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

CHED MEMORANDUM ORDER (CMO)
NO. 43
Series 2006

SUBJECT: POLICIES AND STANDARDS FOR BACHELOR OF SCIENCE IN FISHERIES (BSFi) PROGRAM

In accordance with the pertinent provisions of Republic Act (RA) No. 7722, otherwise known as the "Higher Education Act of 1994," and by virtue of Resolution No. 603 of the Commission en banc dated September 11, 2006 and for the purpose of rationalizing the undergraduate fisheries education in the country with the end view of keeping at pace with the demands of global competitiveness, the following Policies and Standards (PS) are hereby adopted and promulgated by the Commission.

ARTICLE I
INTRODUCTION

Section 1. Rationale and Background

Undergraduate fisheries education (BSFi) in the second half of last century was born when the Philippine Institute of Fisheries Technology (PIFT), formerly School of Fisheries of the Bureau of Fisheries, was transferred to U.P. in 1957. U.P. instituted the Bachelor of Science in Fisheries (BSFi) curriculum using the vocational orientation of the PIFT to provide manpower to the fisheries industries. There were four majors, namely, Marine Fisheries, Inland Fisheries, Fish Processing and Fisheries Education. It also continued the two-and-a-half vocational course as Diploma in Fisheries.

The fishery high schools of the Bureau of Fisheries were absorbed by the Bureau of Secondary Education of the Department of Education. These high schools were elevated to vocational tertiary institutions offering the Diploma in Fisheries or Diploma in Fisheries Technology (DFT), similar to the curriculum of the PIFT. Later many of these vocational fisheries institutions were elevated into colleges and eventually became part of State Universities and Colleges (SUCs). The BSFi curriculum used by these colleges was patterned after the U.P. curriculum and later were modified and diversified into other degrees related to fisheries. They also retained the ladderized BSFi curriculum to allow graduates/students in DFT to acquire a BSFi degree.

The University of the Philippines meanwhile continued to offer the BSFi curriculum that is both oriented to industry and research/teaching but abolished the major in fisheries education and the Diploma course. However, before the end of the twentieth century, government realized that the "open access" policy in fisheries has heavily influenced fishing beyond the maximum sustained yield and has resulted in over-fished aquatic resources and environmental degradation. It has become necessary to modify the curriculum and to provide education that supports sustainable and responsible fisheries and proper conservation and protection of aquatic resources. Very recently U.P. Visayas abolished all majors and adopted a fisheries curriculum that is general in nature. It is also felt that the manpower needs of the fisheries industries may also be supplied by vocational and skills education in Technical Education Skills Development Authority (TESDA).

The new BSFi curriculum herein presented provides knowledge to students as required in the Fisheries Code for proper fisheries and environmental management and sustainable/responsible fisheries, and in the recently approved duties and competencies of fisheries professionals. It also enhances the chances of graduates to pass the fisheries professional licensure examination of the Professional Regulation Commission.

ARTICLE II
AUTHORITY TO OPERATE

All Private Higher Education Institutions (PHEIs) intending to offer Bachelor of Science in Fisheries must first secure proper authority to operate from the Commission in accordance with existing rules and regulations. State Universities and Colleges (SUCs), and Local Colleges and Universities (LCUs) should likewise strictly adhere to the provisions in this Order.

5/F Upper DAP Bldg., San Miguel Avenue, Ortigas Center, Pasig City 1605 Philippines
Web Site: www.ched.gov.ph, Tel. Nos. 633-27-13, 910-08-23, 638-58-35, 636-16-94, Fax No. 635-58-29

ARTICLE III
PROGRAM SPECIFICATIONS

Section 2 Degree

The degree program shall be called Bachelor of Science in Fisheries (BSFi).

The BSFi program has no majors and graduates are intended to be knowledgeable in all aspects of fisheries. The paradigm shift from having majors to non-majors is a call to provide competent fisheries professionals who can contribute better to sustainable and responsible fisheries and total approach to fresh water and marine coastal management, and would be flexible in tackling job opportunities in both private and government sectors.

Section 3 Program Description

3.1 Objectives

The BSFi Program is designed to:

3.1.1 Educate students in the field of fisheries who can contribute to the country's need for sustainable/responsible fisheries and proper concepts of fisheries management, environmental management and multi-sectoral approach to coastal management;

3.1.2 Make students knowledgeable in statistical tools, computer use, social equity, extension service, economics, and proper handling of fish to reduce losses;

3.1.3 Help students acquire knowledge and competencies in all aspects of fisheries such as aquaculture, capture fisheries, post-harvest fisheries, aquatic resources and aquatic ecology; and be capable to do research.

3.2 Specific professions/careers/occupations or trades that the graduate of this program may go into:

3.2.1 Fisheries management
3.2.2 Fisheries research
3.2.3 Fisheries extension service
3.2.4 Fisheries industries
3.2.5 Fisheries instruction

Section 4 Allied Academic Programs

Programs that are allied to BSFi are as follows:

4.1 Biology
4.2 Chemistry
4.3 Aquatic Sciences
4.4 Environmental Science
4.5 Veterinary Medicine
4.6 Marine Science
4.7 Food Science

ARTICLE IV
COMPETENCY STANDARDS

Section 5 Duties and Competencies

Graduates of a BSFi program should be able to: 1) teach, conceptualize, think critically, solve problems, and recognize the limitations of science and its implications to everyday life, 2) know where and how to derive and synthesize information to be able to make an informed decision, 3) execute natural and social

protocols in either a laboratory or fieldwork research setting, 4) perform basic mathematical and statistical computations and formula derivations, 5) have adequate technical writing skills and effective oral communication abilities, and 6) assist in the conduct of research (See Annex A: Duties and Competencies of a Fisheries Technologies).

