes	At the end of the course, the students must be able to: 1. Understand the process involved in the design of steel structures; 2. Demonstrate how to design a steel-framed structure such as a building or a transmission tower.
Course Outline	1. Introduction to the course • Identification of structures for which steel is practical for use; • Specifications and building codes • Philosophies of design • Factors of safety – ASD and LRFD methods of design 2. Gravity loads on structures • Code provisions – NSCP C101 • Dead load • Live load • Other gravity loads 3. Lateral loads • Code provisions – NSCP C101 • Wind load

	• Earthquake load • Other lateral loads 4. Structural framing systems • Bearing wall system • Building frame system • Moment-resisting frame system • Dual system with special moment frames • Dual system with intermediate moment frames • Cantilevered column building systems 5. Structural analysis for stress resultants • Structural modeling • Load combinations for ASD and LRFD methods • Computer-aided structural analysis • Application of code provisions for load combinations • Determination of the design stress resultant for the structural members 6. Selection of structural member sizes for tension, compression, bending, shear, torsion, or their combinations 7. Design of beam-to-beam or girder, girder-to-column connection • Bolted connections • Welded connections
Laboratory Equipment	None
Reference Books	1. Association of Structural Engineers of the Philippines, *National Structural Code of the Philippines (NSCP C101,Vol. I Builings and Other Vertical Structures)*, 7th Ed., 2016 2. Salmon, C.G. and Johnson, J.E., *Steel Structures Design and Behavior,* Harper Collins, 1996 or latest Ed. 3. Williams, A., Steel Structures Design ASD/LRFD.

Course Name	**REINFORCED CONCRETE DESIGN**
Course Description	A specialized professional course for civil engineering students in structural engineering designed to enablethe design of reinforced concrete structures.
Number of Units for Lecture and Laboratory	3 lecture units
Number of Contact Hours per Week	3 hours lecture

Prerequisites	Structural Theory
Co-requisites	None
Program Outcome/s Addressed by the Course	a-E, c-E, e-E, g-E, k-E, m-D
Course Outcomes	At the end of the course, the students must be able to: 1. Understand the process involved in the design of reinforced concrete framed structures; 2. Demonstrate how to design a reinforced concrete structure such as a building.
Course Outline	1. Introduction to the course • Identification of structures for which concrete is practical for use; • Specifications and building codes • Philosophies of design • Factors of safety – ASD and LRFD methods of design 2. Gravity loads on structures • Code provisions – NSCP C101 • Dead load • Live load • Other gravity loads 3. Lateral loads • Code provisions – NSCP C101 • Wind load • Earthquake load • Other lateral loads 4. Structural framing systems • Bearing wall system • Building frame system • Moment-resisting frame system • Dual system • Dual system with intermediate moment frames • Cantilevered column building systems • Shear-wall frame Interaction Systems 5. Structural analysis for stress resultants • Structural modeling • Load combinations for ASD and LRFD methods • Computer-aided structural analysis • Application of code provisions for load combinations • Determination of the design stress resultant for the structural members 6. Structural design of structural elements • Review of structural member sizes for the design stress resultants

	• Determination of longitudinal and transverse reinforcements for the design stress resultants 7. Detailing of reinforcements; placements, splices, hooks and ties, spirals
Laboratory Equipment	None
Reference Books	1 Association of Structural Engineers of the Philippines, *National Structural Code of the Philippines(NSCP C101,Vol. I Buildings and Other Vertical Structures)*, 7th Ed., 2016 2 American Concrete Institute, *ACI 318 Building Code Requirements for Reinforced Concrete*, latest edition 3 McCormac, Jack C, *Design of Reinforced Concrete, 7th Ed., 2005,* John Wiley & Sons 4 Nilson, Arthur H. and Winter, George et. Al, *Design of Concrete Structures*, 13th Ed., 2000, Mc-Graw Hill, Inc. 5 Wang. Chu Kia and Salmon, Charles C, *Reinforced Concrete Design,*6th Ed., 1998, Addison-Wesley

Course Name	**PRESTRESSED CONCRETE DESIGN**
Course Description	A specialized professional course for civil engineering students in structural engineering designed to enable the design of reinforced concrete structures with optimum utilization of post-tensioned prestressed concrete elements.
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours lecture
Prerequisites	Reinforced Concrete Design
Co-requisites	None
Program Outcome/s Addressed by the Course	a-E, c-E, e-E, g-E, k-E, m-D
Course Outcomes	At the end of the course, the students must be able to: 1. Understand the process involved in the design of reinforced concrete framed structures utilizing post-tensioned prestressed concrete elements;

	2. Demonstrate how to design a reinforced concrete structure such as a building with optimum utilization of post-tensioned prestressed concrete elements.
Course Outline	1. Introduction to the course • Identification of structures for whichprestressedconcrete is practical for use; • Specifications and building codes • Philosophies of design • Factors of safety – ASD and LRFD methods of design 2. Gravity loads on structures • Code provisions – NSCP C101 • Dead load • Live load • Other gravity loads 3. Lateral loads • Code provisions – NSCP C101 • Wind load • Earthquake load • Other lateral loads 4. Structural framing systems • Bearing wall system • Building frame system • Moment-resisting frame system • Dual system • Dual system with intermediate moment frames • Cantilevered column building systems • Shear-wall frame Interaction Systems 5. Structural analysis for stress resultants • Structural modeling • Load combinations for ASD and LRFD methods • Computer-aided structural analysis • Application of code provisions for load combinations • Determination of the design stress resultant for the structural members 6. Structural design of structural elements • Review of structural member sizes for the design stress resultants • Determination of post-tensioning reinforcements and their profile for the design stress resultants; • Determination of conventional longitudinal and transverse reinforcements for the design stress resultants 7. Detailing of reinforcements; placements, splices, hooks and ties, spirals
Laboratory Equipment	None

Reference Books	1. Association of Structural Engineers of the Philippines, *National Structural Code of the Philippines(NSCP C101,Vol. I Buildings and Other Vertical Structures)*, 7th Ed., 2016 2. American Concrete Institute, *ACI 318 Building Code Requirements for Reinforced Concrete*, latest edition 3. McCormac, Jack C, *Design of Reinforced Concrete, 7th Ed., 2005,* John Wiley & Sons 4. Nilson, Arthur H. and Winter, George et. Al, *Design of Concrete Structures*, 13th Ed., 2000, Mc-Graw Hill, Inc. 5. Wang. Chu Kia and Salmon, Charles C, *Reinforced Concrete Design,*6th Ed., 1998, Addison-Wesley

Course Name	**STRUCTURAL DESIGN OF TOWERS AND OTHER VERTICAL STRUCTURES**
Course Description	A specialized professional course for civil engineering students in structural engineering designed to enablethe design of towers and other vertical structures.
Number of Units for Lecture and Laboratory	3 lecture units
Number of Contact Hours per Week	3 hours lecture
Prerequisites	Design of Steel Structures
Co-requisites	None
Program Outcome/s Addressed by the Course	a-E, c-E, e-E, g-E, k-E, j-E, m-D
Course Outcomes	At the end of the course, the students must be able to: 1. Understand the process involved in the design towers and other vertical structures; 2. Demonstrate how to design towerstructure such as a transmission tower.
Course Outline	1. Introduction to the course • Identification of structures for which tower is practical for use; • Specifications and building codes • Philosophies of design • Factors of safety – ASD and LRFD methods of design

	2. Gravity loads on structures • Code provisions – NSCP C101 • Dead load • Live load • Other gravity loads 3. Lateral loads • Code provisions – NSCP C101 • Wind load • Earthquake load • Other lateral loads 4. Structural framing systems 5. Structural analysis for stress resultants • Structural modeling • Load combinations for ASD and LRFD methods • Computer-aided structural analysis • Application of code provisions for load combinations • Determination of the design stress resultant for the structural members 6. Selection of structural member sizes for tension, compression, bending, shear, torsion, or their combinations 7. Design of member connections • Bolted connections • Welded connections
Laboratory Equipment	None
Reference Books	1. Association of Structural Engineers of the Philippines, *National Structural Code of the Philippines(NSCP C101,Vol. I Buildings and Other Vertical Structures)*, 7th Ed., 2016 2. Salmon, C.G. and Johnson, J.E., *Steel Structures Design and Behavior,* Harper Collins, 1996 orlatest Ed. 3. Williams, A., Steel Structures Design ASD/LRFD.

Course Name	**BRIDGE ENGINEERING**
Course Description	A specialized professional course for civil engineering students in structural engineering designed to understand the concepts, theories, and principles in the the design process of bridge structures.
Number of Units for Lecture and Laboratory	3 lecture units
Number of Contact Hours	3 hours lecture

per Week	
Prerequisites	Structural Theory
Co-requisites	None
Program Outcome/s Addressed by the Course	a-E, c-E, e-E, g-E, k-E, j-E, m-D
Course Outcomes	At the end of the course, the students must be able to: 1. Understand the concepts, principles and theories of bridge design; 2. Demonstrate how to design a simple span reinforced concrete deck-girder and steel truss through bridge.
Course Outline	1. Introduction to the course • Classification criteria of bridges; materials of construction, usage, structural form, span type, span length, load path, deck type, position; • Factors affecting the location, alignment, span, and elevation of the bridge • Components of a bridge: superstructure, substructure, bearings 2. Loads on bridges • Dead loads • Live loads: truck loadings, lane loadings, extra-legal loads • Wind loads • Thermal, centrifugal, traction loads • Seismic load • Flood load 3. Provisions of the National Structural Code of the Philippines, Vol. II, Bridges 4. Design of simple span RCDG highway bridge • Design of slab • Design bending moments and shears due to a series of truck loads on span; critical look at Code provisions • Design of interior girders • Design of exterior girders • Design of diaphragm • Seismic analysis; wind load analysis • Design of bearings • Design of abutments • Design of superstructure; footings,mats or rafts, pile foundation 5. Design of simple span steel highway through truss bridge • Design of slab • Design bending moments and shears due to a series of truck loads on span; critical look at Code provisions

	• Design of interior beams • Design of exterior beams • Design of diaphragm • Seismic analysis; wind load analysis • Influence lines/influence line diagrams for truss members due to live loads • Design of truss members • Design of connections • Design of bearings • Design of abutments • Design of superstructure; footings, mats or rafts, pile foundatio
Laboratory Equipment	None
Reference Books	1. Association of Structural Engineers of the Philippines (ASEP), *National Structural Code of the Philippines (NSCP C10, Vol. II Bridges)*, latest Ed. 2. Chen, W.F. and Lui, E.M., *Earthquake Engineering for Structural Design*, CRC Press, 2005 3. Hu, Y-X and Liu, S-C., *Earthquake Engineering*, CRC Press, 1996 4. Williams, Martin, *Structural Dynamics*, CRC Press, 2016

