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

CHED MEMORANDUM ORDER (CMO)
No. 46
Series of 2017

SUBJECT: POLICIES, STANDARDS AND GUIDELINES FOR THE BACHELOR OF SCIENCE IN MARINE BIOLOGY PROGRAM

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 No. 46, s. 2012, and for the purpose of rationalizing the Marine Biology education in the country by virtue of Commission en banc Resolution No. 231-2017 dated March 28, 2017, the following policies, standards and guidelines (PSGs) are hereby adopted and promulgated by the Commission.

ARTICLE I
INTRODUCTION

Section 1. Rationale

Based on the Guidelines for the Implementation of CMO No. 46, series of 2012, this PSG implements the "shift to learning competency-based standards/ outcomes-based education." It specifies the 'core competencies' expected of BS Marine Biology graduates "regardless of the type of HEI they graduate from." However, in "recognition of the spirit of outcomes-based education and ... of the typology of HEIs," this PSG also provides "ample space for HEIs to innovate in the curriculum in line with the assessment of how best to achieve learning outcomes in their particular contexts and their respective missions ...."

ARTICLE II
AUTHORITY TO OPERATE

Section 2. Government Authority

All private higher education institutions (PHEIs) intending to offer Bachelor of Science in Marine Biology (BS Marine Bio) must first secure proper authority from the Commission in accordance with this PSG. All PHEIs with existing BS Biology program are required to shift to an outcomes-based approach. State universities and colleges (SUCs), and local colleges and universities (LUCs) should likewise strictly adhere to the provisions in these policies and standards.

ARTICLE III
GENERAL PROVISIONS

Per Section 13 of RA No. 7722, the higher education institutions shall exercise academic freedom in its curricular offerings but must comply with the minimum requirements for specific academic programs, the general education distribution requirements and the specific professional courses.

Section 3. The Articles that follow give minimum standards and other requirements and prescriptions. The minimum standards are expressed as a minimum set of desired program outcomes which are given in Article IV, Section 6. The CHED designed a curriculum to attain such outcomes. This curriculum is shown in Article V, Section 9 as a sample curriculum. The number of units of this curriculum is herein prescribed as the "minimum unit requirement" under Section 13 of RA 7722. In designing the curriculum the CHED employed a curriculum map which is shown in Article V, Section 10 as a sample curriculum map.

Using a learner-centered/outcomes-based approach the CHED also determined appropriate curriculum delivery methods shown in Article V, Section 11. The sample course syllabi given in Article V, Section 12 show some of these methods.

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

Section 4. The HEIs are allowed to design curricula suited to their own contexts 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 from sections in Article VII, Section 19.

These PSGs reflect the reform towards outcomes-based education. Likewise, it is based on K to 12 reform education system and on the CHED proposed GE program.

ARTICLE IV
PROGRAM SPECIFICATIONS

Section 5. Program Description

5.1 Degree Name

The degree program described herein shall be called Bachelor of Science in Marine Biology (BS Marine Biology).

5.2 Nature of the Field of Study

Marine Science by definition is the branch of knowledge which deals with the science of the sea and all the life and the processes and interactions in it. Marine Biology as a discipline in higher education, finds its role in the creation of human resource that will steward the vast marine resources of the Philippines. Considering that the Philippines has the 5th longest coastline in the world (36,289 kilometers) and the strategic location of the Philippines in the heart of the Coral Triangle. More importantly, the Philippines has been identified globally as the Center of the Marine Shore Fish Biodiversity. The major importance of marine resources in food, medicine, tourism, materials, energy, climate, security and pharmaceuticals should be acknowledged.

Therefore, Marine Science and Marine Biology are fields that need to be given attention and priority by the Philippine government. Being an archipelagic country, the Philippines needs to develop manpower to help manage, sustain and enhance marine resources.

The global trend of Marine Biology is to highlight the function of biodiversity not only as a resource but as a strategy for resilience to global change. This is reflected in the recommended curriculum of the Program.

5.3 Program Goals

The program aims to develop graduates that will have a clear recognition and understanding of the dynamics of the marine life and its ecosystem through actual field/hands-on experience which will provide the foundations for future careers in marine biology, conservation, oceanography, biomedicine, molecular biology, university teaching, fisheries, etc.

Graduates of the BS Marine Biology program should be able to:

a. Apply the scientific process in general problem solving
b. Have skills that can contribute to the management of tropical marine resources
c. Pursue further careers in related fields (e.g. research, teaching, resource management, etc)
d. Have knowledge to promote sustainable utilization of marine resources.

5.4 Specific professions/careers/occupations or trades that BS Marine Biology graduates may go into

BS Marine Biology graduates can take career paths in coastal and marine related professions including marine resource management. Specific areas can be in fisheries, oceanography, conservation and biodiversity, environmental biology, research, pollution and siltation control and management, hazard mitigation, coastal land use, tourism, marine archaeology, science communication and education.

5.5 Allied Fields

Marine Biology is allied to biology, chemistry, pharmacy, fisheries, physics, oceanography, marine science, biotechnology, forestry, environmental science, natural resource management.

Specialists from these fields can teach the majors and elective courses in the program.

Section 6. The standards for the BS Marine Biology program are expressed in the following minimum set of learning outcomes:

6.1 Common to all baccalaureate programs in all types of institutions

a) articulate the latest developments in their specific field of practice. (PQF level 6 descriptor)
b) effectively communicate orally and in writing using both English and Filipino languages.
c) work effectively and independently in multi-disciplinary and multi-cultural teams. (PQF level 6 descriptor)
d) demonstrate professional, social, and ethical responsibility, especially in practicing intellectual property rights and sustainable development.
e) preserve and promote "*Filipino historical and cultural heritage*". (based on RA 7722)

6.2 Common to the Science and Mathematics Disciplines

f) demonstrate broad and coherent knowledge and understanding in the core areas of physical and natural sciences
g) apply critical and problem solving skills using the scientific method.
h) interpret relevant scientific data and make judgments that include reflection on relevant scientific and ethical issues
i) carry out basic mathematical and statistical computations and use appropriate technologies in (a) the analysis of data; and (b) in pattern recognition, generalization, abstraction, critical analysis and problem solving
j) communicate information, ideas problems and solutions, both, orally and in writing, to other scientists, decision makers and the public
k) relate science and mathematics to the other disciplines

l) design and perform safe and responsible techniques and procedures in laboratory or field practices
m) critically evaluate input from others
n) appreciate the limitations and implications of science in everyday life
o) commit to the integrity of data

6.3 Specific to BS Marine Biology

The graduates of the BS Marine Biology program should be able to:

p) demonstrate broad and coherent knowledge and understanding in the core areas of marine biology
q) search, gather, evaluate and utilize information as it relates to natural science
r) communicate the inter-relatedness of the ocean processes to overall human quality of life
s) demonstrate knowledge on how to sustainably manage marine resource
t) apply knowledge and skills learned in response to national issues and global concerns

6.4 Common to a horizontal type as defined in CMO No. 46, series of 2012

- For professional institutions: a service orientation in one's profession
- For colleges: an ability to participate in various types of employment, development activities, and public discourses particularly in response to the needs of the communities one serves
- For universities: an ability to participate in the generation of new knowledge or in research and development projects

Graduates of State Universities and Colleges must, in addition, have the competencies to support "national, regional and local development plans." (RA 7722)

The HEIs, at its option, may adopt mission-related program outcomes that are not included in the minimum set.

Section 7. Sample Performance Indicators

Performance indicators (PIs) assist in the evaluation of student learning or the achievement of the program outcomes. These are demonstrable traits developed not only through the core or discipline-specific courses but more importantly through their collective experiences.

To achieve the program outcomes, graduates of the BS Marine Biology program are expected to possess a wide range of knowledge, skills and values as follows:

A. Knowledge
• Taxonomy
• Biological and ocean processes
• Land-sea interaction
• Laws and policies related to the dynamics of the environment
• Marine resource assessment (coral reefs, sea grass & seaweeds, mangroves, fisheries)
B. Problem-solving
• Evaluate problems of the marine environment
• Field sampling design
• Spatial planning and mapping
• Benchmarking
• Data collection, processing and analysis
• Field and laboratory instrumentation
• Specimen processing (including preservation)
• Synthesize and communicate the data to useful forms
C. Decision-making and resource management
• Search , integrate and formulate optimal solutions to problems
• ICRM: Integrative Planning and management
• Resource valuation
• Participatory management
• Communicate information to stakeholders appropriately (both written and oral)
D. Creativity and flexibility
• Generation of new information
• Appropriate application of new information
E. Ethics and integrity
• Data integrity and honesty in the reporting data
F. Value Formation
• Stewardship
• Sustainability

ARTICLE V
CURRICULUM

Section 8. Curriculum Description

The curriculum for BS Marine Biology should be built around a well-defined core of subjects that covers the fundamental aspects in sufficient depth and at the same time allow for flexibility to cover areas and applications in the allied disciplines. The curriculum should also provide the necessary background in natural and physical sciences, and communication to prepare the graduates for both the industry and higher levels of technical expertise.

The Policies and Standards make the recommendations on most of the BS Marine Biology curriculum and the content of each course. The purpose of this is to ensure a common standard for the BS Marine Biology degree. However, the individual institutions are given the flexibility to offer courses and topics of their preference for the remainder of the curriculum and the course contents that are unspecified. It is also emphasized that flexibility is allowed as long as the basic topics are covered.

Section 9. Sample Curriculum

9.1 Curriculum Components

The components of the BS Marine Biology curriculum are listed in Table 1 together with the minimum number of units in each component.

Table1. Components of the BS Marine Bio curriculum and their corresponding units

COMPONENTS	UNITS
a. General Education Curriculum	***36***
b. Foundation Courses	***43***
c. Core Courses	***42***
d. Electives	***9***
e. Thesis	***6***
f. Practicum	***3***
g. National Service Training Program (NSTP)	***6***
h. Physical Education (PE)	***8***
Total	***153***

9.1.1 General Education (GE) Courses

The general education and legislated courses follow existing CHED Guidelines on General Education.