ARTICLE V
CURRICULUM

Section 6 Curriculum Description

This curriculum is designed to prepare well-rounded fisheries professionals with competencies in the science and practice of fisheries science. The curriculum is made up of: 1) General Education courses (50 units) which are geared toward providing basic skills in the arts and sciences, 2) Fundamental courses (32 units) which provide fundamental knowledge in the field of arts and sciences, 3) Professional courses (61 units) which provide the fundamental knowledge and skills on environmental management and conservation and adequate background in all aspects of fisheries, 4) Elective courses (15 units) that will develop competence in the specific field of fisheries science and management freely chosen by a student from a given set of courses.

Section 7 Curriculum Outline

7.1 General Education **50 Units**

1. Language and Humanities 21 units

a. English I – Study and Thinking Skills in English	3
b. English II – Writing in the Discipline	3
c. Filipino I – Sining Pakikipagtalastasan	3
d. Filipino II – Pagbasa at Pagsulat sa Iba't-ibang Disciplina	3
e. Humanities I – Introduction to Humanities	3
f. Humanities II – Philosophy and Ethics	3
g. Humanities III – The Philippine Literatures	3

2. Mathematics 6 units

a. Mathematics I -College Algebra	3
b. Mathematics II -Plane Trigonometry	3

3. Natural Sciences 8 units

a. Chemistry I - Inorganic Chemistry & Biochemistry	5
b. Physics I - Mechanics and Heat	3

4. Computer 3 units

a. Computer Use in Fisheries	3

5.Social Sciences* 12 units

a. Soc. Sci. I	3
b. Soc. Sci. II	3
c. Soc. Sci. III	3
d. Soc. Sci. IV	3

7.2 Fundamental Courses 32 units

a. Mathematics III –Calculus	3
b. Statistics I	3
c. Chemistry II -Organic Chemistry	5
d. Chemistry III- Analytical Chemistry	5
e. Physics II -Electricity and Magnetism	3
f. Botany	5
g. Zoology -Fundamentals of Zoology	5
h. Microbiology	3

* Social Sciences – 12 units

(consists of subjects such as Political, Psychology, Anthropology, Economics, History and the like provided that the following topics are taken up in appropriate subjects: Taxation and Agrarian Reform, Philippine Constitution and Population Education)

7.3 Professional Courses 61 Units

a. Project Development and Management	3
b. Fisheries Entrepreneurship	3
c. Fisheries Extension	3
d. Aquaculture	5
e. Aquatic Ecology	5
f. Aquatic Resources	3
g. Ichthyology	5
h. Fisheries Management	5
i. Oceanography	3
j. Philippine Fishing Ground	3
k. Capture Fisheries	5
l. Post-Harvest Fisheries	5
m. Meteorology	3
n. Fisheries Laws	3
o. Special Problem/On-the-Job Training*	3
p. Research Design and Methodologies	3
q. Seminar	1

* On-the-Job Training is optional and could be taken up during Summer

7.4 Electives 15 units

a. Fishery Product Analysis	3
b. Fish Genetics And Breeding	3
c. Mariculture	3
d. Fish Health Management	4
e. Freshwater Aquaculture	3
f. Hatchery Management	3
g. Brackishwater Aquaculture	3
h. Aquaculture Engineering	3
i. Fish Stock Assessment	3
j. Marine Machineries	3
k. Navigation And Seamanship	3
l. Fishing Systems	3
m. Fish Processing Plant Management	3
n. Minor Fishery Products And By-Product Processing	3
o. Food Engineering	3
p. Product Development And Value Addition	3
q. Post-Harvest Handling And Low Temperature Preservation	5
r. Utilization of Seaweeds and Algae	5

7.5. Mandated Course 3 units

a. Life and Works of Rizal	3

7.6 Other Required Courses 14 units

a. National Service and Training Program (NSTP)	(6)
b. P.E. (1,2,3,4)	(8)

7.7 Sum Total Of The Units In The Curriculum

General Education Courses 50 units
Fundamental Courses 32 units

Professional Courses	61 units
Electives	15 units
Mandated Course	3 units
Other Required Courses	14 units
Total	**175 units**

Section 8 Sample Program of Study

First Year

Semester 1	Units
Zoology - Fundamentals of Zoology	5
Chemistry I - Inorganic Chemistry	5
Mathematics I -College Algebra	3
English I – Study and Thinking Skills in English	3
Filipino I – Sining Pakikipagtalastasan	3
NSTP	(3)
P.E. 1	(2)
Total	**24**

Semester 2	Units
Botany	5
English II – Writing in the Discipline	3
Filipino II – Pagbasa at Pagsulat sa Iba't-ibang Disciplina	3
Chemistry II - Organic Chemistry	5
Mathematics II - Plane Trigonometry	3
Humanities I – Introduction to Humanities	3
NSTP	(3)
P.E. 2	(2)
Total	**27**