Course Name	**FOUNDATION AND RETAINING WALL DESIGN**
Course Description	A specialized professional course for civil engineering students in structural engineering designed to understand the concepts, theories, and principles in the the design process of structural foundations and retaining walls.
Number of Units for Lecture and Laboratory	3 lecture units
Number of Contact Hours per Week	3 hours lecture
Prerequisites	Geotechnical Engineering 1
Co-requisites	None
Program Outcome/s Addressed by the Course	a-E, c-E, e-E, g-E, k-E, j-E, m-D
Course	At the end of the course, the students must be able to:

Outcomes	1. Understand the concepts, principles and theories of structural foundation and retaining wall design; 2. Demonstrate how to design structural foundations and retaining walls.
Course Outline	1. Spread Footings • Common types of footings • Depth of footings • Design of footings • Bearing capacity of soils under footings and mat foundations • Footing size proportions • Soil stresses in lower strata • Settlement of footings • Eccentric loading • Inclined load • Footings on slopes • Uplift of footings • Structural design of footings 2. Strap Footings, Combined Footings, Mat Foundations • Uses of strap footings, combined footings, and mat foundations • Common types of arrangement of strap footings, combined footings, and mat foundations • Design of strap footings • Design of combined footings • Design of mat foundation • Coefficient of subgrade reaction • Allowable bearing pressure for mat foundation 3. Pile Foundations • Use of piles • Types of piles • Determination of type and length of pile • Pile capacity – end bearing or skin friction • Pile spacing and group action • Design of pile foundations • Stresses on lower strata • Settlement analysis • Design of pile caps • Uplift • Lateral loads • Batter piles • Negative skin friction 4. Retaining Walls • Use of retaining walls • Types of retaining walls • Proportioning of retaining walls

	• Earth pressure computation • Stability of retaining walls • Design of structural components • Backfill drainage 5. Sheetpiling Walls • Use of sheetpiling walls • Common types of sheet piles • Common types of sheetpiling walls • Lateral pressure acting on sheetpiling walls • Design of cantilever sheetpiling wall • Design of anchored sheetpiling wall • Stability of sheetpiling in cohesive soils • Types of anchorage • Location of anchorage
Laboratory Equipment	None
Reference Books	1. Peck, R.B, Hanson, W.F. and Thornburn, T.H., *Foundation Engineering*, John Wiley & Sons, latest edition 2. Teng, Wayne C., *Foundation Design*, Prentice-Hall, latest edition

F.4 TRANSPORTATION ENGINEERING

Course Name	**TRANSPORTATION SYSTEMS PLANNING AND DESIGN**
Course Description	The course gives emphasis on the Transportation Sector of the Economy: Its Function, Its Players, Its Technologies, Its Policies, Its Information Sources; Planning and Analysis Tools of Transportation Demand and Investment; The Role of High Technology in Transportation; Current High Profile Transportation Policy & Planning Issues
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours lecture
Prerequisites	Principles of Transportation Engineering
Co-requisites	
Program Outcome/s Addressed by the Course	a-E, c-E, e-E, g-E, j-E, k-E, m-D

Course Outcomes	At the end of the course, the students must be able to: 1. Describe the elements of the transportation, evolution of urban transportation and its policy 2. Explain the Modeling Transportation Systems, Urban Travel & Transportation System Characteristics, Travel Demand with Land Use 3. Make a modeling of Mode Choice and Traffic Assignment 4. Investigate and analyze value pricing, ITS and its policy
Course Outline	1. Elements of the transportation sector of the economy, the player, the technologies, the information sources 2. Evolution of Urban transportation Technology: From the Omnibus to PRT 3. Historical evolution of National Transportation Policy leading to current National Transportation Policy 4. Modeling Transportation Systems; Development of a Formal Urban Transportation Planning (UTP) Process & Decision Making 5. Urban Travel & Transportation System Characteristics: Planning Studies and Methods: Travel Demand Surveys, Data Sources, Intro to Sequential Demand Forecasting Modeling Approaches 6. Relating the Travel Demand with Land Use: Trip generation; Activity-based demand models 7. Random Utility Theory and the modeling of Mode Choice 8. Traffic Assignment and paths through networks; Network Analysis 9. "Value Pricing", other pricing policies in transportation. 10. Toward Real-T Intelligent Transportation Systems (ITS): Advanced Traveler Information Systems (ATIS): In-vehicle Satellite Navigation: From TravTek to Navigation Based Services; Global Positioning Systems (GPS) 11. Current National Transportation Policy, Transportation infrastructure
Laboratory Equipment	
Reference Books	

Course Name	**HIGHWAY ENGINEERING**
Course Description	This course deals with the development of highways in the Philippines, highway design, and the materials that are used in road construction and maintenance. The course includes highway administration; traffic, driver, pedestrian and vehicle characteristics; geometric design, roadside design, highway and related structures; intersection, interchanges, terminals; drainage structures; traffic engineering; asphalt and concrete pavements, survey, plans, estimates, contracts and supervision, earthworks, bases and sub-bases, highway maintenance and rehabilitation. The Standard Specification for Public Works and Highways will also be discussed and be given emphasis in the discussion.

Number of Units for Lecture and Laboratory	3 lecture units
Number of Contact Hours per Week	3 hours lecture per week
Prerequisites	Fundamentals of Surveying
Co-requisites	None
Program Outcome/s Addressed by the Course	a-E, c-E, e-E, g-E, i-E, j-E, k-E, m-D
Course Outcomes	At the end of the course, the students must be able to: 1. Discuss the development of early roads and highway in the Philippines from the early part of 1900 to the present era 2. Recognize the importance of planning stage of a proposed road construction project and be familiar with the items conforming to highway design standards 3. Apply the methods of analysis and design relevant to highway engineering. 4. Define the factors that affect the performance of highways and related structures.
Course Outline	1. The Highway and its Development: Highway in the Philippines, Planning difficulties. Highway programming. Community involvement. Highway economy. Location of the proposed Highway, Highway plans and specifications. 2. Designing the Highway: Consistency. Design speed. Cross-section of typical highway. Road shoulder. Cut or fill slope. Cross slope. Highway median. The grade line. Right of way. Road alignment. Widening of curves. Islands. Types of interchange. Highway intersection. Freeway entrance and exit. 3. Soil: Soil and its origin. Soil types. Characteristics of soil. Soil classification. 4. Road materials: Aggregates. Aggregates for bituminous pavement. Aggregates for Portland Cement Concrete. Mineral fillers. Bituminous materials and binders. Bituminous concrete pavement. Asphalt concrete pavement. Bituminous pavement failure. Macadam asphalt. Surface treatment. 5. Road Bed Construction: Treated and Untreated base courses. DPWH standard specifications on: Aggregate sub-base course, Clearing and grubbing, Excavation, Free haul-overhaul, Construction of fills and embankment, Subgrade preparation, Compaction and stabilization. 6. Concrete Pavement: Concrete pavement characteristics and behavior. Transverse expansion, longitudinal and construction joints.

	Reinforcement of joints. Sub-grade and sub-base for concrete pavement. Concrete proportions and mixtures. Curing of concrete pavement. DPWH specifications on concrete pavement. Preparation of grade. Handling, measuring and batching of materials. Placing of concrete. Removal of forms. 7. Drainage and Slope Protection: Drainage. Hydrology. Drainage economic considerations. Draining the highway. Manholes, inlets and catch basins. Channels and culverts. Stabilization the unsupported slope. Improving the stability of slope. Retaining wall. Highway bridges. 8. Design of Pavement: Rigid pavement. Flexible pavement. Thickness of pavement using McLeod's method, U.S. Corps of Engineers, California Resistance Value Method, Expansion pressure method, Stress at the corner of a slab using Goldbecks formula, Width of widening of a curve section of road, Thickness of base course using triaxial test method. 9. Highway Maintenance and rehabilitation. 10. Recycling equipment and methods.
Laboratory Equipment	None
Reference Books	1. Mannering Fred, Washburn Scott, Kilaresky Walter. 2004. Principles of Highway Engineering & Traffic Analysis. Muze Inc. 2. Wright, Paul H. 2003. Highway Engineering. Wiley & Sons. 3. Garber, Nicholas; & Hoel, Lester. 2001.Highway and Traffic Engineering. Brookes/Cole Publishing. 4. Fajardo, Max Jr. B., Elements of Roads and Highways, Second Edition, 5138 Merchandising Publisher, Manila,1998. 5. Department of Public Works and Highways.1995. Standard Specification for Public Works and Highways(Volume II – Standard Specification for Highways, Bridges and Airports), DPWH, Office of the Secretary, Bonifacio Drive, Port Area, Manila

Course Name	**AIRPORT DESIGN**
Course Description	The course gives emphasis on the Air Transportation; history and airport planning; Aeronautical Requirements for Airport Design; Airside Operations - Navigation & Air Traffic Control; Airport Terminal LOS Standards; Simulation Modeling of Passenger Terminals and Airport Security Issues;;Air Traffic Flow Management; and Environmental Impact – Airport Noise
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours lecture

Prerequisites	Transportation Engineering
Co-requisites	
Program Outcome/s Addressed by the Course	a-E, c-E, e-E, g-E, h-I, i-E, j-E, m-D
Course Outcomes	At the end of the course, the students must be able to: 1. State the history of aviation and requirements of airport design 2. Explain the runway length, airspace requirements, navigation and air traffic control 3. Illustrate airfield capacity and delay, Runway and Taxiway Geometrics, Passenger Terminal Capacity 4. Explain the Air Traffic Flow Management, Airport Management and Economics and Airport Noise
Course Outline	1. Introduction to Air Transportation, History of Aviation and Airport Planning 2. Aeronautical Requirements for Airport Design 3. Aeronautical Requirements for Airport Design – Aircraft Weight Definitions 4. Airfield Design - Runway Length Analysis, Runway Orientation 5. Airspace Requirements and Obstruction Analysis 6. Airside Operations - Navigation & Air Traffic Control 7. Communication, Navigation and Surveillance 8. En route and Terminal Automation Tools 9. Airfield Capacity and Delay 10. Runway and Taxiway Geometrics: Marking, Signage and Lighting 11. Airport Terminal Building Concepts, Passenger Terminal Capacity 12. Airport Terminal LOS Standards; Simulation Modeling of Passenger Terminals and Airport Security Issues 13. Airport Access Operations & Design 14. Collaborative Decision Making (CDM), Air Traffic Flow Management and CDM Example 15. Airport Management and Economics 16. Environmental Impact – Airport Noise, Airport Noise Estimation/Aviation and Climate Change
Laboratory Equipment	
Reference Books	De Neufville, R. and A. Odoni: *Airport Systems - Planning, Design, and Management*, McGraw-Hill, 2003 ISBN 0-07-138477-4.