Table 2. GE courses and corresponding units

Core GE courses (24 units)	
1. Understanding the Self (Nature of identity)	3 units
2. Readings in Philippine History	3 units
3. Mathematics in the Modern World (application of mathematics in daily life)	3 units
4. Purposive Communication (Writing, speaking and presenting to different audiences)	3 units
5. Art Appreciation	3 units
6. Science, Technology and Society	3 units
7. Ethics	3 units
8. The Contemporary World (Globalization and its impact on individuals, communities and nations)	3 units
Elective courses (9 units)	
9. Mathematics, Science and Technology (e.g. Information Technology)	3 units
10. Arts and Humanities (e.g. Entrepreneurship)	3 units
11. Social Sciences and Philosophy (e.g. Economics, Development and Population)	3 units
Rizal course (3 units)	

**will follow the HEIs general offering for as long as the minimum number of units per course are met.*

9.1.2 Foundation Courses (43 units)

The BS Marine Biology program should have a balance foundation of the physical and natural science courses which will be essential in the integration of science-based approaches in dealing with marine biology related cases.

The program requires 7 units of Mathematics, 10 units of Chemistry, 6 units of Physics, 17 units of Biology and 3 units of Earth Science. A.) Mathematics until Calculus and Inferential Statistics B.) General Chemistry until Biochemistry C.) Physics until Thermodynamics and D.) Biology until Ecology and Genetics.

Table 3. Foundation Courses courses and corresponding units

AREA	COURSES	Units
Mathematics	Calculus (Integrative) (4) Inferential Statistics and Biometry (3)	7
Chemistry	Inorganic Chemistry (3) Organic Chemistry (4) Biochemistry (3)	10
Physics	Mechanics, Electromagnetism and Gravitational Theory (3) Waves, Optics, and Thermodynamics (3)	6
Biology	Cell and Molecular Biology (4) General Physiology (3) Developmental and Reproductive Biology (3) Ecology (3) Genetics (4) **All Bio Courses should include laboratory Component*	17
Earth Science	To include climate change and inter-connectivity, spatial planning (in the context of the Marine Environment), Geology, tele-connections, monsoon, El Niño-Southern Oscillations, Pacific Decadal Oscillation, cyclone (with lab)	3
	TOTAL	**43**

**will follow the HEIs general offering for as long as the minimum number of units per course are met.*

9.1.3 Core Courses (42 units)

Table 4 lists the marine biology core courses that should be taken by students in the program. The minimum number of required units per area is also given. Each core course shall have a minimum of 2 units lecture and 1-2 units laboratory. Laboratory units may also include field work.

Table 4. Marine Biology core courses and corresponding units.

COURSES	UNITS
Coral Reefs *	3
Elements of Research (to include field sampling design)	3
Integrated Coastal / Marine Resource Management	4
Oceanography I	4
Oceanography II	4
Marine Zoology I (Invertebrate)	4
Marine Zoology II (Vertebrate)	4
Marine Botany (Plants-Mangrove, Sea grass, Algae)	4
Marine Microbiology and Fungi	4
Marine Ecology	4
Systematics, Biodiversity and Evolution	4
TOTAL	**42**

**Coral Reefs: Philippines is in the middle of the coral triangle*

9.1.4 Electives (9 units)

The Marine Biology department/units have particular strength and orientation. The elective courses will allow flexibility and accommodate the special interests/niche of the various departments. Higher education institutions may offer electives according to their faculty expertise, institutional resources and thrusts. Shown below are sample electives for the BS Marine Biology program. Each elective shall have a minimum equivalent of 3 units, recommended as 2 units lecture and 1 unit laboratory. Laboratory units may also include field work.

The number of units assigned to the electives is left to the discretion of the institution.

Table 5. List of sample electives

Electives	
• Ichthyology	• Marine Reptiles
• Fishery Management	• Meiofauna
• Mariculture / Silviculture	• Phycology
• Marine Chemistry	• Marine Protected Areas
• Marine Biochemistry	• Remote Sensing and Geographic Information System
• Marine Natural Products	• Scientific Diving
• Marine Pollution	• Marine Biotechnology
• Marine Birds	
• Marine Mammals	
• Marine Plankton	

9.1.5 Thesis (6 units)

The thesis component of the BS Marine Biology program is an initiation of the student to conduct scientific research. Under this component a competent adviser is expected to guide and show the student the rigors of the scientific investigation.

The process of a scientific investigation is the same regardless of the level of degree (MS or PhD). The difference between a BS Thesis to that of an MS or PhD Thesis lies in the scope and complexity of the investigation or the questions being addressed only.

Typically should address questions that demonstrate knowledge of topic, capacity to interpret results and synthesize relevant information.

The unit is divided into three parts of two (2) units each starting second (2nd) semester of 3rd year level. A three part thesis is as follows:

- 2nd semester 3rd year level – Development of Problem, Sampling Design & Method of the Study (2 units);
- 1st semester 4th year level – Data Gathering & Data Analysis (2 units);
- and 2nd semester 4th year level–Write-up & Presentation of Results (2units).

9.1.6 Practicum (3 unit lab = 144 hours)

The BS Marine Biology program includes a Practicum component which is equivalent to a minimum of 3 units. This can be in the form of training or professional exposure in museums, scientific expedition, mariculture, MPAs, scientific laboratories, research projects, etc. This is recommended to be offered in the summer of 3rd year level.

9.2 Sample Program of Study

The sample program of study with the recommended sequence of courses is given in Table 6. Institutions may modify the curriculum to suit their particular requirements and thrusts. Institutions may also choose to offer certain courses during the summer. It should be noted that the ideal contact hours during non-thesis semesters is 27-33 hours per week while during thesis semesters the ideal is 21-27 hours per week.

Table 6. Sample program of study and recommended sequence of courses

Year	Course (First Semester)	Units	Year	Course (Second Semester)	Units
1	Foundation Physics I	3 (1)	1	Foundation Physics II	3 (1)
	Foundation Math I	4		Foundation Math II	3
	Foundation Chem I	3 (1)		Foundation Chem II	4 (2)
	Foundation Bio I	4 (1)		Foundation Bio II	3 (1)
	GE 9 ()	3		GE 10 ()	3
	PE I	2		PE II	2
	NSTP I	3		NSTP II	3
	Total	**22 (3)**		**Total**	**21 (4)**
	Total contact hours = 28			Total contact hours = 29	
2	Oceanography I	4 (2)	2	Oceanography II	4 (2)
	Foundation Chem III	3 (1)		Earth Science	3 (1)
	Foundation Bio III	3 (1)		Foundation Bio IV	3 (1)
	GE 5 ( )	3		GE 4 ( )	3
	GE 2 ( )	3		GE 11 ( )	3
	GE 1( )	3		GE 7 ( )	3
	PE III	2		PE IV	2
	Total	**21 (4)**		**Total**	**21 (4)**
	Total contact hours = 29			Total contact hours = 29	

Year	Course (First Semester)	Units	Year	Course (Second Semester)	Units
3	Marine Botany Marine Zoology I Elective Marine Bio I Foundation Bio V **Total** Total contact hours = 27	4 (2) 4 (2) 3 (1) 4 (1) **15 (6)**	3	Marine Ecology Elements of Research Elective Marine Bio II GE 3 ( ) GE 8 ( ) Thesis **Total** Total contact hours = 24	4 (2) 3 3 (1) 3 3 2 **18 (3)**
3 Summer	Practicum	3			
4	Coral Reefs Marine Zoology II Elective Marine Bio III GE 6 ( ) Rizal Thesis **Total** Total contact hours = 26	3 (1) 4 (2) 3 (1) 3 3 2 **18 (4)**	4	Marine Micro & Fungi Integrated Coastal/ Marine Resources Management Systematics Thesis **Total** Total contact hours = 26	4 (2) 4 (2) 4 (2) 2 **14 (6)**

Note: Credited Units (Lab Units)

Section 10. Curriculum Map and Course Map

Based on the required minimum set of program outcomes, the CHED has determined a program of study that leads to the attainment of the outcomes. This program of study specifies a set of courses sequenced based on flow of content, with each course having a specified title, description, course outcome and credit unit. For this purpose, a sample curriculum map (Annex A) is included as part of the PSGs. It is a matrix of all courses and the minimum set of program outcomes showing which outcome each course addresses and in what way. The map also determines whether the outcomes are aligned with the curriculum.

Higher education institutions shall formulate its curriculum map based on its own set of program outcomes and courses.

A sample curriculum map can be found in **Annex A.**

A sample course map can be found in **Annex C.**

Section 11. Sample Means of Curriculum Delivery

The mode of delivery of each course is indicated in the course syllabi discussed below.

Section 12. Sample Syllabi for Core Marine Biology Courses

The course specifications provided in this CMO in **Annex B** apply only to the core courses and indicate the minimum topics to be covered in each area. The HEIs shall formulate the syllabus for all the courses in their respective BS Marine Biology program.

It is suggested that the introductory and/or concluding part of each course present an informative survey of advances and prospects in this area in order to elicit more interest from the student. The course must continue to impart skills to the student through field work or hands on experience.

ARTICLE VI
REQUIRED RESOURCES

Section 13. Administration

The BS Marine Biology Program shall be administered by a Marine Biology/Science department or a unit under the Biology or Fisheries department headed by its own chair/director/coordinator and having its own set of full-time faculty.

The minimum qualifications of the head of the unit that implements the degree program are the following:

13.1 Head of the marine biology/science unit/ department

The head of the unit/department must be at least a master's degree holder in marine biology/science or in any of the identified allied fields (refer to Article IV, Section 5.5) or in any of the discipline for which the unit/ department offers a program.

Section 14. Faculty

The optimize delivery of the core courses and achieve the set program outcomes, the department/unit offering the BS Marine Biology program should have a least five (5) full-time faculty with at least a Master's degree in Marine Biology or in any of the identified allied fields.

Marine Biology is a critical discipline in this century. There should be a faculty development plan to send faculty to graduate school and/or attend some continuing education programs. The faculty should also undertake research activities and publish research outputs, give lectures and present papers in regional/national/international conferences, symposia, and seminars. They should also be active members of recognized professional associations.

Section 15. Library

Library personnel, facilities and holdings should conform to existing CHED requirements for libraries which are embodied in separate CHED issuances.

The HEI is likewise encouraged to maintain journals and other non-print materials relevant to marine biology education to aid the faculty and students in their academic work. CD-ROMs could complement a library's book collection but should not be considered as a replacement for the same.