Second Year

Semester 1	Units
Physics I - Mechanics and Heat	3
Statistics I	3
Ichthyology	5
Soc. Sci. I	3
Mathematics III – Calculus	3
Aquatic Ecology	5
P.E. 3	(2)
Total	**24**

Semester 2	Units
Physics II - Electricity and Magnetism	3
Soc. Sci. II	3
Chemistry III - Analytical Chemistry	5
Capture Fisheries	5
Oceanography	3
Computer Use in Fisheries	3
P.E. 4	(2)
Total	**24**

Third Year

Semester 1	Units
Soc. Sci. III	3
Microbiology	3
Aquaculture	5
Meteorology	3
Humanities II – Philosophy and Ethics	3
Aquatic Resources	3
Total	**20**

Semester 2	Units
Soc. Sci. IV	3
Philippine Fishing Grounds	3
Post-Harvest Fisheries	5
Life and Works of Rizal	3
Fisheries Management	5
Fisheries Laws	3
Total	**22**

Fourth Year

Semester 1	Units
Project Development and Management	3
Elective 1	3
Elective 2	3
Elective 3	3
Fisheries Extension	3
Research Design and Methodologies	3
Total	**18**

Semester 2	Units
Humanities III – The Philippine Literatures	3
Fisheries Entrepreneurship	3
Elective 4	3
Elective 5	3
Special Problem/On-Job-Training	3
Seminar	1
Total	**16**

ARTICLE VI
COURSE SPECIFICATIONS

(See Annex B)

ARTICLE VII
OTHER REQUIREMENTS

Section 9 Program Administration

9.1 Qualifications of a Dean

- The Dean of the unit/college must have a doctoral degree in Fisheries.
- Holder of a valid certificate of registration and professional license in Fisheries.
- With at least three (3) teaching experience and two (2) years on research and/or extension work in any of the disciplines for which the college offers.
- The Dean must be full-time.

9.2 Qualifications of a Department Chair

- The Chair of the department must have at least a master's degree in allied areas of Fisheries for which the unit/department offers a program or a master's degree holder in an allied program identified in the policies and standards
- Holder of a valid certificate of registration and professional license in Fisheries.

Section 10 Faculty

10.1 Qualifications

- All members of the faculty should have a bachelor's degree in fisheries or related field (e.g. food science, aquatic biology, oceanography).
- Holder of a valid certificate of registration and professional license in Fisheries issued by the Professional Regulation Commission (PRC).
- At least 50 percent of the full-time faculty must have a Master's degree in their fields of specialization.

10.2 Number of Faculty

- At the start of the program there should be 3 full-time faculty members per area of elective.
- At full operation of the program, there should be at least 6 full-time faculty per area of elective.
- The maximum student/faculty ratio is 1:20 using the full-time equivalent (FTE) for teaching as basis.

10.3 Teaching Load

- A normal load of a faculty member shall be 12 units to 18 units per semester which is equal to 12 to 18 lecture hours or 36 to 42 laboratory hours per week or any combination of lecture and laboratory hours.
- A research or extension project of a faculty member may be credited as equal to 3 units teaching load to comply with the teaching unit requirement but may not be used for overload computation.

10.4 Faculty Development

10.4.1 The school should have a faculty and staff development program as reflected in its annual budget allocation. It should encourage the faculty to:

a. Pursue graduate studies in the field of fisheries;
b. Attend seminars, symposia and conferences for continuing education;
c. Undertake research activities and to publish their research output; and
d. Give lectures and present papers in national/international conferences, symposia and seminars

10.4.2 The institution must provide opportunities and incentives such as:

a. Tuition subsidy for graduate studies;
b. Study leave with pay;
c. Reduce teaching load to finish a thesis or carry out research activities;
d. Travel grants for academic development activities such as special skills training and attendance in national/international conferences, symposia and seminars;
e. Awards and recognition; and
f. Faculty exchange programs

Section 11 Library

Libraries should service the instructional and research needs of the staff and students making it one of the most important service units within a Higher Education Institution (HEI). It is for this reason that libraries should be given special attention by HEI administrators by maintaining them with a wide and up-to-date collection, qualified staff, and communications and connectivity portals. The HEI should provide on-line services for fast and easy access to information through the internet.

11.1 Library Staff

The Head Librarian should: 1) be an experienced/trained in library management and 2) be a registered/licensed librarian.

There should be: 1) One full-time librarian every 1,000 students and 2) A ratio of 1 librarian to 2 staff/clerks should be observed.

11.2 Space Requirements

At least 126 m² or approximately 2 classrooms shall be required for the library. It should include space for collections, shelving areas, stockroom, and office space for staff and reading area. Minimum library seating capacity equivalent to 25 percent of the total number of fisheries students and academic staff should be maintained.

11.3 Networking

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

11.4 Accessibility

The library should be readily accessible to all students, faculty members, researchers and administrative staff of the school. The school may set its own rules regarding the use of the library by the general public.

The library should be open to serve the needs of the users.

11.5 Book Collections

11.5.1 Minimum of two current book titles per subject for the general education courses and three book titles for science, math and fisheries subjects.