Course Name	**PORTS AND HARBORS**
Course Description	The course gives emphasis on the planning, development, design construction and operation of ports and harbors as modes of transportation.

	It gives a thorough discussion of the types and classification of ports and harbors; theory and principle of oceanographic survey (tides, currents and waves); ports and harbors planning and development, hydraulics of river, its improvements and controls.
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours lecture
Prerequisites	Transportation Engineering, Hydraulics
Co-requisites	
Program Outcome/s Addressed by the Course	a-E, c-E, e-E, g-E, h-I, i-E, j-E, m-D
Course Outcomes	At the end of the course, the students must be able to: 1. Show familiarity in the of concept and importance port operation in the economic development of a nation 2. Knowledgeably plan ports and harbors 3. Knowledgeably discuss the developments and operation of ports and harbors 4. Investigate and analyze areas of improvement in ports and harbors
Course Outline	1. Introduction to Ports and Harbors: Purpose and Classifications of Ports and Harbors 2. Kinds of Harbors according to Usage; Definition and Requisites; Location of Harbor, Site Selection 3. Design of Harbors 4. Meteorological, Physical Conditions and Economic Aspects; Port Anchorage 5. Criteria in Port Development; Tide; Definition, Importance, Types, Datum Plane; Tidal Range; Tidal Pressure; Current 6. Classification and Characteristics of Waves; Breakwater and Jetties; Definition; Types; Purpose; and Factors Affecting the designs 7. PORT PLANNING; Theory and principles of oceanographic survey, hydraulics of rivers, its improvements and controls
Laboratory Equipment	
Reference Books	1. Duxbury, Alyn C., Fundamentals of Oceanography. 2000. CRC Press.

	2. Incised River Channels; processes, forms engineering and Management 1999 CRC Press. 3. Philippine Ports Authority (PPA) Port Design Manual by Jica, 1999. 4. Philippine Ports Authority (PPA) Port Planning Manual by Jica, 1999.

F.5 WATER RESOURCES ENGINEERING

Course Name	WATER RESOURCES ENGINEERING
Course Description	The course covers technical and scientific bases for the design of water supply system and design of drainage with depth and thoroughness. The course deals on the following topics: Flow in Closed Conduits, Design of Water Distribution Systems, Rainfall-runoff relation, Flow Frequency Analysis, and Design of Drainage systems. The course will expose the students in getting data from different institutions/agencies and in designing simple water supply system or basic drainage systems that could be implemented in actual work.
Number of Units for Lecture and Laboratory	3 units of lecture
Number of Contact Hours per Week	3 hours per week for 18 weeks
Prerequisites	Hydrology, Hydraulics
Co-requisites	
Program Outcome/s Addressed by the Course	a-D, c-D, i-E, k-D, m-D
Course Outcomes	At the end of the course, the students must be able to: 1. Estimate peak runoff, determine the appropriate pump rating to deliver water from an identified source to a receiving tank/reservoir, determine the size of pipes given flow rate, and determine the appropriate size of open channel given discharge. 2. Determine the parameters of different probability distributions commonly used in flood frequency analysis.

	3. Design a basic drainage system and/or simple water supply system.
Course Outline	1. Water Resources Engineering 2. The Hydrologic Cycle 3. The water Code of the Philippines 4. Peak runoff Estimation 5. Rational Method 6. Time of concentration formulas 7. NRCS SCS Method 8. NRCS-TR55 Method 9. Pump and Pipeline systems 10. Manometric Head 11. Head loss due to friction 12. Head loss due to connections, bends and valves 13. Pump Characteristics 14. Power requirement for pumps 15. Design of Drainage Channels 16. Best Hydraulic Sections 17. Boundary shear stress 18. Channel slope 19. Freeboard 20. Design of channels with rigid ings 21. Design of channels with flexible linings 22. Frequency Analysis 23. Normal Distribution 24. Gumbel distribution 25. Lognormal distribution 26. Gamma/Pearson Type III Distribution 27. Log-Pearson Type III distribution 28. Design of Water Distribution Systems 29. Water Demand 30. Fire Demand 31. Design flows 32. Components of water distribution system 33. Performance criteria for water distribution systems 34. Design of water supply system/Drainage system 35. Different components of the system 36. What data to secure? 37. Where to secure such data? 38. How to secure and use the data?
Reference Books	Author, Title, Publisher, Place of Publication, Date of Publication 1) David Chin, Water-Resources Engineering, PEARSON, Singapore, 3rd Ed, 2013, 2) Mc Cuen, Pearson, Hydrologic Analysis and Design ,4th2005Ed, , 3) Linsley, Franzini, Freyberg, and Tchobanoglous; Water Resources Engineering, 4th Edition,

	4) Akan and Houghtalen; Urban Hydrology, Hydraulics, and Storm water Quality; John Wiley& Sons, 2003 5) Water Code of the Philippines and the Amended Implementing Rules and Regulations by National Water Resources Board (PDF)

Course Name	**FLOOD CONTROL AND DRAINAGE DESIGN**
Course Description	The course deals on rainwater harvesting,storm runoff utilization for water supply, water infiltration into the soil, road drainage, sizing of inlets and culverts, design of detention and retention ponds, flood models, flood gates and pumping stations.
Number of Units for Lecture and Laboratory	3 units of lecture
Number of Contact Hours per Week	3 hours per week for 18 weeks
Prerequisites	Hydrology, Water Resources Engineering
Co-requisites	
Program Outcome/s Addressed by the Course	a-D, e-E, g-E, k-D, m-D
Course Outcomes	At the end of the course, the students must be able to: 1. Identify and discuss the different components of rainwater harvesting system. 2. Identify and discuss the different components of a storm water drainage system. 3. Identify and discuss the different components of flood gates and pumping systems. 4. Perform calculation related to sizing of gutters, inlets, culverts and channels needed to convey storm water as well as sizing of retention and detention ponds.
Course Outline	1. Introduction to the Course 2. Rainwater Harvesting System (Roof, Lawns, Parking spaces) 3. Culvert Design • Culvert design flows • Culvert hydraulics • Culvert Alignments • Culvert Performance • Roadway Overtopping • Sample design calculations

	4. Gutter flow and Inlet Design • Roadway Gutters • Sample design calculation of gutters • Types of Inlets • Grate inlet on grade • Curb-opening inlets • Combination inlets • Slotted drain inlets • Inlet Spacing and locations • Sample design calculations for inlets 5. Design of Storm Water Detention • Storm water retention vs detention • Types of Storm water Detention facilities • Dry vs wet ponds • Aboveground vs underground detention • Storm water runoff models • Basic considerations in the design of detention ponds • Design storms • Components of detention facilities • Sample design calculations 6. Flood Gates and Pumping systems • Types of gates and their properties • Types of pumps
Reference Books	Author, Title, Publisher, Place of Publication, Date of Publication 1. David Chin, Water Resources Engineering, Pearson , Singapore, 3rd Ed., 2013 2. Haested, Stromwater Conveyance System, Haestad Press, USA, 1st Ed., 2003 3. McCuen, R.H., Hydrologic Analysis and Design, Prentice Hall, 1989 4. Linsley, R.K., M.A. Kohler and J.L.H. Paulhus, Hydrology for Engineers by; McGraw-Hill, 1988 5. Applied Hydrology by VenTe Chow, David Maidment and Larry Mays; McGRAW-HILL International Editions; 1988 6. Handbook of Hydrology David maidment, 1993

Course Name	**IRRIGATION ENGINEERING**
Course Description	The course covers soil-water relation, different techniques of irrigation methods and various technologies, estimation of consumptive use, conveyance of irrigation water, drainage of excess water, sizing of conveyance structures.
Number of Units	3 units of lecture

for Lecture and Laboratory	
Number of Contact Hours per Week	3 hours per week for 18 weeks
Prerequisites	4th year standing
Co-requisites	
Program Outcome/s Addressed by the Course	a-E, e-E, g-E, k-E
Course Outcomes	At the end of the course, the students must be able to: 1. Discuss soil-water relation, enumerate and discuss method of measuring soil moisture. 2. Enumerate and discuss the different types of irrigation systems 3. Perform calculation related to movement of water into the soil. 4. Perform calculation to determine the size of irrigation canals/pipes 5. Estimate consumptive use of water using evaporation ad evapotranspiration formulas.
Course Outline	1. Irrigation - Worldwide 2. Sources and Storage of Irrigation Water 3. Basic Soil-Water Relations 4. Measurement of Soil Moisture 5. Flow of Water Into and Through Soils 6. Salt Problems in Soil and Water 7. Consumptive Use of Water (Evaporation and Evapotranspiration) 8. When to Irrigate and How Much Water to Apply 9. Sprinkler and Trickle Irrigation 10. Surface and Subsurface Irrigation 11. Irrigation Implements and Structures 12. Conveyance of Irrigation and Drainage Water 13. Wells for Irrigation Water 14. Pumping Water for Irrigation and Drainage 15. Drainage of Irrigated Lands 16. Water Measurement 17. Legal and Administrative Aspects of Irrigation and Drainage
Suggested References	Author, Title, Publisher, Place of Publication, Date of Publication 1) Santosh Kumar Gard; Irrigation Engineering and Hydraulic Structures; Khanna ; Publishing; 2006

	2) Sharma, R.K. and Sharma, T.K.; Irrigation Engineering; Chand Publisher; New Delhi, India; 2007 3) Hargreaves, G and Merkley, G.; Irrigation Fundamentals; Water Resource Publications; USA; 2014

Course Name	**WATER SUPPLY PLANNING AND DEVELOPMENT**
Course Description	The course deals on water uses and the corresponding quality, estimation of water demand identification of water sources, possible treatment, and development.
Number of Units for Lecture and Laboratory	3 units of lecture
Number of Contact Hours per Week	3 hours per week for 18 weeks
Prerequisites	Hydrology, Hydraulics
Co-requisites	
Program Outcome/s Addressed by the Course	a-D, e-E, g-E, k-D, m-D
Course Outcomes	At the end of the course, the students must be able to: 1. Identify different water sources and discuss the different treatments needed to comply with standards for water use 2. Discuss the environmental impacts of developing the different water sources 3. Estimate water demands for different users 4. Provide typical layout of water supply system
Course Outline	1. Importance of safe drinking water on public health 2. Common sources of water supply 2.1 Surface water 2.2 Groundwater 2.3 Mixed water resources 2.4 Rain water 3. Assessment of water quantity 3.1 Surface monitoring 3.2 Groundwater 4 Water characteristics and drinking water quality