Internet access is encouraged but should not be made a substitute for book holdings and/or on-line subscription to books and journals.

Libraries shall participate in inter-institutional activities and cooperative programs whereby resource sharing is encouraged.

Section 16. Laboratory

HEIs should provide the appropriate facilities and equipment to ensure the effective delivery of the course and achievement of program outcomes. There should be a system of updating and enhancing the needed facilities and equipment to be provided to the students. The following are the minimum facilities and equipment a HEIs should have:

- field sampling/collection equipment *(includes plankton net, secchi disk, transect, manta board, core, sieves & niskin water sampler or similar device)*
- wet laboratory with aquarium setup
- weighing scale
- GPS
- underwater camera
- incubator
- drying oven
- field thermometer, salinometer, & PH meter
- a good ratio of Microscope to students (not greater than 1:5)
- an access to seawater

ARTICLE VII
QUALITY ASSURANCE

Section 17. Assessment and Evaluation

The institution/department shall have in place a program assessment and evaluation system. The HEI must show this in their syllabi and catalogue. Institutions may refer to the CHED Implementation Handbook for Outcome-Based Education (OBE) and the Institutional Sustainability assessment (ISA) for guidance.

Section 18. Continuous Quality Improvement (CQI) Systems

The HEI shall maintain at all times a high standard of instruction and delivery through the establishment of a program level Continuous Quality Improvement system. Institution/department must show organizational and process plans, and implementation strategies. Institutions may refer to the CHED Implementation Handbook for Outcome-Based Education (OBE) and the Institutional Sustainability assessment (ISA) for guidance.

Section 19. CHED Monitoring and Evaluation

The CHED, in harmony with existing guidelines on monitoring and evaluation, shall conduct regular monitoring on the compliance of respective HEIs to these policies and standards. An outcomes-based assessment instrument shall be used during the conduct of monitoring and evaluation.

Using the CHED Implementation Handbook for OBE and ISA as reference, a HEI shall develop the following items which will be submitted to CHED when they apply for a permit for a new program:

1. The complete set of **program outcomes**, including its proposed additional program outcomes.
2. Its proposed **curriculum** and its justification including a **curriculum map.**
3. Proposed **performance indicators** for each outcome. Proposed **measurement system** for the level of attainment of each indicator.
4. Proposed **outcomes-based syllabus** for each course.
5. Proposed **system of program assessment and evaluation**
6. Proposed **system of program Continuous Quality Improvement** (CQI).

ARTICLE VIII
TRANSITORY, REPEALING AND EFFECTIVITY PROVISIONS

Section 20. 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 Marine Biology program are hereby given a period of three (3) years from the effectivity thereof to fully comply with the requirements in this CMO. However, the prescribed minimum curricular requirements in this CMO shall be implemented starting Academic Year 2018-2019.

Section 21. Repealing Clause

All CHED issuances, rules and regulations or parts thereof, which are inconsistent with the provisions of this CMO, are hereby repealed.

Section 22. 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 Academic Year 2018-2019.

Quezon City, Philippines, May 17 2017.

For the Commission:

PATRICIA B. LICUANAN, Ph.D.
Chairperson

Attachments:

Annex A – Curriculum Mapping
Annex B – Course Specifications
Annex C – Course Map

ANNEX A
CURRICULUM MAPPING - BS MARINE BIOLOGY

PROGRAM OUTCOMES

At the end of this program, the students are expected to be able to:

A. **Common to all baccalaureate programs in all types of institutions**

a) articulate the latest developments in their specific field of practice. (PQF level 6 descriptor)
b) effectively communicate orally and in writing using both English and Filipino languages.
c) work effectively and independently in multi-disciplinary and multi-cultural teams. (PQF level 6 descriptor)
d) demonstrate professional, social, and ethical responsibility, especially in practicing intellectual property rights and sustainable development.
e) preserve and promote "*Filipino historical and cultural heritage*". (based on RA 7722)

B. **Common to the Science and Mathematics Discipline**

f) Demonstrate broad and coherent knowledge and understanding in the core areas of physical and natural sciences.
g) Apply critical and problem solving skills using the scientific method.
h) Interpret relevant scientific data and make judgments that include reflection on relevant scientific and ethical issues.
i) Carry out basic mathematical and statistical computations and use appropriate technologies in (a) the analysis of data; and (b) in pattern recognition, generalization, abstraction, critical analysis and problem solving.
j) Communicate information, ideas problems and solutions, both, orally and in writing, to other scientists, decision makers and the public.
k) Relate science and mathematics to the other disciplines.
l) Design and perform safe and responsible techniques and procedures in laboratory or field practices.
m) Critically evaluate input from others.
n) Appreciate the limitations and implications of science in everyday life.
o) Commit to the integrity of data.

C. **Specific to BS Marine Biology**

p) demonstrate broad and coherent knowledge and understanding in the core areas of marine biology
q) search, gather, evaluate and utilize information as it relates to natural science
r) communicate the inter-relatedness of the ocean processes to overall human quality of life
s) demonstrate knowledge on how to sustainably manage marine resource
t) apply knowledge and skills learned in response to national issues and global concerns

ANNEX A. CURRICULUM MAPPING - BS MARINE BIOLOGY

COURSES	RELATIONSHIP OF COURSES TO PROGRAM OUTCOME																			
	A	b	c	d	e	F	g	h	i	j	k	l	m	n	o	p	q	r	s	t
A. Core GE																				
Understanding the Self																				
Readings in Philippine History																				
Mathematics in the Modern World																				
Purposive Communication																				
Art Appreciation																				
Science, Technology and Society																				
Ethics																				
The Contemporary World																				
B. GE Electives																				
Mathematics, Science and Technology																				
Arts and Humanities																				
Social Sciences and Philosophy																				
C. Required																				
Life and Works of Rizal			*L*	*P*	*P*								*P*		*P*					
D. Others																				
P.E. 1, 2, 3, 4			*P*	*P*									*P*		*P*					
NSTP 1, 2			*P*	*P*	*P*								*P*		*P*					

E. Foundation Courses (42 u)																				
a. Mathematics																				
Inferential Statistics (3 u)							L		L		O									
Calculus (4 u)							L		L		O									
b. Chemistry																				
Inorganic Chemistry (3 u)			L	O			L	L	P	L	P	L	O	L	L					
Organic Chemistry (4 u)			L	O			L	L	P	L	P	L	O	L	L					
Biochemistry (3 u)			L	O			L	L	P	L	P	L	O	L	L					
c. Physics																				
Mechanics, Electromagnetism and Gravitational Theory (3 u)			L	O			L	L	P	L	P	L	O	L	L					
Waves, Optics, and Thermodynamics (3 u)			L	O			L	L	P	L	P	L	O	L	L					
d. Biology																				
Cell and Molecular Biology (4 u)	L	P	P	P		L	L			P										
General Physiology (3)	L	P	P	P		L	L	P	L	P			L	L	L					
Devt & Reproductive Biology (3 u)	L	P	P	P		L	L	P	L	P			L	L	L					
Ecology (3 u)	L	P	P	P		L	L	P	L	P				L						
Genetics (4 u)	L	P	P	P		L	L	P	L	P				L						
F. Core Courses (40 u)																				
Oceanography I (4 u)	L	O				P	P	P	P	O	O	O		O	P	P	P	O		O
Oceanography II (4 u)	L	O				P	P	P	P	O	O	O		O	P	P	P	O		O
Marine Botany (4 u)	L	O				P	P	P	O	O	O	O		O	P	P	P	O		
Marine Zoology I (Invertebrate) (4 u)	L	O				P	P	P	O	O	O	O		O	P	P	P	O		
Marine Zoology II (Vertebrate) (4 u)	L	O				P	P	P	O	O	O	O		O	P	P	P	O		
Marine Ecology (4 u)	L	O				P	P	P	O	O	O	O		O	P	P	P	O		
Coral Reefs (3 u)	L	O			O	P	P	P	O	O	O	O		O	P	P	P	O		O
Marine Microbiology and Fungi (4 u)	L	O				P	P	P	O	O	O	O		O	P	P	P	O		
Integrated Coastal / Marine Resource Mngt (4 u)	L	O			O	P	P	P	O	O	O	O		P	P	P	P	O	P	O
Systematics (4u)	L	O			O	P	P	P	O	O	O	O		P	P	P	P	O		O
Elements of Research (4 u)		P		O				P				O				P				

G. Electives (9 u)																				
H. Thesis and Practicum (9 u)																				
Thesis (6 u)	*L*	*P*		*P*		*P*	*P*	*P*	*P*	*P*	*P*	*O*	*L*		*P*	*P*	*P*	*O*	*O*	*O*
Practicum (3 u)	*O*	*P*	*O*	*O*	*O*	*O*	*O*	*O*	*O*	*O*	*O*	*O*		*O*	*P*	*O*	*O*	*O*	*O*	

***L**: facilitates learning of competency*
***P**: allows student to practice competency (no input, but competency is evaluated)*
***O**: opportunity for development (no input or evaluation, but competency is practiced*

ANNEX B. COURSE SPECIFICATIONS

BS MARINE BIOLOGY

OCEANOGRAPHY I

A. Course Details

COURSE NAME	**Oceanography I**
COURSE DESCRIPTION	The study of the physical setup of the oceans. (Geology, Physics)
NUMBER OF UNITS (Lec/Lab)	2 units (lecture); 2 units (laboratory)
Pre-Requisite	Calculus (Differential) Physics (Thermodynamics)
Co-Requisite	

B. Course Outcome and Relationship to Program Outcome

COURSES OUTCOMES	PROGRAM OUTCOMES																			
At the end of this course, the students should be able to:	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t
View the ocean as a dynamic environment	✓	✓				✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		
Understand the inter-relatedness of ocean processes to overall human quality of life	✓	✓				✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓
Understand the physical and geological ocean processes	✓	✓				✓	✓	✓	✓	✓		✓		✓	✓	✓		✓		