11.5.2 Minimum of three technical journal titles (current) for each of the major fisheries areas.

11.5.3 Internet access is encouraged but should not be made a substitute for book holdings.

Section 12 Facilities and Equipment

12.1. Building Requirements

A school building should conform to appropriate zoning and building regulations.

12.2. Classroom Requirements

12.2.1 The classroom floor space should be at least 1.20 sq. m. per student.

12.2.2 For lecture classes, ideal size is 35 students per class, maximum is 50.

12.2.3. For laboratory and research classes, class size shall be specific to the discipline to be stated in the policies and standards.

12.2.4. Special lectures with class size more than 50 may be allowed as long as the attendant and facilities are provided.

12.3 Laboratory Requirement

Laboratories should conform to existing requirements as specified by law (RA 6541), “The National Building Code of the Philippines” and Presidential Decree 856, “Code of Sanitation of the Philippines”. The school should have adequate laboratory equipment and space for the following:

12.3.1 Fisheries sciences

12.3.2 Physical sciences

12.3.3 Chemical sciences

12.3.4 Biological sciences

12.3.5 Aquaculture laboratories

12.3.6 Post-Harvest laboratories

12.3.7 Capture Fisheries laboratories

The laboratory floor space should be at least 1.85 sq. m. per student.

12.4 Laboratory Equipment and Other Materials

The specific equipment/instrument and other materials needed are listed in the course specifications (Annex B).

12.5 Audio-Visual Equipment

12.6 Water and Power Supply

An institution should have its own electric power source if the source of electricity in the community is inadequate. A good source of water supply for school use is very essential.

12.7 Hatchery Pond Facilities

There should be an adequate hatchery and pond facilities, 50 percent of which should have been developed at the start of the program. For Aquaculture, the school should have at least one hectare hatchery pond.

Section 13 Admission and Retention

The basic requirement for eligibility for admission of a student to any tertiary level degree program shall be graduation from the secondary level recognized by the Department of Education. Higher Education Institutions (HEIs) must specify admission, retention and residency requirements. They should ensure that all students are aware of these policies.

ARTICLE VIII
TRANSITORY, REPEALING AND EFFECTIVITY CLAUSE

Section 14 Transitory Clause

HEIs that have been granted permit or recognition for Bachelor of Science in Fisheries Program are given three (3) years from the date of effectivity hereof to fully comply with all the requirements as stipulated in this CMO. Compliance to these requirements shall also be required to State Universities and Colleges (SUCs) and Local Colleges and Universities (LCUs). In the event that the HEI fails to comply, in which case, it is given a non-extendable period of two (2) years for compliance.

Currently enrolled students in the BS Fisheries program shall be allowed to graduate under the old curriculum. However, students enrolling for the above-mentioned programs beginning school year 2007-2008 shall be covered by this CMO.

Section 15 Repealing Clause

All pertinent rules and regulations or parts thereof that are inconsistent with the provisions of this policy are hereby repealed or modified accordingly.

Section 16 Effectivity Clause

This CMO shall be effective beginning SY 2007-2008 after publication in the Official Gazette or in a newspaper of general circulation.

Pasig City, Philippines October 16, 2006.

FOR THE COMMISSION

CARLITO S. PUNO, DPA
Chairman

ANNEX A

Commission on Higher Education
TECHNICAL PANEL FOR AGRICULTURE EDUCATION

Workshop to Update the Policies and Standards for BS Fisheries
June 23-24, 2005, Legend Villas, Mandaluyong City

A MATRIX OF DUTIES AND COMPETENCIES OF A FISHERIES TECHNOLOGIST

DUTIES	COMPETENCIES			
1. To communicate useful and relevant ideas and concepts	1.1 Employ latest information, computer technology (ICT) and other audio visual media in communication	1.2 Prepare basic communication, descriptive and narrative reports	1.3 Prepare technical reports and results of research studies using acceptable terms, language and format	1.4 Present oral reports in technical forums and clientele seminars/meetings using concise, correct and acceptable language
2. To maintain a high level of integrity and ethical standards	2.1 Set good example in work place and in the community	2.2 Dedication and commitment to work with honesty and integrity	2.3 Respect for Intellectual Property Rights (IPRs)	2.4 Practice the principles of good governance, professional and ethical standards
3. To demonstrate Organizational and Managerial Skills	3.1 Work effectively with a team	3.2 Earn respect of peers	3.3 Knowledge on project development and management	3.4 Appreciation on Networking and stakeholder involvement
4. To continually upgrade of knowledge and skills	4.1 knowledge of recent technological advances and innovations in	4.2 Ability to undergo advanced training	4.3 Ability to participate in scientific conferences, meetings and other	

	fisheries and related fields		related policies	
5 To understand and advocate policies and laws in fisheries and related environmental laws	5.1 Knowledge of fishery laws, rules and regulations and other related policies	5.2 Articulation of policies, rules and regulations in fisheries and related environmental concerns to various audience		
6 To conduct research	6.1 Ability to prepare research proposals	6.2 Ability to implement, monitor and evaluate projects	6.3 Ability to critically analyze and interpret research data	6.4 Ability to publish research output
7 To engage in entrepreneurial Fisheries activities	7.1 Formulate business plan	7.1 Demonstrate entrepreneurial skills	7.2 Sourcing of capital/investment	
8 To prepare project feasibility studies	8.1 Identify resource to be harnessed and corresponding technologies	8.2 Determine output targets and costs	8.3 Determine target beneficiaries	8.4 Prepare project feasibility report
9 Conceptualize and design fishery structures and facilities for translation into engineering plans	9.1 Characterize resources to be harnessed and corresponding technologies	9.2 Participate in crafting innovative fishery structures and facilities		