	4.1 Parameters and standards with regard to physical, chemical, bacteriological and organoleptical properties. 4.2 Water related diseases 4.3 Factors affecting water quality 4.4 Sources of environmental contaminants 5 Estimation of water demand 5.1 Classification of water use 5.2 Quantifying present and future use 5.3 Domestic water demand 5.4 Industrial, commercial, agricultural and other types of water demands 5.5 Fluctuations in water use, factor of inequality low rate patterns 6 Development of water sources 6.1 Groundwater 6.3 Construction of wells 6.4Environmental effects and sea water intrusion 6.5 Surface water 6.6 Watershed and reservoir management and dam siltation 7. Introduction to conventional water purification processes 7.1 Physical treatment processes 7.2 Chemical treatment processes 8. Water Transport and Distribution systems 8.1 General procedure and layout of masterplan of a distribution system 8.2 Design criteria for normal and fire demand 8.3 Hydraulic design of branched and grid systems 8.4 Pipes, appurtenances and pipe laying, metering, flow and pressure control 9 Introduction to water laws, codes, finance and water rates
Reference Books	Author; Title; Publisher; Place of Publication; Date of Publication 1. David W. Prasifka; Water Supply Planning; 1994

Course Name	**Coastal Engineering**
Course Description	The course emphasizes the familiarization of the basic theory and concepts and the application of these to design situations in the field of coastal engineering. The course covers overview of coastal and estuarine environments, behavior of real fluids, theoretical representations of fluid turbulence, effects of waves and currents on structures, and coastal engineering issues such as shoreline erosion and sedimentation and water quality degradation.
Number of Units for Lecture and Laboratory	3 units of lecture

Number of Contact Hours per Week	3 hours a week for lecture and 3 hours per week for laboratory
Prerequisites	Differential equation, Numerical solutions to CE, hydraulics
Co-requisites	
Program Outcome/s Addressed by the Course	a-E, c-D, e-E, g-E
Course Outcomes	At the end of the course, the students must be able to: 1. Discuss thedifferent coastal problems related to environmental degradation, pollution, flooding, erosion and sedimentation. 2. Discuss wave transformations at coastal sites (shoaling, refraction, breaking, reflection) 3. Perform calculations related to wave properties (pressure, velocity, acceleration) 4. Estimate forces of waves on structures 5. Estimate size of armor stone for breakwaters 6. Estimate shoreline change using model/s
Course Outline	1. Introduction to Coastal Engineering: Environmental Issues, coastal problems, available resources 2. Wave Classifications and wave properties: Storm surge, tides, seasonal and long-term fluctuations 3. Wind and waves generation 4. Standing Waves, Wave shoaling, Wave refraction and diffraction, wave breaking 5. Cross shore and Longshore currents, sediment transport, beach response and profiles 6. Engineering sediment budget (erosion/accretion) 7. Forces on coastal structures: Piles, pipelines, cables, breakwaters, sea walls 8. Estimate size of armor stone for breakwaters 9. Model/s to estimate shoreline change 10. Coastal zone management practices of the country and respective regions
Reference Books	Author; Title; Publisher; Place of Publication; Date of Publication 1. Sorensen, RM; Basic Coastal Engineering; Springer Verlag; New York, 3rd Ed.; 2006 2. Tucker MJ and Pitt EG;Waves in Ocean Engineerin;,Elsevier; United Kingdom; 2004 3. A. Chadwick and J. Morfett; Hydraulics in Civil and Environmental

	Engineering; F&FN Spon; 1993 4. Kamphuis, JW; Introduction to Coastal Engineering and Management; World Scientific; Singapore; 2nd edition, 2010.

Course Name	**RIVER ENGINEERING**
Course Description	This subject deals with a wide range of basic knowledge on rivers required to make an integrated river basic management plan based on natural & social sciences and engineering. The contents included in the class are described as follows: various view-points in relation to river systems, long term environmental changes of rivers and their factors, river flows and river channel processes, structure and function of river and lake ecosystems, recent characteristics of flood disasters, integrated river basin planning including flood control, sustainable reservoir management, nature restoration, and sediment transport management
Number of Units for Lecture and Laboratory	3 units of lecture
Number of Contact Hours per Week	3 hours per week for 18 weeks
Prerequisites	Hydraulics, Numerical Methods for CE
Co-requisites	
Program Outcome/s Addressed by the Course	a-E, e-E, g-E, k-E, m-D
Course Outcomes	At the end of the course, the students must be able to: 1. Discuss the contribution of rivers in flood control, water supply, environmental conservation, and economic activities of the area 2. Perform calculation related to measurements, movement, and storages in the different processes of the hydrologic cycle.
Course Outline	1. Basic Terminologies in River Description 2. Open channel flows andflood flow simulation 3. Sediment transport in alluvial streams 4. River environmental improvement plan 5. Normal discharge 6. River restoration projects 7. Environmental assessment 8. Classification of river structures and their functions 9. Impact assessment for construction of dam reservoirs and

	estuary barrages 10. Comprehensive management of sediment outflow and sediment budgets in river basins 11. Concepts of recent sediment control dams, asset management of dam reservoirs, management of sediment dynamism for integrated river planning, etc.
Reference Books	Author, Title, Publisher, Place of Publication, Date of Publication 1) Walter H. Graf; Fluvial Hydraulics, Wiley; Singapore; 1998 2) A Osman Akan; Open Channel Hydraulics; Elsevier; Amsterdam; 2006 3) US Army Corps of Engineers; Engineering and Design: River Hydraulics; Books Express Publishing; UK; 1993 4) Fenton, J; River Engineering; Institute of Hydraulic and Water Resources Engineering, Vienna University of Technology; Vienna; 2011

Course Name	**Groundwater Flow Modelling**
Course Description	The course deals on the different types of aquifers and applications of Darcy's law to formulate water movement through these aquifers. The course also covers contamination of groundwater and transport of contaminants and basic groundwater flow modelling software.
Number of Units for Lecture and Laboratory	3 units of lecture
Number of Contact Hours per Week	3 hours per week for 18 weeks
Prerequisites	Hydrology, Differential Equations, Numerical Methods for CE
Co-requisites	
Program Outcome/s Addressed by the Course	a-D, e-E, g-E, k-D, m-D
Course Outcomes	At the end of the course, the students must be able to: 1. Discuss the different types of aquifers and the Law of Darcy and its limitations. 2. Discuss the formulation of groundwater flow equations for the different

	types of aquifers. 3. Perform calculations related to groundwater movement (velocity, flow rate, piezometric levels) 4. Perform groundwater flow modelling using available groundwater flow software
Course Outline	1. Definition of terms 2. Different types of aquifers 3. Groundwater Flow o Darcy's Law on groundwater flow o Steady-state Groundwater Flow in confined , unconfined, and semi-confined aquifers o Streamlines and Flow Nets o Groundwater Interaction with Streams and Lakes 4. Well Hydraulics o Equations of Flow in Polar Coordinates o Steady flow to a well in a confined, unconfined, and semi-confined aquifers o Unsteady flow to a Well in a Confined, unconfined, and semi-confined aquifer s o Partially Penetrating Wells o Multiple Well Systems o Wells Near Boundaries Treated by the Method of Images o Recharging and Pumping Wells in Uniform Flow o Thiem and Theis Equations o Pump Tests and Slug Tests o Groundwater pollution o Causes of pollution o Contaminant Transport o Advection and Dispersion o Sorption and Diffusive Mass Transfer o Aquifer Remediation 5. Vadose Zone Hydrology o Unsaturated Flow, Retention Curves and Richard's Equation o Infiltration and Evapotranspiration 6. Groundwater flow modelling software
Reference Books	Author, Title, Publisher, Place of Publication, Date of Publication 1. Bear, et al; Modelling Groundwater Flow and Contaminant Transport; Springer; Netherlands; 2010 2. Applied Groundwater Modeling: Simulation of Flow and Advective Transport; Elsevier; Amsterdam; 2015 3. C.W. Fetter, Jr; Applied Hydrogeology; Pearson Educational Limited; Harlow,England; 2014

G. GENERAL EDUCATION COURSES
REFER TO CMO No. 20, s. 2013 – NEW GENERAL EDUCATION CURRICULUM

H. TECHNOPRENEURSHIP COURSE

Course Name	**TECHNOPRENEURSHIP 101**
Course Description	*Technopreneurship is a philosophy, a way of building a career or perspective in life.* The course covers the value of professional and life skills in entrepreneurial thought, investment decisions, and action that students can utilize in starting technology companies or executing R&D projects in companies as they start their careers. The net result is a positive outlook towards wealth creation, high value adding, and wellness in society.
Number of Units for Lecture and Laboratory	Lecture - 3 units
Number of Contact Hours per week	Lecture - 3 hours
Prerequisite	None
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

Sample Syllabus

Course Title : TECHNOPRENEURSHIP 101

Course Description : *Technopreneurship is a philosophy, a way of building a career or perspective in life.* The course covers the value of professional and life skills in entrepreneurial thought, investment decisions, and action that students can utilize in starting technology companies or executing R&D projects in companies as they start their careers. The net result is a positive outlook towards wealth creation, high value adding, and wellness in society.