C. Lecture Course Outline

Week	Topic/s	Common Teaching Strategies	Common Assessment/Evaluation
1	- History of Oceanography - Oceanography in the Philippines	Lecture	Class participation; exam at mid-sem & Finals
2	*Geological Oceanography* - earthquakes, plate tectonics and the making of the oceans - marine provinces and the overview of the oceans	Lecture	Class participation; exam at mid-sem & Finals
3	*Geological Oceanography* - sources of marine sediments - discussion on ocean sediment cores (methods of field measurement and assessment)	Lecture	Class participation; exam at mid-sem & Finals
4	*Geological Oceanography* - coastal geology and geomorphology - field lab at nearest beach (sediment sampling & assessment)	Lecture & Lab	Class participation& lab report; exam at mid-sem & Finals
5	*Geological Oceanography* - paleo sea-level rise -present sea-level rise, groundwater extraction and subsidence (w/ field lab at nearest ground water pumping station)	Lecture & Lab	Class participation& lab report; exam at mid-sem & Finals
6	*Geological Oceanography* - coastal integrity - impact of coastal structures (w/ field lab at nearest port)	Lecture & Lab	Class participation& lab report; exam at mid-sem & Finals
7	*Geological Oceanography* Marine Geohazards (e.g. liquefaction, tsunamis)	Lecture	Class participation; exam at mid-sem & Finals
8	*Geological Oceanography* - field trip (equivalent to 24 hours lab)	Field work	Field participation
9	*Physical Oceanography* - energy from the sun	Lecture	Class participation; exam at end-sem & Finals

Week	Topic/s	Common Teaching Strategies	Common Assessment/Evaluation
	(tilt, orbit, latitude, atmospheric interference) -air-sea interaction (Coriolis effect; Ekman, upwelling)		
10	*Physical Oceanography* - ocean circulation (gyres & western intensification) - eddies	Lecture	Class participation; exam at end-sem & Finals
11	*Physical Oceanography* - watermasses (temp/sal/density, deep water formation, ocean conveyor) - discussion on how measurements are done at sea (CTD and interpretation of data)	Lecture	Class participation; exam at end-sem & Finals
12	*Physical Oceanography* - PDO, ENSO, SIO	Lecture	Class participation; exam at end-sem & Finals
13	*Physical Oceanography* - tides - tidal tables	Lecture & Lab	Class participation& lab report; exam at end-sem & Finals
14	*Physical Oceanography* - estuaries (types using interaction between tides & rivers) - water renewal	Lecture & Lab	Class participation& lab report; exam at end-sem & Finals
15	*Physical Oceanography* - wind waves (w/ wave observations at nearest beach) - internal waves - storm surges	Lecture & Lab	Class participation& lab report; exam at end-sem & Finals
16	*Physical Oceanography* - field trip (equivalent to 24 hours lab)		Field participation

D. Learning Resources

A. Laboratory Equipment, Facilities and Supplies, Field exposure

B. Suggested References

E. Course Details

COURSE NAME	**Oceanography II**
COURSE DESCRIPTION	The study of the bio-chemical setup of the oceans.
NUMBER OF UNITS (Lec/Lab)	2 units (lecture); 2 units (laboratory)
Pre-Requisite	Chemistry (Analytical)
Co-Requisite	Chemistry (Organic) Biology (Physiology)

F. Course Outcome and Relationship to Program Outcome

COURSES OUTCOMES	**PROGRAM OUTCOMES**																			
At the end of this course, the students should be able to:	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**m**	**n**	**o**	**p**	**q**	**r**	**s**	**t**
view the ocean as a living environment	✓	✓				✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		
understand the inter-relatedness of ocean processes to overall human quality of life	✓	✓				✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓
understand the chemical and biological ocean processes	✓	✓				✓	✓	✓	✓	✓		✓		✓	✓	✓		✓		

G. Lecture Course Outline

Week	Topic/s	Common Teaching Strategies	Common Assessment/Evaluation
1	*Chemical Oceanography* -Brief introduction on oceanography -Properties of Water, effect of salts on water properties	Lecture	Class participation; exam at end-sem & Finals
2	*Chemical Oceanography* -Salinity and major constituents of seawater -Methods of measuring salinity (w/ demo & lab) -Background on ocean circulation (surface and deep)	Lecture & Lab	Class participation& lab report; exam at end-sem & Finals
3	*Chemical Oceanography* -Dissolved Gases (N, O, CO_2) -Hypoxia, pH & ocean acidification (w/demo & lab on measuring pH)	Lecture & Lab	Class participation& lab report; exam at end-sem & Finals
4	*Chemical Oceanography* -Nutrients (N, P, Si) -Issues on Eutrophication	Lecture	Class participation; exam at end-sem & Finals
5	*Chemical Oceanography* -Trace Elements (types of distribution) -Iron fertilization	Lecture	Class participation; exam at end- sem & Finals
6	*Chemical Oceanography* -Marine pollution -Measuring water quality	Lecture & Lab	Class participation& lab report; exam at end-sem & Finals
7	*Chemical Oceanography* -Marine toxins -Marine natural products	Lecture	Class participation; exam at end-sem & Finals
8	*Chemical Oceanography* -Field trip (equivalent to 24 hours lab)	Field work	Field participation
9	*Biological Oceanography*	Lecture	Class participation; exam at end-sem

	The Sea as a Biological Environment		& Finals
10	*Biological Oceanography* -Energy Flow in Marine Systems -Phytoplankton and Primary Production	Lecture	Class participation; exam at end-sem & Finals
11	*Biological Oceanography* -Microbes and the Microbial Loop -Zooplankton and Grazing (microscope demo & hands-on)	Lecture & Lab	Class participation& lab report; exam at end-sem & Finals
12	*Biological Oceanography* -Movement of Materials Through Marine Systems -Trophic levels & the Marine Food Web (investigate the food web that can be seen around the nearest pier/port)	Lecture & Lab	Class participation& lab report; exam at end-sem & Finals
13	*Biological Oceanography* -The Benthic Environment (Intertidal zone; Soft Bottom; Deep Sea)	Lecture	Class participation; exam at end-sem & Finals
14	*Biological Oceanography* -Tropical Benthos (Coral Reefs, Seagrass, Seaweeds, Mangroves) (using google earth identify local areas that pertain to the different benthos)	Lecture & Lab	Class participation& lab report; exam at end-sem & Finals
15	*Biological Oceanography* -Populations, Communities, and Ecosystems	Lecture	Class participation; exam at end-sem & Finals
16	*Biological Oceanography* -field trip (equivalent to 24 hours lab)	Field work	Field participation

H. Learning Resources

C. Laboratory Equipment, Facilities, Chemicals and Supplies

D. Suggested References

MARINE BOTANY

A. Course Details

COURSE NAME	**Marine Botany (Plants-Mangrove, Seagrass, Algae)**
COURSE DESCRIPTION	A 4-unit course designed to familiarize student with marine plants (mangroves and seagrasses) and algae, their nature and evolution, classification, distribution, habitats, morphology, physiology, and reproduction.
NUMBER OF UNITS (Lec/Lab)	2 units (lecture); 2 units (laboratory)
Pre-Requisite	None
Co-Requisite	

B. Course Outcome and Relationship to Program Outcome

COURSES OUTCOMES	PROGRAM OUTCOMES																		
At the end of this course, the students should be able to:	a	b	C	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t
recognize and characterize marine plants (mangroves and seagrasses) and algae and differentiate one from another	✓	✓	✓			✓	✓	✓	✓	✓		✓	✓		✓	✓	✓			
know their evolutionary histories and classification	✓	✓	✓			✓	✓	✓			✓		✓		✓	✓	✓	✓		
describe their basic morphology, anatomy, reproduction and physiologic processes	✓	✓	✓			✓	✓	✓				✓			✓	✓	✓	✓		
describe their distribution and habitats	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
know the importance of each group and threats to their existence; learn some management options	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

C. Lecture/Laboratory Course Outline

Week	Topic/s	Common Teaching Strategies	Common Assessment/Evaluation
1	Introduction to the Plant Body Plant and Algal Cells and Tissue Composition of Plant and Algal Cells Embryonic Development of the Plant and Algal Bodies Primary Structure of Mangrove Trees: Shoots and Roots Secondary Structure of Mangrove Trees	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
2	Plant and Algal Reproduction Structures of reproductive organs of mangroves: flowers and fruits Structure of algal reproductive structures Mitosis and Meiosis	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
3	Plant Growth Substances Hormones Phytochrome and Photoperiodism	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
4	Mineral Nutrition Water Relations	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
5	Energy Transformations Light-absorbing organs and organelles Photosynthesis –C3 pathway	Lecture Laboratory	**Prelim Examination** Lecture: Written Laboratory: Moving Examination
6	Photosynthesis: C4, CAM	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
7	Respiration	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
8	Mangrove Diversity and Classification	Lecture Laboratory	Student's participation in lecture

		Field visit to a nearby mangrove area	Submission of Laboratory Worksheets
9	Seagrass Diversity and Classification	Lecture Laboratory Field visit to a nearby seagrass bed	Student's participation in lecture Submission of Laboratory Worksheets
10	Macroalgae or Seaweeds Chlorophyta (Green)	Lecture Laboratory	**Midterm Examination** Lecture: Written Laboratory: Moving Examination
11	Phaeophyta (Brown)	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
12	Rhodophyta (Red Algae)	Lecture Laboratory Field visit to a nearby intertidal area	Student's participation in lecture Submission of Laboratory Worksheets
13	Microalgae Pyrrophyta (Dinoflagellates) Diatoms (Bacillariophyta		Student's participation in lecture Submission of Laboratory Worksheets
14	Chrysophyta (Golden Brown Algae) Cryptophyta (Unicellular falglIates) and Other Divisions		Student's participation in lecture Submission of Laboratory Worksheets
15	Communities, Ecosystems, Biomes		Student's participation in lecture Submission of Laboratory Worksheets **Final Examination** Lecture: Written Laboratory: Moving Examination

D. **Learning Resources**

- Raven, P.H., R.F. Evert and S.E. Eickhorn. 6th ed. Biology of Plants. New York: Worth Publishers, Inc.
- Dawes, Clinton. Marine Botany, 2nd Ed. 1998. ISBN 0-471-19208-2 (cloth US$79.95) 480pp. John Wiley & Sons, 605 Third Ave. New York NY 10158.