10 Promote the development and transfer of appropriate fishery technology	10.1 Knowledge on the appropriateness (technically, feasible, economically viable, socially acceptable and environmentally sound)	10.2 Adapt, demonstrate and transfer appropriate fishery technology	10.3 Evaluate the acceptance and adoption of technology	10.4 Utilize untapped aquatic resources with appropriate
11 Monitor, evaluate and manage aquatic health	11.1 Implement data gathering and profiling of the fisheries and aquatic environment	11.2 Use holistic approach in ecosystem assessment and prepare resource management plan	11.3 Implement, monitor and evaluate resource management plan in cooperation with stakeholders	11.4 Develop continuing monitoring and evaluation system for aquatic health management
12. To ensure product safety and quality	12.1 Knowledge in laws and regulations concerning standards and food safety	12.2 Ability to assess hazards in fish and fishery products	12.3 Design HACCP & GMP programs	12.4 Implement, monitor and evaluate quality management programs

Definition -

1. **Fisheries** is the science and practice that deals with the capture, culture, post harvest and marketing of aquatic plants and animals at sustainable levels for food security and economic benefits.

2. **Fisheries Education** is a program in preparing human resource in the science and practice that deals with the capture, culture, post harvest and marketing of aquatic plants and animals at sustainable levels for food security and economic benefits.

3. **Fisheries Technologist** a fisheries graduate who has passed the PRC licensure examination. (*PRC definition*)

ANNEX B

COURSE SPECIFICATION

A. PROFESSIONAL COURSES

Course Name	PROJECT DEVELOPMENT AND MANAGEMENT
Course Description	Preparation and development of project proposals, and management of projects
Objectives	1. To learn how to prepare and develop project proposals 2. To know stakeholders consultation and learn principles of risk analysis and management 3. To prepare objectives, methods, logical frame, time scheduling, budget preparation, and presentation of a project proposal 4. To become aware of management procedures in implementation of projects
Units For Lecture And Laboratory	3 units
Contact Hours Per Week	3 hrs lec/wk
Prerequisite/Co-Requisite	Third year student
Lecture Topics	1. Fundamentals of project preparation, project design and development of project proposals 2. Objectives, methodology, logical frame, budget preparation, time scheduling, and formatting of proposal 3. Presentation of project proposal 4. Management of projects
Textbooks and References	1. Angus, R.B. and Gundersen, N.A. Planning, Performing and Controlling Projects: Principles and Applications. 1997. Upper Saddle River, NJ: Prentice-Hall, 232 pp. 2. Badiru, A.B. and Pulat, P.S. Comprehensive Project Management: Integrating Optimization Models, Management Principles, and Computers. 1998. Upper Saddle River, NJ: Prentice-Hall, Inc., 548 pp. 3. MacArthur, J.D. Stakeholders Analysis in Project Planning: Origins, Applications and Refinements of the Method. 1997. Project Appraisal, 12(4): 251-265. 4. Spinner, M.P. Project Management: Principles and Practices. 1997. Upper Saddle River, NJ: Prentice-Hall. 5. Saldanhan, C. and Whittle, J., Using the Logical Framework for Sector Analysis and Project Design – A User Guide. 1998. Asian Development Bank, Manila, Philippines. 57 pp.

Course Name	FISHERIES ENTREPRENEURSHIP
Course Description	Principles and practices of forming and managing small and medium scale business fisheries enterprises with attention to individual, cooperative and people organization management.
Objectives	1. To provide students knowledge on formation and development of small and medium scale fisheries businesses 2. To know the requirements of registration and approval/permission of doing business 3. To learn organization and management of entrepreneurship in individual and group organization (cooperative/PO) 4. To learn financial accounting of small/medium scale fisheries enterprise
Units For Lecture And Laboratory	3 units
Contact Hours Per Week	3 hrs lec/wk
Lecture Topics	1. Principles and practices of small/medium scales fisheries businesses 2. Formation, organization and registration/approval of small/medium scale fisheries business 3. Establishment and management of fisheries cooperatives/people

	organizations 4. Financial accounting of small/medium scale fisheries enterprises 5. Field visits to fisheries enterprises and cooperatives
Textbooks And References	1. An Act Creating the Cooperative Development Authority (RA 6939). 2. Cooperative Code of the Philippines (RA 6938). 3. Business Opportunities for the Small Firm, Small Enterprises Research and Development Foundation (SERDEF) in cooperation with UP-ISSI 1990. (no paging). 4. Starting a Small Enterprise, Bureau of Small and Medium Enterprise Development (BSMED) and JICA, 34 pp. 5. Santiano, M.A., A. Bravo, and E. Bravo. 1985. You, Too, Can Start Your Own Business, SERDEF, 200 pp.