Course Code : TECHNOP 101

Course Units : 3 units

Pre-requisites : none

Course Outcomes and Relationships to Student/Program Outcomes

Course Intended Learning Outcomes After completing the course, the student must be able to:	Student/Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1. Define market needs					/							
2. Define competitive and differentiated product			/									
3. Identify strategies to form design and execution team				/								
4. Design Strategic Plan and initial year operational plan											/	
5. Pitch idea to raise funds enough to create first product and perform validation							/					

Learning Plan

Week	CILO	Topics	Teaching and Learning Activities	Assessment Tasks
1	1,2,3	Introduction: Entrepreneurial Mindset, Team Formation, Innovation and Ideas, Products and Services	Team formation, Lecture Environmental Scanning and Ideation	Individual/ Group Presentation, video presentation, reflection
2	1,2	Customers	Technology Focus (invited speakers and/ or videos)	Reflection/ Journal/ Video Blog
3	1,2	Value Proposition	Lecture	Group presentation
4	1,2	Market Identification and Analysis	Competitive Market Survey	Group presentation
5	2	Creating Competitive Advantage	Competitive Market Analysis	Group presentation/ product comparison matrix
6	2,3,4	Business Models	Business Model Workshop, Product Attribute and Value	Group Presentation

			Map	
7	2,4	Introduction to Intellectual Property	Patent Search	Patent Search Report
8	4,5	Execution and Business Plan	Project Management/ Planning, SCRUM,	Milestone/Work Breakdown Structure
9	4,5	Financial Analysis and Accounting	Basic Finance and Accounting Workshop, Cash Flow Board Game	Balance Sheet, Cashflow Statements, 3-year projection
10	4,5	Raising Capital	Demo Day, Start Up Weekend, Pitching Activity	Elevator Pitch, Venture Pitch
11	2	Ethics and social responsibility & globalization	Case Studies	Case Study Report

Grading System:

(Include standard grading system of HEI and rubrics (if applicable)

References:

The Art of the Start: The time-tested, battle-hardened guide for anyone starting anything, Kawasaki, Guy; ISBN: 1591840562, Portfolio — a member of Penguin Group; 2004
Technology Ventures: From Idea to Enterprise, Dorf, Richard, Byers, Thomas, and Nelson, Andrew; ISBN 978-0073380186; 3rd Edition, 2009
C. R. Carlson and W.W. Wilmot, "Innovation. The five disciplines for creating what customers want", Crown Business (August 8, 2006).
Rich Dad Series by Robert Kiyosaki
The Start-Up Playbook by David S. Kidder
Go Negosyo by Joey Concepcion: 21 steps on how to start your own business By Dean Pax Lapid and Ping Sotto
The Lean Startup by Eric Ries
Zero to One by Peter Thiel
Market Research on a Shoestring by Naeem Zafar

On – line Resources:

Technopreneurial.com

Course Policies and Standards:

(Include policies regarding deadline of submission of requirements, absences and tardiness in attending classes, missed exams, etc.)

ANNEX IV

LABORATORY REQUIREMENTS FOR THE BS CIVIL ENGINEERING PROGRAM

A. PHYSICAL / NATURAL SCIENCES

1. CHEMISTRY FOR ENGINEERS

Experiment	Equipment / Chemicals	Quanity
Calorimetry	Thermometer 250 ml Beaker Test Tubes Stirring Rod Filter paper Ice cubes HCl solution NaOH solution NaOH pellets	5 pcs 5 pcs 60 pcs 5 pcs 5 pcs
Heats of Combustion	Bomb calorimeter Fuse wire Solid fuels (*e.g. granulated charcoal, rice husk, sawdust*)	1 pc
Metals and Some Aspects of Corrosion	Petri Dish Test Tubes Graduated cylinder Syringe Stirring Rod Iron Stand and Ring Wire gauze Bunsen Burner Mg ribbon Zn pellets Fe fillings Cu wire Sn shavings Pb pellets Fe nails Agar-agar powder Magnesium Nitrate Zinc Nitrate Iron Natrate Copper Nitrate Lead Nitrate Tin Chloride Potassium Ferrocyante Phenolphthalein	5 pcs 60 pcs 5 pcs 5 pcs 5 pcs 5 pcs 5 pcs 5 pcs

Mechanical Properties of Materials	Universal Testing Machine Metal rods	1 unit 5 pcs
Water: Its Properties and Purification	Bunsen burner Tripod Wire gauze Erlenmeyer Flask Boiling chips Delivery tube Cork Beaker Test tubes	5 pcs 5 pcs 5 pcs 5 pcs 5 pcs 5 pcs 5 pcs 5 pcs
Determination of the Dissolved Oxygen Content of Water	Amber Bottles Erlenmeyer Flasks Burette Phenolphthalein Sulfuric acid solution DO meter, if available	10 pcs 5 pcs 5 pcs
Determination of Air Pollutants (e.g. cigarette smoke)	Erlenmeyer Flask Glass Tubing Cork Cotton Pump	5 pcs 5 pcs 5 pcs 2 units

2. PHYSICS FOR ENGINEERS - SUGGESTED PHYSICS LABORATORY EXERCISES (Pick 12 to relate with Covered Lecture Topics)

Exercise	Suggested Equipment	Suggested Quantity*
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	5 pcs. 5 pcs. 5 pcs. 5 sets
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	5 pcs. 20 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 15 pcs. 15 pcs. 5 sets 5 pcs.

3. An exercise to observe and verify the elements of motion along the straight line	Linear air track with blower and trolley Timer/stopwatch Meter stick Free fall apparatus Metal balls of different sizes Clamp Support rod Alternate apparatus: Spark timer/ticker timer Paper tape Stopwatch Plane board with stand Clamp Wooden cart Scissors Carbon paper Masking tape Meter stick	5 pcs. 5 pcs. 5 pcs. 5 pcs. 12 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 1 set 5 pcs.
	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 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.
5. An exercise to verify the laws of motion	Atwood's machine Masses Stopwatch String Alternate apparatus: Frictionless dynamic	5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs.

	track Smart pulley Stopwatch Weight holder String Clamp	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.
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	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 sets
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	5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.
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	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 10 pcs. 10 pcs. 1 set
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	5 pcs. 5 pcs. 5 pcs. 10 pcs. 5 pcs. 10 pcs. 10 pcs. 1 set

10. An exercise to verify the condition of the body in rotational equilibrium	Demonstration balance Vernier caliper Platform/triple beam balance Masses Meter stick	5 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs.
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	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.
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	5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.
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	 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs.
14. An exercise to observe and verify the elements of transverse wave motion	Sonometer Weight holder Set of masses Tuning forks of three	5 pcs. 5 pcs. 5 pcs. 5 sets

	different frequencies Rubber hammer Meter stick	5 pcs. 5 pcs.
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	5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 5 sets
16. An exercise to measure the coefficient of linear expansion	Thermal expansion apparatus Steam generator Ohmmeter/VOM Connectors Basin/container Hot and cold water	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.
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	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.
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	2 sets 2 sets 2 sets 2 sets 2 sets 1 set 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 sets
19. An exercise to illustrate Ohm's Law	Panel board/circuit board VOM or multitester DC power supply	5 pcs. 5 pcs. 5 pcs.

	Bridging plugs/connecting wires Fixed resistor SPST switch SPDT switch Alternate apparatus: Bread board Jumper	5 sets 15 pcs. 5 pcs. 5 pcs. 5 pcs. 5 sets
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	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 sets
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	5 pcs. 5 pcs. 5 pcs. 5 sets 15 pcs. 5 pcs. 5 sets
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	10 pcs. 5 pcs. 5 pcs. 10 pcs. 5 pcs. 5 sets 5 pcs. 5 sets
23. An exercise to observe the applications of Kirchhoff's Law	Power supply Fixed resistors VOM or multitester Bridging	10 pcs. 25 pcs. 10 pcs. 5 sets

	plugs/connecting wires Panel board/circuit board Alternate apparatus: Bread board Jumper	5 pcs. 5 pcs. 5 sets
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	5 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs.
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	5 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs.
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	5 pcs. 5 pcs. 10 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 2 sets

27. An exercise to demonstrate the Faraday's law of electromagnetic induction	Coils Galvanometer VOM or multitester AC power supply Bar magnets Connecting wires	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.
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	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.
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	5 pcs. 5 pcs. 5 pcs. 15 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.

3 ALLIED AND PROFESSIONAL COURSES

1. FUNDAMENTALS OF SURVEYING

Laboratory Exercises	Specifications	Minimum Required Quantity**	Units
1. Determination of Pace Factor	Tape (Steel, Vinyl or Fiberglass, 30m or more)	5	pcs.
2. Measuring Distances on Level and Sloping Surfaces with a tape	Marking Pins	60	pcs.
	Plumb Bob	5	pcs.
	Range Pole	10	pcs.
	Steel Tape (30 meters.)	5	pcs.

3. Closed Traverse with a Compass	Compass	5	pcs.
	Marking Pins	60	pcs.
	Tape	5	pcs.
4. Differential Leveling	Engineer's Level or Dumpy Level or Tilting Level or Self Leveling or Automatic Level	5	pcs.
	Leveling Rod	10	pcs.
5. Orientation of Engineer's Transit and Theodolite a. Setting b. Measuring angles by repetition c. Determination of Height of a point d. Prolonging a line	Marking Pins	60	pcs.
	Plumb Bob	5	pcs.
	Range Pole	10	pcs.
	Tape	5	pcs.
	Theodolite, 1 minute	1	pc.
	Engineer's Transit	4	pcs.
6. Topographic Survey	Engineer's Level or Dumpy Level or Tilting Level or Self Leveling or Automatic Level	5	pcs.
	Stadia Rod	10	pcs.
	Tape	5	pcs.
	Theodolite, 1 minute	4	pcs.
	Engineer's Transit	1	pc.
	Marking Pins	60	pcs.
	Range Pole	10	pcs.
7. Triangulation Survey	Tape	5	pcs.
	Theodolite, 1 minute	4	pcs.
	Engineer's Transit	1	pc.
8. Closed Traverse	Marking Pins	60	pcs.
	Range Pole	10	pcs.
	Tape	5	pcs.
	Theodolite, 1 minute	4	pcs.
	Engineer's Transit	1	pc.
9. . Closed Traverse with GPS	Global Positioning	1	pc.
	System Set		
10. Measuring Discharge	Current Meter	1	pc.
	Meter Stick	1	pc.
	Tape	1	pc.
11. Hydraulic Survey	Depth Measuring Apparatus	2	pcs.
	Flags	2	pcs.
	Marking Pins	60	pcs.
	Stop Watch	2	pcs.
	Tape	1	pc.

	Engineer's Transit	4	pcs.
	Theodolite, 1 minute	1	pc.
12. Determination of Latitude, Longitude and Elevation	Global Positioning	1	pc.
	System Set	1	pc.

Laboratory Exercises	Specifications	Minimum Required Quantity**	Units
1. Layout of Simple Curve by Deflection, Tangent Offset and when Obstruction are present	Marking Pins	60	pcs.
	Range Pole	10	pcs.
	Tape (Steel, Vinyl, or Fiberglass, 30 meters or more)	5	pcs.
	Theodolite, 1 minute	1	pc.
	Engineer's Transit	4	pcs.
2. Layout of a Compound or Reverse Curve	Marking Pins	60	pcs.
	Range Pole	10	pcs.
	Tape	5	pcs.
	Theodolite, 1 minute	1	pc.
	Engineer's Transit	4	pcs.
3. Staking Out a Vertical Parabolic Curve	Marking Pins	60	pcs.
	Stadia / Leveling Rod	10	pcs.
	Tape	5	pcs.
	Theodolite, 1 minute	1	pc.
	Engineer's Transit	4	pcs.
4. Survey and Layout of Proposed Civil Works Structure	Batter Board	10	pcs.
	Stadia / Leveling Rod	5	pcs.
	Engineer's Level	5	pcs.
	Marking Pins	60	pcs.
	Plumb Bob	5	pcs.
	Range Pole	10	pcs.
	Tape	5	pcs.
	Theodolite, 1 minute	1	pc.
	Engineer's Transit	4	pcs.
5. Determination of Alignment of Civil Work Structure	Marking Pins	60	pcs.
	Range Pole	10	pcs.
	Theodolite, 1 minute	1	pc.
	Engineer's Transit	4	pcs.
6. Highway Profile Survey	Engineer's Level or Dumpy Level or Tilting Level or Self Leveling or Automatic Level	5	pcs.