A. Course Details

COURSE NAME	**Marine Zoology I (Invertebrates)**
COURSE DESCRIPTION	In this course, students will learn what marine invertebrates are, how they are classified, how each is similar and different to ourselves and how each is connected to us. The anatomy and life history of approximately 35 currently recognized invertebrate phyla, their evolutionary relationships, and their ecological roles in marine environments will be covered. Students will go to the habitats where marine invertebrates live including tide pools, experimental aquaria.
NUMBER OF UNITS (Lec/Lab)	2 units (lecture); 2 units (laboratory)
Pre-Requisite	None
Co-Requisite	

B. Course Outcome and Relationship to Program Outcome

COURSES OUTCOMES	PROGRAM OUTCOMES																		
At the end of this course, the students should be able to:	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	T
Able to correctly classify marine invertebrates on their own	✓	✓	✓			✓	✓	✓	✓	✓		✓	✓		✓	✓	✓			
Understand how different marine invertebrates relate to one another	✓	✓	✓			✓	✓	✓			✓		✓		✓	✓	✓	✓		
Understand differences among local habitats and how marine invertebrates adapt	✓	✓	✓			✓	✓	✓				✓			✓	✓	✓	✓		
Gain an educated perspective of what climate change will mean to the local ecology.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓

C. Lecture/Laboratory Course Outline

Week	Topic/s	Common Teaching Strategies	Common Assessment/Evaluation
1-2	Introduction to marine habitats (open ocean, deep sea, intertidal, kelp forest) Poriferans (sponges) Cnidarians (jellyfish and anemones) Platyhelminthes (flatworms)	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
3-4	Small, obscure phyla (tardigrades, rotifers, chaetognaths, etc.) Molluscs (snails, mussels, etc.) Polychaetes (worms) Arthropods (shrimp, crab, etc.)	Lecture Laboratory Field sampling	Student's participation in lecture Submission of Laboratory Worksheets
5-7	Lophophorates (bryozoans) Field trip to beach for sand community and local geology	Lecture Laboratory Field sampling Field visit to a nearby Museum (e.g. National Museum)	**Prelim Examination** Lecture: Written Laboratory: Moving Examination
8-12	Echinoderms (sea stars, sea urchins, sea cucumbers) Urochoradates and hemichordates (tunicates and amphioxus)	Lecture Laboratory Field visit to a nearby intertidal area	Student's participation in lecture Submission of Laboratory Worksheets
13-15	Human environmental impacts Work on final project	Lecture Laboratory Field visit to a nearby intertidal area	**Final Examination** Lecture: Written Laboratory: Moving Examination

D. Learning Resources

A. Laboratory Equipment, Facilities, Chemicals and Supplies
B. Suggested References

Pechenik, J. Biology of the Invertebrates. Invertebrate Zoology: A Functional Evolutionary Approach 7th Edition Ruppert EE, Fox RS, Barnes RD

Marshall, D. J., P. J. Krug, E. K. Kupriyanova, M. Byrne, and R. B. Emlet. 2012. The Biogeography of Marine Invertebrate Life Histories. Annual Review Of Ecology Evolution And Systematics 43:97–114.

MARINE ZOOLOGY II - Vertebrates

A. Course Details

COURSE NAME	**Marine Zoology II (Vertebrates)**
COURSE DESCRIPTION	This course covers the behavior and classification of marine fishes, reptiles, birds and mammals. Topics include identification, feeding behavior, reproduction, migration and other marine vertebrate characteristics.
NUMBER OF UNITS (Lec/Lab)	2 units (lecture); 2 units (laboratory)
Pre-Requisite	None
Co-Requisite	

B. Course Outcome and Relationship to Program Outcome

COURSES OUTCOMES	PROGRAM OUTCOMES																			
At the end of this course, the students should be able to:	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	T
able to identify marine vertebrates and demonstrate an understanding of the methods marine vertebrates use to survive in the ocean.	✓	✓	✓			✓	✓	✓	✓	✓		✓	✓		✓	✓	✓			
understand the identifying characteristics of major classes and families of marine	✓	✓	✓			✓	✓	✓			✓		✓		✓	✓	✓	✓		

COURSES OUTCOMES	PROGRAM OUTCOMES																			
At the end of this course, the students should be able to:	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	T
vertebrates.																				
understand some of the behavioral habits, such as feeding behavior, migration locomotion, and reproduction of each group.	✓	✓	✓			✓	✓	✓				✓			✓	✓	✓	✓		
classify individual vertebrates by class, order, family and Genus species.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓

E. Lecture/Laboratory Course Outline

Week	Topic/s	Common Teaching Strategies	Common Assessment/Evaluation
1	Review of syllabus and course outline Vertebrate Ancestry and Introduction to module – vertebrate evolution	Website and e-mail orientation Lecture	Student's participation in lecture
2-3	Marine mammal diversity and anatomy	Lecture Laboratory (Basic External Anatomy Finding and Measuring Taxonomic Characteristics)	Student's participation in lecture Submission of Laboratory Worksheets
4	Pathology of marine mammals	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
5	Cetacean biology and ecology	Lecture Laboratory (Basic Internal Anatomy; Character Trends and Morphological Variation)	Student's participation in lecture Submission of Laboratory Worksheets
6	Cetacean distribution, abundance and population structure	Lecture Laboratory	Student's participation in lecture Submission of Laboratory

Week	Topic/s	Common Teaching Strategies	Common Assessment/Evaluation
			Worksheets
7	Cetacean behaviour, social structure and communication	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
8	Teleost diversity, anatomy and physiology	Lecture Laboratory Field visit to a nearby intertidal area Field sampling	Student's participation in lecture Submission of Laboratory Worksheets
9	Elasmobranch diversity, anatomy and physiology	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
10	Pinnipeds	Lecture Laboratory	**Prelim Examination** Lecture: Written Laboratory: Moving Examination
11	Foraging ecology of pinnipeds and birds	Lecture Laboratory Field visit to a nearby sea or bay.	Student's participation in lecture Submission of Laboratory Worksheets
12	Diving physiology I	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
13	Diving physiology II	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
14-15	Sirenians, Ursids and Mustelids	Lecture Laboratory	**Final Examination** Lecture: Written Laboratory: Moving Examination

F. Learning Resources

C. Laboratory Equipment, Facilities, Chemicals and Supplies

D. Suggested References:

A. Moyle, P.B., Cech, J.J., Fishes: An Introduction to Ichthyology. 1995

B. Helfman, G.S., Collette, B.B., Facey, D.E., The Diversity of Fishes. 1999

MARINE ECOLOGY

A. Course Details

COURSE NAME	**Marine Ecology**
COURSE DESCRIPTION	This course examines patterns of abundance and diversity of marine plants and animals and the general physic-chemical and biological processes that structure these patterns
NUMBER OF UNITS (Lec/Lab)	2 units (lecture); 2 units (laboratory)
Pre-Requisite	Marine zoology and marine botany
Co-Requisite	

B. Course Outcome and Relationship to Program Outcome

COURSES OUTCOMES	PROGRAM OUTCOMES																			
At the end of this course, the students should be able to:	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t
Understand concepts of marine ecology	✓	✓	✓			✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Understand the processes that govern ocean habitats	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Identify and quantify ecological patterns in nature	✓					✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓

C. Lecture Course Outline

Week	Topic/s	Common Teaching Strategies	Common Assessment/Evaluation
1	Ecological and evolutionary principles	Lecture	
2	Investigating pattern vs. process in ecology	Lecture	
3	Special features of life in water	Lecture	
4	Bottom up processes: nutrient dynamics and primary production	Lecture, Lab experiment (equivalent to 16 hours lab)	Lab report
5	Dynamics of plankton based food webs -- Pelagic Ecology	Lecture	
6	Nektons	Lecture	
7	Dynamics of Deep Sea Ecology	Lecture, Film showing – Deep Sea	Mid-term
8	Seaweeds, sea grasses and benthic microorganisms	Lecture, Field equivalent to 16 hours lab)	Field report
9	Benthic ecology - Subtidal	Lecture, Field equivalent to 16 hours lab)	Field report
10	Benthic Ecology - Intertidal	Lecture, Field equivalent to 16 hours lab)	Field report
11	Benthic Ecology - Estuarine	Lecture, Field equivalent to 16 hours lab)	Field report
12	Benthic Ecology – Coral Reefs	Lecture, Field equivalent to 16 hours lab)	Field report
13	Top down processes: herbivory and predation	Lecture	
14	Reproduction, dispersal and migration	Lecture, Film showing – marine turtles	
15	Biodiversity and conservation of the ocean	Lecture, Group Discussions	
16	Food from the Sea	Lecture	Finals

D. Laboratory Course Outline

A. Laboratory Equipment, Facilities, Chemicals and Supplies

Field gear, access to subtidal, intertidal, estuarine, seagrass and coral reefs.
Aquarium set-up, access to fertilizer, microscope

B. Suggested References

Connell SD & Gillanders BM 2007. Marine Ecology. Oxford University Press, 630p. ISBN: 9780195553024

Nybakken, JW and MD Bertness. 2004. Marine Biology: An Ecological Approach. Pearson. San Fransisco.