Course Name	FISHERIES EXTENSION
Course Description	Extension philosophy, organization and programming, methods and basic principles of extension program
Objectives	1. To know the fundamentals of fisheries extension 2. To design a fisheries extension program
Units For Lecture And Laboratory	3 units
Contact Hours Per Week	3 hrs lec/wk
Prerequisite/Co-Requisite	Junior Standing
Lecture Topics	1. National fisheries extension program 2. Methods and basic principles of extension program 2.1 Preparation and presentation of extension project 2.2 Preparation of extension materials 2.3 Training of extension officers 2.4 Organization and programming of extension activities 2.5 Preparation and presentation of extension report 2.6 Publication of extension report
Equipment	Audio-visual
Textbooks And References	1. Battad, T.T., P.S. Coloma, and A.S. Paderes. Agricultural Exension. 2003. Grandwater Publications, Makati City, Philippines. 224 pp. 2. Benor, D. and J.Q. Harrison. Agricultural Extension: The Training and Visit System. 1977. World Bank. 3. BFAR. (Undated). Fisheries Extension: A Handbook for Fishery Extension Specialists. Bureau of Fisheries and Aquatic Resources. Quezon City, Philippines. 46 pp. 4. Fontelar, P.F., M.M. Tayamen, and S.M. Hipolito (eds.). Philippine (BFAR) Aquaculture Extension (Vol. 1-Extension). 1984. Bureau of Fisheries and Aquatic Resources Freshwater Fish Hatchery and Extension Training Center in Cooperation with the United States Agency for International Development and the Texas A&M University. 117 pp.

Course Name	AQUACULTURE
Course Description	Principles, methods and developments in the culture of selected organisms in fresh, brackish and marine waters
Objectives	1. To know the fundamental principles of farming aquatic species 2. To gain knowledge on the various occupational opportunities in the aquaculture industry 3. To recognize the environmental issues pertaining to aquaculture 4. To develop an insight on the best practices in aquaculture
Units For Lecture And Laboratory	5 units (3 units lec; 2 units lab)
Contact Hours Per Week	9 hrs/wk (3 hrs lec; 6 hrs lab)
Prerequisite/Co-Requisite	Ichthyology

Lecture Topics	1. Brief history and development of aquaculture in the Philippines 2. Water resources for aquaculture in the Philippines 3. Principles of aquaculture 4. Natural food and fish production 5. Carrying capacity 6. Improvement of reproduction and selection and special cultivation techniques 7. Aquaculture systems
Laboratory Topics	1. Inventory of aquaculture technologies 2. Comparison of brackishwater and freshwater fishponds 3. Hands-on in fish culture
Equipment	Water parameter measuring instruments, microscope
Textbooks And References	1. Bardach, J.E., J.H. Ryther, Larney, M.C., O. Williams. 1972. Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms. 868 pp. 2. Huet, M. Textbook of Fish Culture, Breeding and Cultivation of Fish. 1972. 436 pp. 3. Pillay, T.V.R. Aquaculture: Principles and Practices. 1990. Fishing News Books. London. 575 pp. 4. Stickney, R.R. Principles of Aquaculture. 1994. John Wiley & Sons, Inc., New York. 502 pp.

	AQUATIC ECOLOGY
Course Description	Study of the aquatic ecosystems focusing on the chemistry, physics and biology of aquatic ecosystems
Objectives	1. To know the geology and origins of lakes 2. To learn the physical, chemical and biological properties of aquatic ecosystems 3. To know the interaction of the ecosystem in an aquatic ecosystem 4. To comprehend the tidal action, saltwater chemistry, and marine biology
Units For Lecture And Laboratory	5 units (3 units lec; 2 units lab)
Contact Hours Per Week	9 hrs/wk (3 hrs lec; 6 hrs lab)
Prerequisite/Co-Requisite	Biology, Chemistry I, Physics I, Zoology
Lecture Topics	1. Limnology and aquatic ecosystems 2. Lake geology and origins 3. Physical: Water, light, and heat in aquatic ecosystems and movement of water 4. Chemical characteristics of aquatic ecosystems 5. Biological: Organisms in aquatic ecosystems 6. Food chains and webs
Laboratory Topics	1. Lake /pond morphometry 2. Physico-chemical component 3. Biotic components of aquatic systems 4. Functioning of aquatic ecosystems
Equipment	Plane table alidade, oxygen/pH meter, Kemerer sampler, Engineers transit
Textbooks And References	Odum. Fundamentals of Ecology. 1971. (3rd ed.). W.B. Saunders Company/Topan Company, Philadelphia. 588 pp.

Course Name	AQUATIC RESOURCES
Course Description	Non-fish aquatic resources and their production and biology, fish habitats and their rehabilitation and aquatic ecology
Objectives	1. To know the classification of general biology, distribution and production of non-fish aquatic resources 2. To understand the concepts to conserve and manage non-fish aquatic resources including threatened and invasive species 3. To know the biology and production of non-fish aquatic resources

Units For Lecture And Laboratory	3 units
Contact Hours Per Week	5 hrs/wk (2 lec; 3 lab/field work)
Prerequisite/Co-Requisite	Aquatic Ecology
Lecture Topics	1. The value of aquatic resources 2. Human impacts 3. Evaluation of conservation interest 4. Protection and management 5. Sustainable resource use 6. Legislation
Laboratory Topics	Identification of non-fish organism
Equipment/facilities	Microscope, computer, collection of species
Textbooks And References	1. Knight, H.G. Managing the Sea's Living Resources: Legal and Political Aspects of High Seas Fisheries. 1977. 2. Maitland, P.S. and N.C. Morgan. Conservation Management of Freshwater Habitats: Lakes, Rivers and Wetlands. 1997. Chapman & Hall. London, UK. 233 pp.