	Stadia / Leveling Rod	5	pcs.
	Marking Pins	60	pcs.
	Range Pole	10	pcs.
	Tape	5	pcs.
	Theodolite, 1 minute	1	pc.
	Engineer's Transit	4	pcs.
7. Determination of Volumes with Prismoidal correction (Actual Computation and using a Computer Software)	Planimeter	3	pcs.
	Computer Software	1	pc.
8. Preparation of Mass Diagram (Actual Computation and using a Computer Software)	Computer Software	1	pc.

2. MATERIALS TESTING

Laboratory Exercises	Specifications	Minimum Required Quantity**	Units
1. Determination of specific gravity, water absorption, and density of aggregates and filters	Absorbent cloth, dry, soft	2	pcs.
	Balance, 3 kg. cap., 0.1 acc	1	pc.
	Container	1	pc.
	Glass vessel / jar, wide mouth 1.5 L capacity	5	pcs.
	Oven, therm. Controlled	1	pc.
	Sieve, 3 / 8"	5	pcs.
	Thermometer, 0 – 50 ^{C}	5	pcs.
	Tray	5	pcs.
	Wire / Density basket, 0.25"		
	Mesh (max) (6.5 mm)	5	pcs.
2. Determination of moisture Content of aggregates	Air tight container or Dessicator, 3 kg cap.	1	pc.
	Balance, 3 kg cap, 0.5 g acc.	1	pc.
	Oven, therm. Controlled	1	pc.
	Sieve, standard		
	Coffee cans	5	pcs.
3. Making and curing of concrete Test specimens	Air content apparatus:		
	Standard	1	pc.
	Chace type	4	pcs.
	Balance	1	pc.
	Beam molds, 6"x6"x21"	6	pcs.
	Cement mold brush	2	pcs.
	Measuring tape / ruler	2	pcs.
	Pail, 1.5 kg capacity	4	pcs.
	Sampling & mixing receptacle, 48" x 48" x 3" (min.)	2	pcs.
	Scoop	2	pcs.

	Shovel, 1.5 kg capacity	4	pcs.
	Slump apparatus, std.	2	pcs.
	Straight edge	2	pcs.
	Tamping rods	2	pcs.
	Trowel	2	pcs.
	Cylindrical mold, 6" dia x 12"	6	pcs.
	Wood float	2	pcs.
4. Determination of Compressive Strength of cylindrical concrete Specimen	Compressive testing machine, 50 tons capacity	1	pc.
	Capping apparatus	1	set
	Deformation indicating device	1	pc.
5. Determination of setting Time of hydraulic cement	Balance, accurate to 0.1 g	1	pc.
	Gillmore or Vicat apparatus	3	sets
	Graduated cylinder, 200 ml.	3	pcs.
	Mixing Container	3	pcs.
	No. 200 Sieve	3	pcs.
	Scoop & Spatula (1 each)	3	sets
	Stop watch	3	pcs.
	Set of weights	3	sets
6. Penetration of bituminous Materials /Centrifuge test extraction (alternate)	Penetration apparatus w/ needles	1	set
	Sample container (70 mm. Diam. x 45 mm depth)	1	pc.
	Thermometer	1	pc.
	Stop watch	1	pc.
	Transfer dish	1	pc.
	Weights, 100 g.	1	pc.
7. Determination of modulus of rupture of concrete beam	Compressive testing machine	1	pc.
	Dial gage	1	pc.
	Flexure loading & reaction set		
	For concrete beam	1	set
8.Determination of tensile Strength of concrete cylinder (Split Tension or Equivalent)	Bearing flat bars	2	pcs.
	Bearing wooden blocks/plywood		
	Strips	2	pcs.
	Compressive testing machine	1	pc.
	Measuring tape / device	1	pc.

Laboratory Exercises	Specifications	Minimum Required Quantity**	Units
9. Test of wood:	Comp. testing mach., 5 – 10T cap.	1	pc.
	Deformation indicator / dial gage	1	pc.
a. static bending	Loading & reaction set – up	1	set
b. comp. perpendicular to grain	Loading & reaction set – up	1	set
b. comp. parallel to grain	Loading & reaction set – up	1	set
d. shear parallel to grain	Loading & reaction set – up	1	set
e. moisture cont. determination	Balance, 3 kg. Cap. 0.1 g acc.	1	pc.
	Oven, thermo. Controlled	1	pc.
10. Determination of Compressive Strength of Concrete hollow blocks	Compressive testing machine	1	pc.
	Dial gage	1	pc.
	Compression block / plywood strip	2	pcs.
11. L.A. Abrasion Test	L.A. Abrasion Test Apparatus		
12. Marshall or Hveem Test of asphalt	See attached sheet		
13. Tensile test of steel bars	See attached sheet		

Lab. Exercise Title: Marshall or Hveem Test of Asphalt

Objective: To determine the resistance to deformation and cohesion of bituminous mixtures.

Procedure Abstracts:

Equipment Required: Qty. per group

Marshall test set	1 set
For Hveem Test:	
Stabilometer	1 pc.
Compression testing machine	1 unit
Test specimen device	1 pc.
Oven	1 pc.

Calibration cylinder, hollow metal
4 in. outside, diam. By 5.5 in. high 1 pc.

Lab. Exercise Title: Determination of Compressive Strength of Concrete Hollow Blocks

Objective: To determine the compressive strength of concrete hollow blocks

Procedure Abstract:

Equipment Required: Qty. per group

Compressive testing machine	1 unit
Dial gage	1 pc.
Compression block / plywood strip	2 pcs.

Lab. Exercise Title: Tensile Test of Steel Bar

Objective: To determine the tensile strength of steel bar

Procedure Abstract:

Equipment Required: Qty. per group

Tensile testing machine	1 unit
Loading and reaction set – up for steel bar	1 set – up
Dial gage	1 pc.

3. **Hydraulics**

Laboratory Exercises	Specifications	Minimum Required Quantity**	Units
1.Discharge measurement using Volumetric tank	Meter Stick	2	pcs.
	Timing Device	1	pc.
	Volumetric Tank	1	pc.
	Weighing Scale	1	pc.
Laboratory Exercises	**Specifications**	**Minimum Required Quantity****	**Units**
2. Discharge measurement using different types of weirs	Flume, Tilting	1	set
	Meter Stick	2	pcs.
	Set of weirs (sharp crested, v – notch, trapezoidal)	1	set
3. Discharge measurement	Flume, Tilting	1	set
	Meter Stick	2	pcs.
	Orifice	1	pc.

	Plumb Bob	1	pc.
	Timing Device	1	pc.
	Vernier Caliper	1	pc.
	Volumetric Tank or Equivalent	1	pc.
4. Open channel flow	Flume, Tilting	1	set
	Meter Stick	2	pcs.
	Timing Device	1	pc.
	Volumetric Tank or Equivalent	1	pc.
5. Measurement of Water Hammer	Water Hammer Set – Up or Equivalent	1	set
6. Measurement of Hydraulic Jump	Flume, Tilting	1	set
	Model Dam (to fit the flume) With sluice gate or spillway	1	set
	Meter Stick	2	pcs.
	Timing Device	1	pc.
	Volumetric Tank or Equivalent	1	pc.
7. Determination of Metacenter of Body	Metacentric height apparatus	3	sets
	Measuring Stick	3	pcs.
	Set of Weights	3	sets
	Suitable Tanks	3	pcs.
8. Velocity Measurement Using Pitot Tube	Flume, Tilting	1	set
	Manometer	1	pc.
	Meter Stick	1	pc.
	Pitot Tube	1	pc.
	Timing Device	1	pc.
	Volumetric Tank or Equivalent	1	pc.
Laboratory Exercises	**Specifications**	**Minimum Required Quantity****	**Units**
9. Determination of center of pressure	Hydrostatic pressure apparatus	3	sets
	Measuring Stick / Tape	3	pcs.
	Set of Weights	3	sets
	Water Supply		
10. Analysis of Pipe Network	Manometer	1	set
	Peizometer taps / pressure gages	1	set
	Pipe Assembly	1	set
	Timing Device	1	pc.

	Volumetric Tank	1	pc.
11. Demonstration of seepage	Aquarium, glass or fiber glass	1	pc.
	Model Dam (to fit the aquarium)	1	pc.
	KMn04 solution or equivalent	1	L
	White Sand		

4. **Soil Mechanics**

Laboratory Exercises	Specifications	Minimum Required Quantity**	Units
1. Soil sampling and preparing of samples for testing	a. Soil Sampling, Labelling & Storage:		
	Labelling Device	1	pc.
	Moisture tight bags / cans	30	pcs.
	Petrowax or Paraffin		
	Shovel / Scoop, 1.5 kg. cap.	3	pcs.
	Soil Auger or post tool digger	3	pcs.
	b. Preparation of Disturbed Soil Sample for Test:		
	Bal., 1 kg cap., 0.1 g acc.	1	set
	Bal., 25 kg. cap. 1.0 g acc.	1	set
	Container w/ cover, 250 ml	10	pcs.
	Oven, Thermo. Controlled	1	pc.
	Rubber Mallet or Rubber – Covered		
	Pestle	15	pcs.
	Sample Splitter / Divider	1	set
	Standard Sieves	3	sets
	c. Preparation of Undisturbed Soil Sample for Test:		
	Caliper	2	pcs.
	Cellophane or wax paper		
	Thin walled sampler (2" dia. max.) w/ extractor / ejector	2	sets
	Knife or Hacksaw	2	pcs.
	Ruler / Measuring Tape	2	pcs.
	Soil Lathe	2	sets
	Wire Saw	2	pcs.
	Miter box	2	pcs.