ELEMENTS OF RESEARCH

A. Course Details

COURSE NAME	**Elements of Research** *(to include field sampling design)*
COURSE DESCRIPTION	A 3-unit course designed to provide an overview of the conduct of a scientific process and ethics in research. It will guide and motivate the students to practice scientific thinking, learn scientific process and writing of a scientific paper
NUMBER OF UNITS (Lec/Lab)	3 units (lecture)
Pre-Requisite	Basic Statistics
Co-Requisite	

B. Course Outcome and Relationship to Program Outcome

COURSES OUTCOMES	PROGRAM OUTCOMES																			
At the end of this course, the students should be able to:	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t
understand the scientific basic research process								√						√		√				
know the ethical dimensions of conducting research			√	√	√			√							√		√			
apply correct statistical tool in the analyses of data	√					√	√	√	√		√				√		√	√		
learn to write a scientific research paper		√		√				√		√						√				√

C. Lecture Course Outline

Week	Topic/s	Common Teaching Strategies	Common Assessment/Evaluation
1	Introduction a. Elements of research b. Hypothesis setting and prediction	Lecture	Student's participation in lecture
2	Introduction (cont'd) c. Experimental and non-experimental design d. Identifying independent and dependent variables e. Elements of the scientific paper	Lecture	Student's participation in lecture Submission of scientific questions/problems
3	Data collection a. Identifying sources of data b. Sampling methods	Lecture	Student's participation in lecture Submission of thesis objectives

Week	Topic/s	Common Teaching Strategies	Common Assessment/Evaluation
4	Data collection (cont'd) c. Sampling methods (cont'd) d. Sample size	Lecture	Student's participation in lecture Submission of outline of the introduction
5	Report writing a. Title and abstract construction	Lecture	Student's participation in lecture
6	Class reporting of students thesis title and objectives	Lecture Reporting	Critiquing of the Student's report
7	Report writing (cont'd) b. Characteristics of scientific writing c. Organization of the report	Lecture	Student's participation in lecture
8	Data analyses and interpretation a. Use of appropriate statistical tools		Student's participation in lecture Submission of completed introduction and objectives
9	Data analyses and interpretation (cont'd) b. Quantitative and qualitative analyses c. Types of data presentation	Lecture	Student's participation in lecture Submission of outline of methods
10	Ethical issues in research a. Plagiarism b. Intellectual property rights c. Proper citation of lifted/modified figures	Lecture	Student's participation in lecture
11	Sources and citation of information a. Internet	Lecture	Student's participation in lecture Submission of refined methodology

Week	Topic/s	Common Teaching Strategies	Common Assessment/Evaluation
	b. Journal, books/book chapter c. Conventions used in formatting Content of review or related literature		
12	Class reporting on methodology and statistical tool to use (part 1)	Lecture Reporting	Critiquing of the Student's report
13	Class reporting on methodology and statistical tool to use (part 2)	Lecture Reporting	Critiquing of the Student's report Submission of review of related literature
14	Paper presentation from an invited guess	Seminar	
15	Review of the scientific process	Lecture	Student's participation in lecture Submission of the thesis outline (introduction, objectives, RRL and methods, references)

D. Learning Resources

- Day RS (1994) How to Write and Publish a Scientific Paper, 4th edition, Oryx Press, Phoenix, USA
- Strunk W Jr. and EB White (1987) The Elements of Style, 3rd ed. Macmillan, New York, USA

A. Course Details

COURSE NAME	**Coral Reefs**
COURSE DESCRIPTION	This course deals with the biological and physical interactions that govern the functional mechanisms of the coral reef ecosystem.
NUMBER OF UNITS (Lec/Lab)	2 units (lecture); 1 unit (laboratory)
Pre-Requisite	Marine Ecology
Co-Requisite	

B. Course Outcome and Relationship to Program Outcome

COURSES OUTCOMES	PROGRAM OUTCOMES																			
At the end of this course, the students should be able to:	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t
Assess the process of coral reef formation		✓													✓	✓				
Examine the food web, cycle of nutrients and energy production	✓	✓				✓										✓			✓	
Discuss the ecological and economic importance of coral reefs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	
Discuss natural and anthropogenic effects on coral reefs		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	
Evaluate status of coral reefs			✓	✓		✓	✓	✓	✓	✓	✓	✓			✓		✓	✓		✓

C. Lecture Course Outline

Week	Topic/s	Common Teaching Strategies	Common Assessment/Evaluation
1	Introduction to coral reef ecosystem a. Global distribution and center of marine biodiversity b. Structure of coral reefs c. Biology of corals d. Reef building corals	Lecture aided by power point presentation, video presentation (sex on the reef)	Short quiz
2-3	Reef zonation (reef flat, crest, slope) and components of coral reefs (Seagrass beds, seaweeds, reef fishes, other invertebrates and vertebrates)	Lecture and video presentation	Recitation and short quiz
4-5	Ecological roles of coral reefs a. Coral reef food web b. Nutrient cycle c. Carbon cycle	Lecture aided by power point presentation	Recitation and short quiz
6-7	Student reporting 1st Exam		Oral reporting by group and individual written examination
8-9	Threats/Issues and concerns to coral reef health (top down and bottom up approach) a. Coral diseases b. COTs c. Coral bleaching d. Tourism and Fishing e. Ocean acidification	Lecture and video presentation	Recitation and short quiz
10-11	Reef resilience and sustainability	Lecture aided by power point presentation Presentation actual studies	Recitation and short quiz
12	Ecosystem goods and services provided by reefs	Presentation of case studies	Recitation and short quiz
13	Economic valuation of coral reefs (e.g. case studies)	Presentation of case studies	Recitation and short quiz
14-15	Student reporting 2nd exam		Oral reporting by group and individual written examination

D. Laboratory Course Outline

Week	Topic/s	Common Teaching Strategies	Common Assessment/Evaluation
1	Exercise 1: Laboratory activity Coral taxonomy and nomenclature: Guide to the identification of corals and species diversity	Field guides and laboratory examination of coral structures; species area curve	On line submission of exercise by group
2	Exercise 2: Field activity Examination of reef structures and its components (note: Data gathering for Exercise 3)	Field exposure (skin diving)	On line submission of exercise by group
3-4	Exercise 3: Laboratory activity Coral reef food web (note: use of food web models [ecopath] as demo)	Actual examination of gut contents of at different trophic levels (vertebrates and invertebrates)	On line submission of exercise by group
5	Student reporting	Power point presentation	Oral reporting and in depth knowledge of the topic assigned
6-7	Exercise 4: Laboratory activity Assessment coral reefs (e.g. benthic survey and fish census)	Hands on data analyses of benthic cover and fish census information using Microsoft excel	On line submission of exercise by group
7-8	Exercise 5: Field activity Evaluating coral diseases, COTS infestation and anthropogenic impacts (e.g. fishing, tourism) on coral reefs	Actual examination of coral diseases and coral damages caused by anthropogenic factors	On line submission of exercise by group
9-10	Student reporting	Power point presentation	Oral reporting and in depth knowledge of the topic assigned
11-12	Exercise 6: Laboratory activity Reef resilience and sustainability (note: data gathered under Exercise 5)	Use of models such as FISH-DA and others	On line submission of exercise by group
13	Exercise 7: Laboratory activity Case study: Economic valuation of coral reefs	Examination of the economic losses due to ship grounding and typhoons	On line submission of exercise by group

Week	Topic/s	Common Teaching Strategies	Common Assessment/Evaluation
14	Student reporting	Power point presentation	Oral reporting and in depth knowledge of the topic assigned
15	Laboratory exam	Practical exam by group	Testing of knowledge and acquired skills

E. Learning Resources

A. Laboratory Equipment, Facilities, Chemicals and Supplies
B. Suggested References

Adam TC, Schmitt RJ, Holbrook SJ, Brooks AJ, Edmunds PJ, Carpenter RC, Bernardi G (2011) Herbivory, Connectivity, and Ecosystem Resilience: Response of a Coral Reef to a Large-Scale Perturbation. PLoS ONE 6(8):e23717

Birkeland C (1997) Life and Death of Coral Reefs. Chapman & Hall.

Burke L, Reytar K, Spalding M, Perry A (2011) Reefs at risk revisited. Washington, DC : World Resources Institute, 114 p

Carpenter KE, Springer VG (2005) The center of the center of marine shore fish biodiversity: the Philippine Islands. Environ Biol Fish 72:467-480

Cruz-Trinidad AC, RC Geronimo, RB Cabral RB and PM Alino (2009) Development trajectories and impacts on coral reef use in Lingayen Gulf, Philippines. Ocean and Coastal Management 52 (3-4):173-180

Cruz-Trinidad AC, RC Geronimo, RB Cabral RB and PM Alino (2011) How much are the Bolinao-Anda coral reef worth? Ocean and Coastal Management 54:696-705

English S, Wilkinson C, Baker V (1997) Survey manual for tropical marine resources-second edition. Australian Institute of Marine Science, ASEAN-Australia Marine Science Project

Lavides MN, Polunin NVC, Stead SM, Tabaranza DG, Comeros MT, Dongallo JR (2010) Finfish disappearances around Bohol, Philippines inferred from traditional ecological knowledge. Environ Conserv 36(3):235-244

Nañola CL Jr, Aliño PM, Carpenter KE (2011) Exploitation-related reef fish species richness depletion in the epicenter of marine biodiversity. Environ Biol Fish 90:405-420

Pratchett MS, Munday PL, Wilson SK, Graham NAJ, Cinner JE, Bellwood DR, Jones GP, Polunin NVC, McClanahan TR (2008) Effects of climate-induced coral bleaching on coral-reef fishes ecological and economic consequences. Oceanogr Mar Biol Annu Rev 46:251-296

Nybakken, J.W. and M. D. Bertness. 2004. Marine Biology: An Ecological Approach (6th Edition). Benjamin Cummings

Russell K (2009) The Australian Coral Reef Society Coral Finder, Indo-Pacific. Russell Kelley, 29 pp.

Veron JEN (2000) Corals of the World Vols 1,2,3. Townsville, Qld. Australian Institute of Marine Science

INTEGRATED COASTAL / MARINE RESOURCES MANAGEMENT

A. Course Details

COURSE NAME	**Integrated Coastal / Marine Resources Management**
COURSE DESCRIPTION	A 4-unit course designed to introduce students to the principles and elements of integrated coastal/marine resource management
NUMBER OF UNITS (Lec/Lab)	2 units (lecture); 2 units (laboratory)
Pre-Requisite	None
Co-Requisite	

B. Course Outcome and Relationship to Program Outcome

COURSES OUTCOMES	PROGRAM OUTCOMES																			
At the end of this course, the students should be able to:	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	T
state the elements of coastal and marine resource management	✓	✓															✓	✓	✓	

COURSES OUTCOMES	PROGRAM OUTCOMES																			
At the end of this course, the students should be able to:	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	T
differentiate the various models of coastal and marine resource management	✓	✓			✓								✓	✓			✓	✓	✓	
learn the methods and techniques employed in coastal and marine resource management	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
describe the legal, jurisdictional and institutional framework in coastal and marine resource management	✓	✓		✓	✓												✓		✓	
develop skills in formulating a CRM Plan		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
develop skills necessary in managing coastal and marine resources		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			✓	✓	✓	✓