Course Name	ICHTHYOLOGY
Course Description	Biology, classification and life histories of fishes with emphasis on commercial species
Objectives	1. To know the world of fishes 2. To know and understand the different external / Internal parts of fish 3. To understand the importance of maintaining a diverse fish population 4. To know the systematics of fishes
Units for Lecture and Laboratory	5 units (3 units lec; 2 units lab)
Contact Hours per Week	9 hrs/ wk (3 hrs lec; 6 hrs lab.)
Pre-requisite	Zoology
Lecture Topics	1. Introduction to the study of fishes 2. History of Ichthyology 3. Structures and Forms 4. Classification and evolution 5. Fish bio-diversity and the future of fishes 6. Relationship between fishes and man
Laboratory Topics	1. Examination of the anatomical parts of the fish (External/Internal) 2. Identification of different types of fish scales 3. Identification of Fishes 4. Demonstration of *Ex-situ* conservation
Equipment/facilities	1. Microscope 2. Stereoscope 3. Micro-projector 4. Dissecting Pans 5. Dissecting Sets 6. Multi-media Projector 7. Collection of fishes 8. Measuring devices 9. Vernier caliper
Textbooks And References	1. Bond, C.E. Biology of Fishes. 1979. W.B. Saunders Co., Philadelphia, USA. 513 pp. 2. Conlu, P.V. Guide to Philippine Flora and Fauna: Fishes (Volume IX). 1986. Natural Resources Management Center, Ministry of Natural Resources and University of the Philippines. 495 pp. 3. FishBase 2004 A Global Information System on Fishes. CD-ROM, WorldFish Center-Philippine Office, Los Baños, Laguna, Philippines, Published in July 2004. 4. Herre, A.W. Check List of Philippine Fishes. Research Report 20. 1953. United States Government Printing Office, Washington

	25, D.C., USA. 977 pp. 5. Jobling, M. Environmental Biology of Fishes. 1995. Chapman & Hall, New York, USA. 455 pp. 6. Lagler, K.F., J.E. Bardach, R.R. Miller, D. R. M. Passino. Ichthyology. 1977. John Wiley & Sons, New York. 506 pp. 7. Love, M.S. and G.M. Cailiet. 1979. Readings in Ichthyology. Goodyear Publishing Co., Inc., California, USA. 525 pp. 8. Moyle, P.B. and J.J. Cech. Fishes: An Introduction to Ichthyology. 1988. Prentice Hall, New Jersey, USA. 559 pp. 9. Samuel, E. and J.C. Underhill. How to Know the Freshwater Fishes (3rd ed.) 1978. Wm. C. Brown Co. Publishers, Iowa, USA. 215 pp. 10. Thamrongnasawat, T., A. Saisaeng, B. Temboonkiat and N. Sumanatemeya. 2004. Reef Fish of Thailand (Volume I). Baan Phra Arhit Publications, Bangkok, Thailand. 248 pp. 11. Villoso, E.P. Fishes of the Philippines: A Guide to the Identification of Families of Fishes Found in Philippine Waters. UPV-MNS Contribution No. 2. 2000. University of the Philippines in the Visayas, Mia-gao, Iloilo, Philippines. 132 pp.

Course Name	FISHERIES MANAGEMENT
Course Description	Principles and methods of managing and conserving fish resources in aquatic ecosystems.
Objectives	1. To study the principles and methods in managing and conserving in aquatic ecosystem 2. To apply management tools for a sustainable fishery 3. To integrate fisheries management in integrated coastal management
Units for Lecture and Laboratory	5 units (3 units lec: 2 units lab)
Contact Hours per Week	9 hrs/wk (3 hrs lec; 6 hrs lab)
Prerequisite	Statistics, Calculus, Ichthyology, Aquatic Resources
Lecture Topics	1. Resource Assessment 2. Code of conduct for responsible fisheries 3. Management Approaches 4. Integration of Fisheries Management and Integrated Coastal Management 5. Monitoring Control and Surveillance
Laboratory Topics	1. Field Survey 2. Data Analyses 3. Data Base Development
Equipment	Computers
Textbooks And References	1. Bennet, G.W. Management of Lakes and Ponds. 1970 Litton Educ. Publishing, Inc., London. 375 pp. 2. Karleskint, G. Jr. Introduction to Marine Biology. 1998. Saunders College Publishing, Philadelphia. 420 pp. 3. King, M. Fisheries Biology, Assessment and Management. 1995. Fishing New Books, Blackwell Science Ltd., London. 341 pp. 4. Kohler, C.C. and W.A. Hubert (eds.). Inland Fisheries Management in North America. 1993. American Fisheries Society. Bethesda, Maryland, USA. 594 pp. 5. Lagler, K.F. Freshwater Fishery Biology. 1975. W.M. C, Brown, Iowa. USA. 421 pp. 6. Maitland, P. S. and N.C. Morgan. Conservation Management of Freshwater Habitats 1997 (Lakes, rivers and wetlands). Chapman & Hall, London. 223 pp. 7. Mamaril, A. Freshwater Zooplankton in the Philippines. 1997 p. 2542. In Guerrero, R.D. et al (eds.) Aquatic Biology Research and Development in the Philippines (Proceedings of the First National Symposium-Workshop on Aquatic R & D, November