2. Determination of particle size by sieve analysis and hydrometer method	a. Sieve Analysis:		
	Bal., 1 – 2 kg. cap, 0.1 g acc.	1	set
	Bal., 25 kg. cap., 1 g acc.	1	set
	Bristle Brush	3	pcs.
	Set of Sieves	3	sets
	Soil Sample Containers / Pans	10	pcs.
	b. Hydrometer Test:		
	Balance, 0.01 g. accuracy	1	set
	Beaker, 250 ml	3	pcs.
	Distilled Water		
	Drying Oven, Thermo. Controlled	1	set
	Graduated Cylinder, 1000 ml	6	pcs.
	Large Evaporating Dish / Drying Pan	18	pcs.
	Mixer (1 set) or Stirring Rod, gass 3 mm diam, 250 mm long	3	pcs.
	Sodium Silicate (deflocculating agent)		
	Soil Hydrometer (151 H or 152 H in ASTM Specification E 100)	3	pcs.
	Spatula	3	pcs.
	Stopwatch / Clock	3	pcs.
	Thermometer, 10 to 50 ^{C}	3	pcs.
	Wash -- Water Bottle / Sprayer or Large syringe	3	pcs.
3. Determination of Moisture Content of Soils	Balance, acc. to 0.01 g	1	set
	Drying oven, Thermo. controlled	1	set
	Drying Pans / cans (tin or Aluminum moisture cans w/ lids)	20	pcs.
	Palette Knife / Spatula	3	pcs.

4. Determination of Liquid Limit and Plastic Limit of Soil	a. Liquid Limit Test:		
	Balance, 0.01 g. acc.	1	set
	Distilled Water		
	Drying cans / containers	20	pcs.
	Drying oven, Thermo. Controlled	1	set
	Dessicator (Optional)	2	pcs.
	Evap. dish / mixing bowl	3	pcs.
	Grad. Cylinder, 100 ml cap.	3	pcs.
	Liquid Limit device w/ grooving tool	3	pcs.
	No. 40 Sieve	3	pcs.
	Spatula & Straight Edge	6	pcs.
	b. Plastic Limit Test:		
	Balance, 0.01 g. acc.	1	set
	Dessicator (Optional)	2	pcs.
	Distilled Water		
	Drying cans / containers	20	pcs.
	Drying oven, Thermo. Controlled	1	set
	Evap. dish / mixing bowl	3	pcs.
	Metal Tray	3	pcs.
	Mixing Pan	3	pcs.
	Rubber tipped Pestle / Mortar	6	pcs.
	Scoop	3	pcs.
	Grad. Cylinder, 100 ml cap.	3	pcs.
	Ground glass plate, at least 30 cm (12") square by 1 cm (3 / 8") thick	3	pcs.
	No. 40 Sieve	2	pcs.
	Spatula	3	pcs.
	Straight Edge / Ruler	3	pcs.
5. Determination of Specific gravity	Balance, 0.01 g. acc.	1	set
	Drying oven, Thermo. Controlled	1	set
	Evaporating Dish	2	pcs.
	Large Beaker	2	pcs.
	Mortar & Rubber Covered pestle	1	set
	No. 10 Sieve	2	pcs.

	Pychnometer (volumetric flask), cap. 50 ml or more	5	pcs.
	Sample Divider / Splitter	1	set
	Spatula	5	pcs.
	Stirring Glass Rod, 1 / 4" diam., 12" in length	5	pcs.
	Thermometer, 0 to 50 ^{C}	5	pcs.
	Vacuum Pump (optional)	1	pc.
	Wash – water bottle, 500 ml. cap	5	pcs.
6. Field Density Test	Balance, acc. to 0.01 g.	1	set
	Calibration Bucket, not less than 0.01 cu.ft. cap. (optional)	3	pcs.
	Digging tools (chisels, hammers, picks, & spoons)	3	sets
	Drying oven, Thermo. Controlled	1	set
	Guide Plate, 12" square by 3 / 16" thick w/ 6" diam hole in center	3	C
	Metal Tray (excavated soil)	3	pcs.
	Moisture Cans	3	pcs.
	Sand Cone Apparatus / Rubber Balloon Set	3	pcs.
	Spatula / pallete knife	3	Sets
	Soil Anger	3	pcs.
7. Soil Permeability Test (Constant & Falling Head Combined)	Balance, acc. to 0.01 g.	1	set
	Constant – Head Filter Tank (Water Supply)	1	set
	Graduated Cylinder or Flask, 500 ml.	3	pcs.
	Mixing Pans	3	pcs.
	Permeability Device Set Falling & Constant Head w/ accessories	3	sets
	Scoop	3	pcs.
	Sieve, Standard	3	sets
	Thermometer, 0 to 50 ^{C}	3	pcs.
	Stop watch	3	pcs
8. Compaction Test	Balance, acc. to 0.01 g.	1	set
	Compaction Mold, Standard	5	pcs.
	Drying oven, Thermo. Controlled	1	set
	Dessicator	2	pcs.
	Drying / Moisture cans	30	pcs.
	Graduated Cylinder, 500 ml.	5	pcs.

	Compaction, Rammer, Standard	2	sets
	Metal Trays	5	pcs.
	Mixing Pans	5	pcs.
	No. 4 Sieve	2	pcs.
	Rubber Tipped Pestle & Mortar	2	sets
	Scoops	5	pcs.
	Spatula	5	pcs.
	Straight Edge, 300 mm long	5	pcs.
9. Unconfined Compression Test	Balance, acc. to 0.01 g.	1	set
	Drying / Moisture Cans	20	pcs.
	Drying oven, Thermo. controlled	1	set
	Deformation Dial gage	2	pcs.
	Remolding Apparatus / Mat'ls. (plaster of Paris, grease, etc.)	1	set
	Soil Extractor / Ejector (tube sample)	1	set
	Soil Lathe	1	set
	Trimming Tools	1	set
	Stop Watch	1	set
	Unconfined Compression Device (ASTM D 2166 or equivalent)	1	set
10. CBR Determination	Balance, acc. to 0.01 g.	1	set
	CBR Compaction Mold, Standard with Extension Collar	2	pcs.
	Compaction Rammer, Standard	2	sets
	Dessicator	2	pcs.
	Disc, Spacer w/ Handle	1	pc.
	Dial Gages (acc. to 0.001")	2	pcs.
	Expansion, apparatus (Tripod w/ dial gage) optional	1	pc.
	Filter Paper, 15 cm diam.	10	pcs.
	Loading Machine, 5,000 lb. (min.) ,cap. rate 0.05 in / min	1	set
	Moisture cans	20	pcs.
	Mixing bowls / pans	2	pcs.
	Oven, Thermo. Controlled	1	set
	Penetration Piston	1	pc.
	Perforated Plate w/ Adjustable Stem	1	pc.
	Soaking Tank	1	set
	Surcharge Weights	2	pcs.
	Spatula	2	pcs.

	Straight Edge, Steel	2	pcs.
11. Consolidation Test	See attached sheet.		
12. Direct Shear	Direct Shear testing machine, standard	1	pc.
	Specimen trimmer 2.5 in. dia. by 3 / 4 in. thick	1	pc
	Apparatus for moisture content determination	1	pc.
Laboratory Exercises	**Specifications**	**Minimum Required Quantity****	**Units**
13. Standard Penetration Test	Drilling Equipment Set	1	set
	Split – spoon sampler	1	pc.
	Standard Penetration Test Set	1	set
	Pipe Linar	40	ft.
14. Triaxial Test	Vacuum shear base and cap	1	pc.
	Rubber membrane – for holding sample	1	pc.
	Forming jacket, funnel, tampers – for molding sample	1	set
	Vacuum gage and source – for internal vacuum	1	set
	Loading machine to apply axial load	1	set

Lab. Exercise Title: Consolidation Test

Objective:

Procedure Abstract: Compute the void ratio corresponding to 100 percent consolidation for each load. Plot a curve showing the void ratio as a function of the log of the stress. Compute the compression index and estimate the preconsolidation load.

Equipment Required: Qty. per group

Consolidometer with micrometer dial gauge	1 pc.
Loading machine capable of maintaining constant loads up to 2000 or 3000 lb. for long periods of time	1 unit
Trimming knives, wire saws	1 set
Trimming lathe or special cutter having same diameter as consolidation ring	1 pc.
Glass plates, oven	1 set
Balance 2000 g capacity, 0.1 sensitivity	1 pc.
Graph paper, 5 cycle	4 shts.
Stop watch	1 pc.

Exercises: **Direct Shear**

Objective: To determine shear strength parameters, cohesion and angle of internal friction using the direct shear test.

Procedure Abstract:

A square or circular sample is placed inside the metal shear box. Normal force is applied from the top of the shear box by dead weights. Shearforce is applied to the side of the top half of the box to cause failure shear stress are computed. The direct the direct shear tests are repeated on similar samples at various normal stresses. The normal stresses and corresponding values of the failure shear stress is obtained from a number of tests are plotted in a graph from which the shear strength parameters are obtained.

Equipment Required: Qty per group

Direct shear testing machine, standard 1 pc.
Specimen trimmer 2.5 in. dia. by 3 / 4 in. thick 1 pc.
Apparatus for moisture content determination

Mechanics of Fluid

Laboratory Exercises	Specifications	Minimum Required Quantity**	Units
1. Determination of specific Gravity using U – tube	Beaker or Graduated Cylinder	5	pcs.
	Funnels		
	Liquids of unknown specific density		
	Manometer Stand	5	pcs.
	Measuring Stick	5	pcs.
	Mercury Liquid		
	Plastic or Glass U – tubing	5	pcs.
	Thermometer	5	pcs.
	Water, distilled		
2. Pressure head measurement using manometer	Liquid Mercury		
	Meter Stick	2	pcs.
	Manometer, diff. (plastic tubing)	1	set
	Pipe Assembly or equivalent	1	set
3. Determination of friction loss	Piezometer taps / pressure gages		
	Pipe Assembly		
4. Identification of laminar and turbulent flow using Reynold's number	Reynolds Apparatus	2	sets
	Stop Watch	2	pcs.
	KMn04 solution or equivalent	500	ml.
	Volumetric / Gravimetric Discharge Measurement	2	sets

	Piezometer taps w/ manometer	2	sets
5. Discharge measurement using venturimeter	Manometers	2	pcs
	Meter Stick	2	pcs
	Pipe Assembly	1	set
	Timing Device	1	pc.
	Venturimeter	1	pc.
	Volumetric / Gravimetric Discharge Measurement	1	set
6. Weir Calibration	Flume Tilting	1	set
	Hook Gauge / Measuring Stick	1	pc.
	Stop Watch	1	pc.
	Set of Weirs	1	set
	Volumetric / Gravimetric		
	Discharge Measurement	1	set
Laboratory Exercises	**Specifications**	**Minimum Required Quantity****	**Units**
7. Fall velocity of sphere	Balance	1	set
	Caliper	2	pcs.
	Liquid Samples (3 samples /set)	2	sets
	Meter Stick	2	pcs.
	Stop Watch	2	pcs.
	Spherical ball, 1/8" – ¼" dia.	6	pcs.
	Transparent Cylinders 6" diam x 24" or longer	6	pcs.
8. Determination of Pump Efficiency	Meter Stick	1	pc.
	Pump, Motorized	1	set
	Calibrated water tank, elevated Pressure gages / piezometer taps	1	set
	Stop Watch	1	pc.
	Thermometer	1	pc.
9. Wind Tunnel (optional)			

ANNEX V - SAMPLE SYLLABUS

(*Name of HEI*)
College of Engineering
Department of Civil Engineering

Vision

College envisions itself to become the leading Educational institution committed to Quality Education in the Philippines

Mission

a. Provide competent and morally upright faculty, state-of-the-art facilities and curriculum and instruction that are up-to-date and responsive to the dynamically changing local and international environment;
b. Strengthen the commitment, compliance, work values, research and productivity, skills and community involvement of the faculty, staff and students; and
c. Promote quality education that will impart knowledge and imbue students with values.