C. Lecture Course Outline

Week	Topic/s	Common Teaching Strategies	Common Assessment/Evaluation
1	Definitions: coastal zone, the marine ecosystem, integrated resources management; Goals of integrated coastal and marine resources management	Lecture	Participation in lecture
2	The Philippine coastal zone and marine ecosystem	Lecture	Participation in lecture
3	Legal, jurisdictional and institutional framework for coastal and marine resource	Lecture	Participation in lecture

	management.		
4	The Management Cycle Planning, Benchmarking, Implementation, Monitoring and Evaluation …	Lecture	Participation in lecture
5	Management Protocols - Benchmarking	Lecture	**Written Prelim Examination**
6	Benchmarking Protocols - Techniques in Issue/Threat Identification - Techniques in Resource/Socio-economic Assessment	Lecture	Participation in lecture
7	Planning	Lecture	Participation in lecture
8	Monitoring and Evaluation	Lecture	Participation in lecture
9	Participatory Approaches, Co-management	Lecture	Participation in lecture
10	Landscape and Integrated Approaches	Lecture	**Written Midterm Examination**
11	Risk, Vulnerability Assessments	Lecture Participation in real benchmarking project	Participation in lecture
12	Impact Assessments	Lecture Writing of practicum experience	Participation in lecture
13	Conservation	Lecture Preparation of practicum presentation and paper	Participation in lecture
14	Restoration, mitigation	Presentation of Practicum	Participation in lecture
15			**Written Midterm Examination** Paper Submission

D. Learning Resources

A. Textbooks

- Brahtz, J.F.P., ed. 1972. Coastal Zone Management – Multiple Use with Conservation. John Wiley & Sons, Inc., 353 pp.
- Bunce, L. and B. Pomeroy. 2003. Socio-economic Monitoring Guidelines for Coastal Managers in Southeast Asia: SOCMON SEA. World Commission on Protected Areas and Australian Institute of Marine Science, Australia. 82 pp.
- Craven, J.P. 1982. The Management of Pacific Marine Resources: Present Problems and Future Trends. Westview Press, Boulder, Colorado. 105 pp.
- English, T.S., ed. 1973. Ocean Resources and Public Policy. University of Washington Press, Seattle, 184 pp.
- English, S., Wilkinson, C., and Baker, V. (eds.). 1994. Survey Manual for Tropical Marine Resources. Australian Institute of Marine Science. Townsville. 368 pp.
- Gamble, Jr., J.K.. 1974. Global Marine Attributes. Ballinger Publishing Company, Cambridge, Mass. 270 pp.
- Iversen, E.S. 1996. Living Marine Resources: Their Utilization and Management. Chapman and Hall. New York. 403 pp.
- IIRR. 1998. Participatory Methods in Community-based Coastal Resource Management. 3 vols. Vol. 1. Introductory Papers. 84 pp., Vol. 2. Tools and Methods. 289 pp. Vol. 3. Tolls and Methods. 262 pp. International Institute of Rural Reconstruction, Silang, Cavite, Philippines.
- Woodley, S., J. Kay, G. Francis. 1993. Ecological Integrity and the Management of Ecosystems. St. Lucie Press, 220 pp.

B. Other References

- Dight, I., R. Kenchington and J. Baldwin, eds.1998. International Tropical Marine Ecosystems Management Symposium (ITMEMS) Proceedings. The Great Barrier Reef Marine Park Authority, Australia.
- DENR, BFAR, DA and CRMP. 2001. Philippine Coastal Guidebook Series. Coastal Resource Management Project of the Department of Environment and Natural Resources, Cebu City, Philippines.
    - No. 1: Coastal Management Orientation and Overview. 58 pp.
    - No. 2: Legal and Jurisdictional Framework for Coastal Management. 170 pp.
    - No. 3: Coastal Resource Management Planning. 94 pp.
    - No. 4: Involving Communities in Coastal Management Planning. 84 pp.
    - No. 5: Managing Coastal Habitats and Marine Protected Areas.106 pp.
    - No. 6: Managing Municipal Fisheries.122 pp.

  - No. 7: Managing Impacts of Development in the Coastal Zone.108 pp.
  - No. 8: Coastal Law Enforcement. 164 pp.
  -

- Rais, J., I.M. Dutton, L. Pantimena, J. Plouffe, and R. Dahuri (eds.), 1991. Integrated Coastal and Marine Resource Management, Proceedings of International Symposium, 25-27 November, Batu, ITN, BAKOSURTANAL and Proyek Pesisir, Malang.
- Repetto, R., D. Rothman, P. Faeth and D. Austin. 1996. Has Environmental Protection Really Reduced Productivity Growth? We Need Unbiased Measures. World Resources Institute, U.S.A.
- Short F.T. and R.G. Coles (eds.), 2001. Global Seagrass Research Methods. Elsevier Science B.V. Amsterdam.
- Sutinen, J.G. and L.C. Hanson, eds. 1986. Rethinking Fisheries Management. Proceedings from the Tenth Annual Conference, Center for Ocean Management Studies, University of Rhode Island, Kingston, Rhode Island, 236 pp.
- Torell, M. and A.M. Salamanca. 2001. Institutional Issues and Perspectives in the Management of Fisheries and Coastal Resources in Southeast Asia. ICLARM – The World Fish Center and Swedish International Development Cooperation Agency (Sida) Contribution No. 1654. 212 pp.
- Walters, J.S., J. Maragos, S. Siar and A.T. White. 1998. Participatory Coastal Resource Assessment. Coastal Resource Management Project, Silliman University Center of Excellence in Coastal Resources Management. 102 pp. Cebu City, Philippines.

MARINE MICROBIOLOGY and FUNGI

A. Course Details

COURSE NAME	**Marine Micro and Fungi**
COURSE DESCRIPTION	General classification and familiarization in taxonomy of marine microorganisms. Distribution and importance of microorganisms and fungi in the marine habitats. Understanding the role of marine microbes and fungi in the ecosystem.
NUMBER OF UNITS (Lec/Lab)	2 units (lecture); 2 units (laboratory)
Pre-Requisite	None
Co-Requisite	

B. Course Outcome and Relationship to Program Outcome

COURSES OUTCOMES	PROGRAM OUTCOMES																			
At the end of this course, the students should be able to:	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t
Familiarize and classify the marine microbes and fungi.	✓	✓	✓			✓	✓	✓	✓	✓		✓	✓			✓	✓			
Understand the importance of marine microorganisms and fungi	✓	✓	✓			✓	✓	✓					✓		✓	✓	✓	✓		
Identify their microbial habitat and role in ecology.	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓		
Prepare and maintain marine microbial cultures	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

C. Lecture/Laboratory Course Outline

Week	Topic/s	Common Teaching Strategies	Common Assessment/Evaluation
1-3	Introduction and History of Microbiology; Cell Organization, Evolution and Microbial Diversity, Fungi	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets Homework assignments
3-4	General Classification and Taxonomy of Marine Microorganisms (Bacteria: Photoautotrophs, Chemoautotrophs and Heterotrophs; Archea, Viruses and Protists), Fungi	Lecture Laboratory Field sampling in Marine Sanctuaries and Laboratories	Student's participation in lecture Submission of Laboratory Worksheets Homework assignments
5-7	Marine Microbial Ecology: Marine and microbial	Lecture	**Prelim Examination**

	interaction, variation in microbe's ecosystem and marine biogeochemical cycles, the roles of microbes and biotechnology in marine ecology.	Laboratory Field sampling Field visit to a nearby Marine sanctuaries and bays.	Lecture: Written Laboratory: Moving Examination
8-12	Culture techniques in protozoans, micrometazoans, microalgae and fungi. Bacterial and Fungal Pathogenesis;	Lecture Laboratory Field visit to a nearby intertidal area	Student's participation in lecture Submission of Laboratory Worksheets
13-15	Staining techniques, methods of sterilization, inoculation techniques using different media methods of isolation of bacteria and fungi.	Lecture Laboratory	**Final Examination** Lecture: Written Laboratory: Moving Examination

D. Learning Resources

A. Laboratory Equipment, Facilities, Chemicals and Supplies

B. Suggested References

Books:

1. Pelczar, Chann and Kreig : Microbiology (5th Edition).McGraw Hill Inc. New York
2. Salle A.J: Fundamental principles of Bacteriology Tata McGraw Hill
3. Stainer RT et al : General Microbiology. Mac Millan
4. Madigan,Martinko and parker : Brock biology of microorganisms. 9th edition
5. Dimmock and primrose : Introduction to viruses. 2nd edition
6. Biswas and Biswas : An introduction to viruses. 2nd edition
7. Luria, Darnell, Baltimore and Campbell : General Virology, Wiley, New York
8. Ross : Introduction to Microbiology. 1986. Addison-Wesley Educational Publishers.
9. Tauro, Kapoor and Yadav : An introduction to Microbiology
10. Cappuccino and Sherman : Microbiology: A Laboratory Manual

A. Course Details

COURSE NAME	**SYSTEMATICS, BIODIVERSITY AND EVOLUTION**
COURSE DESCRIPTION	A 4-unit course designed to introduce students to the principles and methods used in identifying, classifying, and naming organisms and understanding their evolutionary relationships
NUMBER OF UNITS (Lec/Lab)	2 units (lecture); 2 units (laboratory)
Pre-Requisite	Marine Botany/Marine Zoology/Marine Microbiology
Co-Requisite	

B. Course Outcome and Relationship to Program Outcome

COURSES OUTCOMES	**PROGRAM OUTCOMES**																			
At the end of this course, the students should be able to:	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**m**	**n**	**o**	**p**	**q**	**r**	**s**	**t**
State the philosophy and principles of classification.	✓	✓	✓			✓	✓	✓	✓	✓		✓	✓			✓	✓			
Differentiate the various systematics "schools".	✓	✓	✓			✓	✓	✓					✓		✓	✓	✓	✓		
Describe their basic morphology, anatomy, reproduction and physiologic processes	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓		
Learn the methods used in classification.	✓	✓	✓			✓	✓	✓		✓	✓			✓	✓	✓	✓		✓	✓
Classify a family of Philippine plants, animals, protists, fungi or any prokaryotic organisms.	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓		✓	✓	✓		✓	✓

C. Lecture/Laboratory Course Outline

Week	Topic/s	Teaching Strategies	Assessment/Evaluation
1	Identification vs. Classification The Functions of Classification History of Taxonomy and Binomial System of Classification: Aristotle and Linnaeus Lab: Classification of Plants by the Ancients and Herbalists Function and Habitat as Classifying Criteria	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
2	Taxonomic Categories Species Concepts History of Evolutionary Thought: Darwin Lab: Methods of preserving specimens for taxonomic purposes	Lecture Required Reading: Darwin's, *On the Origin of Species.* Laboratory	Student's participation in lecture Submission of 10 properly preserved and labeled specimens (marine plants, animals and seaweeds)
3	Taxonomic Categories Species Concepts History of Evolutionary Thought: Darwin Lab: Linnaeus' Sexual System: a study of flowers	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets

4	"Schools" of Systematics: Phenetics vs. Cladistics Lab: Taxonomic Characters Characters, data and data matricies	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
5	Character Analysis: Homology and Polarity Lab: Measures of Similarity and Differences	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets **Written Prelim Examination**
6	Computer-assisted systematics Lab: Cluster Analysis and the Construction of Evolutionary Trees	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
7	Parsimony and Character Conflicts Lab: Construction of Taxonomic Keys	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
8	The Botanical, Zoological, Bacteriological Codes of Nomenclature Lab: Museum Cataloguing Systems	Lecture Visit to Biological Museum	Student's participation in lecture Submission of Laboratory Worksheets
9	Chemical taxonomy: secondary metabolites Lab: Types	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets
10	Molecular systematics and Proteomics Lab: DNA Extraction Demo	Lecture Laboratory	Student's participation in lecture Submission of Laboratory Worksheets

			Written Midterm Examination
11	Diversity and Evolution	Lecture Laboratory: Students work on their own organisms	Student's participation in lecture
12	Adaptations and Natural Selection	Lecture Laboratory: Students work on their own organisms	Student's participation in lecture
13	Units of evolution Sources of variations in populations	Lecture Laboratory: Students work on their own organisms	Lecture Laboratory Laboratory: Students work on their own organisms
14	Mechanisms of inheritance Modern synthesis	Lecture Laboratory: Students work on their own organisms	Lecture Laboratory Laboratory: Students work on their own organisms
15	Role of ecology and geography in systematics	Lecture Laboratory: Students work on their own organisms	Project Presentation (In lieu of Final Examination): A systematic study of a selected group of organism

D. Learning Resources

a. Textbooks:

Chenhall, R.G. 1975. **Museum Cataloging in the Computer Age**. American Association for State and Local History, Nashville, Tennesee.

Claridge, MF., H.A. Dawah and M.R. Wilson. 1997. **Species, the Units of Biodiversity.** Chapman & Hall, London. 439 pp.

Darwin, C.R. 1859. **On the Origin of Species**. John Murray. London.

Duncan, T. and T.F. Stuessy (eds.). 1984. **Cladistics: Perspectives on the Reconstruction of Evolutionary History.** Columbia University Press, New York.

Dunn, G. and B.S. Everitt. 1982. **An Introduction to Mathematical Taxonomy**. Cambridge University Press, Cambridge, England.
Futuyma, D.J. 1998. Evolutionary Biology, 3rd ed. Sunderland, Massachusetts. Hand, D.J. 1981. **Discrimination and Classification**. J. Wiley and sons, New York.
Henning, W. 1966. **Phylogenetic Systematics**. University of Illinois Press, Urbana, Illinois.
Jardine, N. A. R. Simpson. 1971. **Mathematical Taxonomy**. John Wiley and Sons, London.
Mayr, E. 1982. **The Growth of Biological Thought: Diversity, Evolution and Inheritance**. The Belknap Press of Harvard University Press, Cambridge, Massachusetts. 973 pp.
Pankhurst, R.J. 1978. **Biological Identification: the Principles and Practice of Identification Methods in Biology**. Edward Arnold, London.
Pielou, E.C. 1977. **Mathematical Ecology**. Wiley-Interscience, New York.
Pielou, E.C. 1984. **The Interpretation of Ecological Data: A Primer on Classification and Ordination**. Wiley-Interscience, New York.
Ridley, M. 1993. Evolution. Boston : Blackwell Scientific. 670 p.

763pp.Romesburg, H.C. 1984. **Cluster Analysis for Researchers**. Lifetime Learning Publications, Belmont, California.
Sarasan, L. and A.M. Nuener (eds.). 1983. **Museum Collections and Computers**. Assoc. of Systematics Collections, Lawrence, Kansas.
Schiffman, S.S., M.L. Reynolds and F.W. Young. 1981. **Introduction to Multidimensional Scaling.** Academic Press, New York.
Sneath, P.H.A. and R.R. Sokal. 1973. **Numerical Taxonomy**. Freeman, San Francisco.
Stace, **Plant Taxonomy and Biosystematics**. 1980. University Park Press, Baltimore.278 pp.
Wagner, W.H. 1969. **The role and taxonomic treatment of hybrids.** Bioscience 19(9):785-789.
Wiley, E.O. 1981. **Phylogenetics: the Theory and Practice of Phylogenetic Systematics**. Wiley-Interscience, New York.

b. Other References:

Heywood, V.H. 1959. **The taxonomic treatment of ecotypic variation.** Systematic Association Publication Number 3: 87-112.
Johns, R.J. 1978. **A new approach in the construction of field keys for the identification of tropical trees.** Australian Journal of Ecology 3: 403-409.

THESIS

A. Course Details

COURSE NAME	**THESIS**
COURSE DESCRIPTION	2nd Sem 3rd Year – Development of Problem, Sampling Design & Method of the Study (2 u) 1st Sem 4th Year – Data Gathering & Data Analysis (2 u) 2nd Sem 4th Year – Write-up & Presentation of Result (2 u)
NUMBER OF UNITS (Lec/Lab)	6 units
Pre-Requisite	

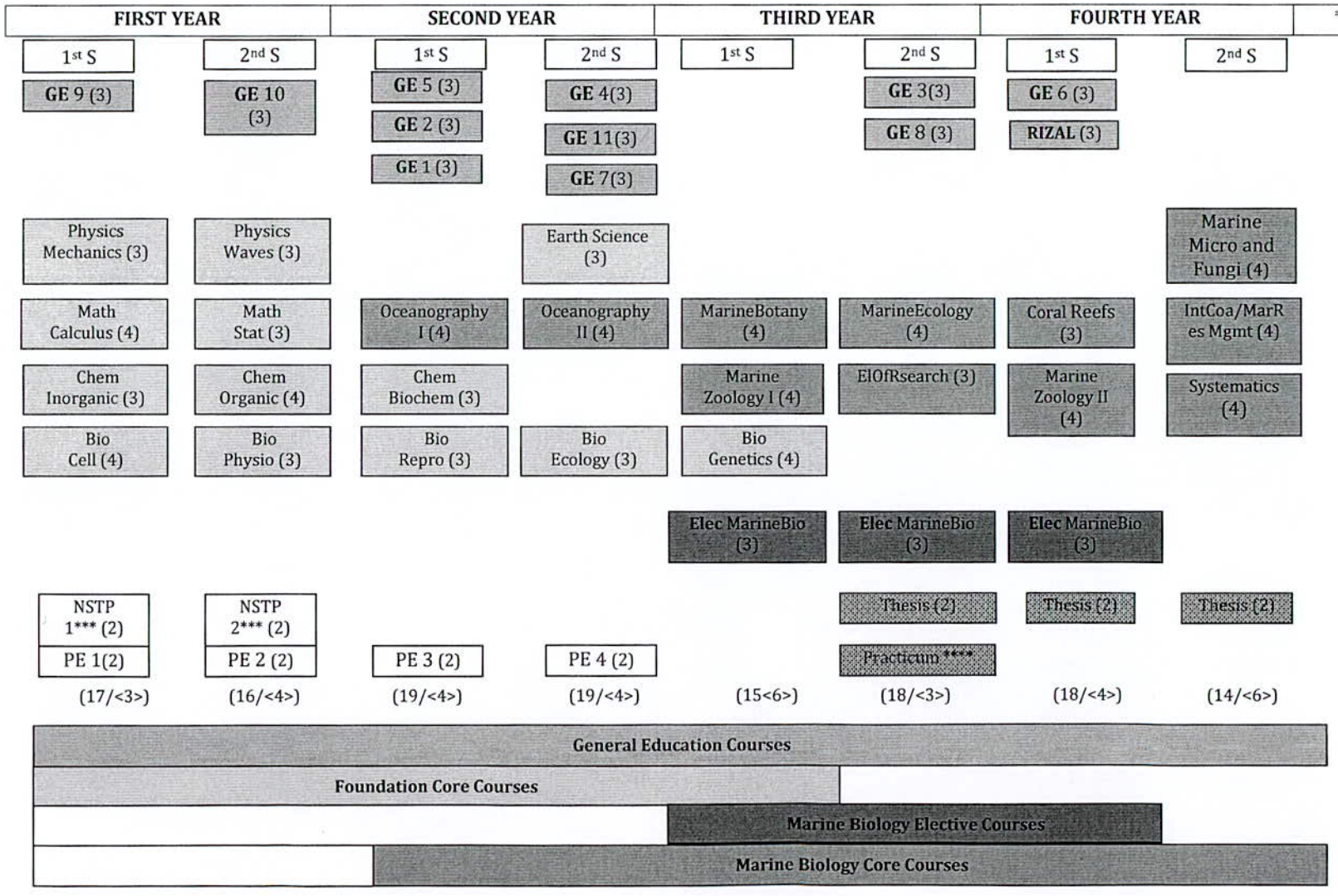
PRACTICUM

A. Course Details

COURSE NAME	**Practicum**
COURSE DESCRIPTION	The BS Marine Biology program includes a Practicum component which is equivalent to a minimum of 3 units. This can be in the form of training or professional exposure in museums, scientific expedition, mariculture, MPAs, scientific laboratories, research projects, etc.. This is recommended to be offered in the summer of 3rd year level.
NUMBER OF UNITS (Lec/Lab)	3 units
Pre-Requisite	

ANNEX C. COURSE MAP

COURSE MAP OF THE BS MARINE BIOLOGY CURRICULUM



***Thesis (Thesis) may be taken 3 times at 2 units each or one time (Special problem) at 2 unit plus 6 units of additional elective major courses taken during the last two semesters.*

*****Recommended to be taken summer 3rd year*

******All students are required to undergo National Service Training Program (NSTP; 6 units) for one year as a requirement for graduation.*

Total = 139 units
153 units incl. NSTP & PE

153 units incl.