Program Educational Objectives	Mission		
	a	b	c
Within 3 to 5 years after graduation, the program expects that the Civil Engineering graduates will:			
1.) Be able to impart essential knowledge, elements, tools and skills necessary to become successful engineers;	√	√	√
2.) Develop students' ability to recognize, formulate and solve civil engineering problems; and	√	√	√
3.) Provide the students with a meaningful experience in research and design that are relevant to the civil engineering field.	√	√	√

Course Syllabus in Civil Engineering
___ Semester, SY _____

I. **Course Title:** Mechanics of Deformable Bodies
Course Code: MDB
Credit Units: 4 units
Prerequisites: Statistics of Rigid Bodies (SRB)
Co-requisites: Dynamic of Rigid Bodies

II. **Course Description:** The course deals with the axial stress and strain; stresses for torsion and blending; combined stresses; beam deflections; indeterminate beams; and elastic instability.

III. **Program Outcomes and Relationships to Program Educational Objectives**

Program Outcomes	Program Educational Objectives		
A graduate of the Bachelor of Science in Civil Engineering program must attain:	1	2	3
a) An ability to apply knowledge of mathematics, physical, life and information sciences; and engineering sciences appropriate to the field of practice.	√	√	√
b) An ability to design and conduct experiments as well as to analyze and interpret data.	√	√	√
c) An ability to design a system, component, or process to meet desired needs within identified constraints.	√	√	√
d) An ability to work effectively in multi-disciplinary and multi-cultural teams.	√	√	√
e) An ability to recognize, formulate, and solve engineering problems.	√	√	√
f) Recognition of professional, social, and ethical responsibility.	√	√	√
g) An ability to effectively communicate orally and in writing using the English language.	√	√	√
h) An understanding of the effects of engineering solutions in a comprehensive context.	√	√	√
i) An ability to engage in life-long learning and an understanding of the need to keep current of the developments in the specific field of practice.	√	√	√
j) A knowledge of contemporary issues.	√	√	√
k) An ability to use techniques, skills, and modern engineering tools necessary for engineering practice.	√	√	√
l) Knowledge and understanding of engineering and management principles as a member and leader in a team, to manage projects and in multidisciplinary environments.	√	√	√
m) An appreciation of "Filipino historical and cultural heritage" (based on RA 772)			

IV. Relationship of Course Learning Outcomes (CLOs) to Program Outcomes (PO)

Course Learning Outcomes	Program Outcome (PO)												
	a	b	c	d	e	f	g	h	i	j	k	l	m
At the end of the course, the student should be able to:													
CLO 1 : Describe/Understand the concepts of stress and strain;	√				√					√			
CLO 2 : Compute/Calculate stresses due to axial tension and compression,bending, shear, and torsion under plain and combined loading; and	√				√					√			
CLO 3 : Be able to relate the course to structural design.	√				√					√			

V. Course Coverage

DATE	WEEK	CLO Code Link			TOPIC	TEACHING & LEARNING ACTIVITIES (TLA)	ASSESSMENT METHODS/ TOOLS	TARGET
		1	2	3				
	1	√			**Introduction & Static Equilibrium** Pretest	Lecture Group Discussion	Pretest	
	2	√			**Simple Stress** Compressive Stress Tensile Stress Shear Stress	Lecture Group Discussion Problem Solving Board Work	Seatwork	
	3	√			Bear Stress Thin-walled Cylinders	Lecture Group Discussion Problem Solving Board Work	Quiz Examination	50% of the students shall have a rating of at least 70%
	4	√	√		**Simple Strain** Stress-Strain Diagram Hooke's Law: Axial Deformation	Lecture Group Discussion Problem Solving Board Work	Quiz Seatwork	
	5				**Preliminary Examination**	Problem Solving	Preliminary Examination	
	6		√		Shearing Deformation	Lecture Group Discussion Problem Solving	Seatwork	

DATE	WEEK	CLO Code Link			TOPIC	TEACHING & LEARNING ACTIVITIES (TLA)	ASSESSMENT METHODS/ TOOLS	TARGET
		1	2	3				
	7		√	√	Statically Indeterminate Members	Lecture Group Discussion Problem Solving	Quiz Examination	50% of the students shall have a rating of at least 70%
	8		√	√	Applications	Problem Solving Board Work	Quiz Examination	50% of the students shall have a rating of at least 70%
	9	√	√		Thermal Stress Applications	Lecture Group Discussion Problem Solving Board Work	Seatwork	
	10	√	√	√	**Torsion** Introduction and Assumptions Derivation of Torsion Formula Applications Bolt Couplings Torsion of Thin-Walled Tubes Helical Springs	Lecture Group Discussion Problem Solving Board Work	Quiz /Seatwork Examination	50% of the students shall have a rating of at least 70%
	11	√	√	√	**Shear and Moment in Beams** Center of Areas Shear and Moment Equations Shear and Moment Diagrams Moment of Inertia	Lecture Group Discussion Problem Solving Board Work	Seatwork	
	12				**Mid Term Examination**	Problem Solving	Mid Term Examination	
	13		√	√	Relations between Load, Shear and Moment Point of Zero Shear and Moment	Lecture Group Discussion Problem Solving Board Work	Quiz Examination	50% of the students shall have a rating of at least 70%

DATE	WEEK	CLO Code Link			TOPIC	TEACHING & LEARNING ACTIVITIES (TLA)	ASSESSMENT METHODS/ TOOLS	TARGET
		1	2	3				
	15		√	√	Moving Loads **Stresses in Beams** Derivation of Flexure Formula – Flexure Stress	Lecture Group Discussion Problem Solving Board Work	Seatwork	
	16		√	√	Applications Economic Sections	Problem Solving Board Work	Seatwork	
	17		√	√	Unsymmetrical Beams Horizontal Shearing Stress Design for Flexure and Shear	Lecture Group Discussion Problem Solving Board Work	Quiz Examination	50% of the students shall have a rating of at least 70%
	18				**Final Examination**	Problem Solving	Final Examination	

Legend: 1 – CO has minor contribution to PO
2 – CO has moderate contributions to PO
3 – CO has major contribution to PO

VI. Course Requirements:

Class standing requirements (problem solving exercises, seatworks, assignments and oral presentations, group participation and evaluation) – Problem solving exercises are scheduled. Seatworks are unannounced and are usually given at the start or near the end of the lecture period. Problem set assignments are to solved through team effort to maximize peer tutoring and cooperative learning. Outputs are collected at the beginning of the next class session. Students will be required to do oral presentation of assignment solutions or any special topics. Individual contribution to group work will be rated by the instructor and by the co-group members.

Grading System:

GRADING SYSTEM FOR ALL COE SUBJECTS
Lecture and Laboratory Subjects

LECTURE	LABORATORY
PRELIM GRADE (PG) = 60% (PRELIM LECTURE GRADE) + 40% (PRELIM LAB GRADE)	
MIDTERM GRADE (MG) = 60% (MIDTERM LEC GRADE) + 40% (MIDTERM LAB GRADE)	
FINAL GRADE (FG) = 60% (FINAL LECTURE GRADE) + 40% (FINAL LABORATORY GRADE)	
FINAL FINAL GRADE = 1/3 (PG + MG + FG)	

VII. Learning Resources

Textbook: Singer, Ferdinand and Pytel, Andrew; *Strength of Materials*, 4th Edition, Harper Collins Publisher, 1987
References: Hibbeler, Russell C.; *Mechanics of Materials*, 6th Edition, Pearson/Prentice Publisher, 2005
Higdon, Archie, et al.; *Mechanics of Deformable Bodies*, 4th Edition, John Wiley & Sons, 1989
Online Reference and Journals

VIII. Class Policies

Attendance:

Attendance sheets will be passed around and the student is responsible to sign to prove his presence for that sessions. This is to monitor whether absences incurred by the student is still within the allowed number of absences for a course stipulated in the Student

Handbook. The only valid excuses for missing exam are illness requiring medical care or a personal/family emergency of a serious nature. For such, valid medical certificate and parent's/guardian's letter will be required and subjected to verification.

Cooperative Learning:

The goal is to have everyone learn more than they would have working alone. Nevertheless, individual work provides the foundation for productive and synergistic group work. Teams will be formed, with three or four students per team. These will be used in two ways. First, in-class discussion and reporting on assignments will be by group (whenever possible). Second, problem set assignments will be group activities but the submission of assignment outputs will be done individually. Presentation of output will be done on a rotation basis. All students will evaluate themselves and their fellow group members with respect to contributions to group function at least twice during the semester. This evaluation will contribute to the class standing portion of the course grade and will be used primarily in deciding borderline grades.

Academic Honesty Policy:

It is a part of your education to learn responsibility and self-discipline, particularly with regards to academic honesty. The most important issue of academic honesty is cheating. Cheating is defined to include an attempt to defraud, deceive, or mislead the instructor in arriving at an honest grade assessment. Plagiarism is a form of cheating that involves presenting as one's own work the ideas or work of another.

All portions of any test, project, or final exam submitted by you for a grade must be your own work, unless you are instructed to work collaboratively. Specific requirements will be described for collaborative projects, but all work presented must be the work of members of that group. Research materials used must be properly cited. Cheating in a major course examination by a student will entail a failing mark of **F** for the given course. Cheating, dishonesty or plagiarism in papers and other works will entail zero (0) score for the said requirement.

Prepared by:	**Evaluated by:**	**Approved by:**	**Noted by:**
_____	_____	_____	_____
Professor	**Department Chairman** **Civil Engineering**	**Dean** **College of Engineering**	**Vice President for Academic Affairs**