	28-29, 1995, Los Baños, Laguna: Philippine Council for Aquatic and Marine Research and Development, 150 pp. 8. Nielsen, L.A. and D. L. Johnson (eds.). Fisheries Techniques. 1983 American Fisheries Society. Bethesda, Maryland, USA. 468 pp. 9. Templeton, R.G. Freshwater Fisheries Management. 1995 (2nd ed.) Fishing News Books, Osney Mead, Oxford. 254 pp. 10. Welcomme, R.L. Inland Fisheries Ecology and Management. 2001. FAO/Fishing News Books Blackwell Science, Osney Mead, Oxford. 376 pp. 11. Zar, J.H. Biostatistical Analysis. 1974 Prentice-Hall, Inc., N.J., USA. 619 pp. 12. Department of Environment and Natural Resources (DENR), Department of Interior and Local Government (DILG), Department of Agriculture-Bureau of Fisheries and Aquatic Resources (DA-BFAR), and the Coastal Resource Management Project (CRMP). 1997. Legal and Jurisdictional Guidebook for Coastal Resource Management in the Philippines. Coastal Resource Management Project, Manila, Philippines. 196 pp.

Course Name	OCEANOGRAPHY
Course Description	Physical, geological, chemical and biological properties of marine waters, including their relationship to atmosphere
Objectives	1. To explain the physical, geological, chemical and biological properties of marine waters and their interactions and processes 2. To explain the effects of marine waters on the atmosphere
Units for Lecture and Laboratory	3 units
Contact Hours per Week	3 hrs lec/wk
Prerequisite	Calculus, Chemistry, Physics, Zoology, Botany
Lecture Topics	1. Geological 2. Physical (including Meteorology) 3. Chemical 4. Biological 5. Instrumentation 6. Sampling and Analyses
Textbooks And References	1. Brewer, Peter G. Oceanography: The Present and Future 2. Cracknell, A.P. Remote Sensing in Meteorology, Oceanography, and Hydrology 3. Cross, Grant M. Oceanography, A View of the Earth 4. Davis, Richard A. Jr. Principles of Oceanography 5. Dietrich, Gunter General Oceanography an Introduction. Second Edition (2 copies) 6. Drake, Imbrie, Knauss, Turekian. Oceanography 7. Fairbridge, Rhodes W. The Encyclopedia of Oceanography 8. Gibbs, Ronald J. Transport Processes in Lakes and Oceans 9. Horne, R.A. Marine Chemistry 10. I. Hela and Laevastu T. Fisheries Oceanography 11. Kraus, E.B. Modeling & Prediction of the Upper Layers of the Ocean 12. Lewis, Tony. Wave Energy 13. Loury, William. Weather on Life 14. Moiseev, P.F. Biological & Oceanographic Conditions for the Formation of Commercial Concentrations of Fish 15. Officer, R. Physical Oceanography of Estuaries 16. Parker S. Ocean and Atmospheric Sciences 17. Parsons, T.R. and Takahashi, M. Biological Oceanographic Processes

	18. Platt, T. et.al. Mathematical Models in Biological Oceanography 19. Pugh, D.T. Tides, Surges and Mean Sea-Level 20. Riley, J. and Skirrow, G. Chemical Oceanography Vols. 1, 2, 3 & 4 21. Ross, J. Oceanography 2nd Edition 22. Russel, F. and Yonge, M. Advances in Marine Biology Vol. 6 23. Sears, M. Merrinas. Oceanography the Past 24. Turekian, Karl. Oceans 25. Waves, Tides and Shallow Water Processes by Open University Course Team 26. Wells, N. The Atmosphere and Ocean 27. Weyl, P. Oceanography: An Introduction to the Marine Environment

Course Name	PHILIPPINE FISHING GROUND
Course Description	General survey of Philippine fishing grounds including the status of fisheries resources and their utilization
Objectives	1. To be knowledgeable on the conditions of Philippine fishing ground 2. To apply special analyses/tools to identify potential fishing ground in the Philippines
Units for Lecture and Laboratory	3 units
Contact Hours per Week	3 hrs lec/wk
Prerequisite	Senior standing
Lecture Topics	1. Geography 2. Bathymetry 3. Spatial Distribution of Aquatic Resources 4. Migration of Fishes 5. Hydro-acoustics
Equipment	1. Maps 2. Charts 3. GIS 4. Computers 5. GPS 6. Portable fish finders
Textbooks And References	1. Barnes, R.S.K. Coastal Lagoons 2. Barnes, R.S.K. The Coastline 3. Blecker, P., Dr. Weber and Dr. Beaufort. The Fishes of Indo-Australian Archipelago Vol. 1-11 4. Broad, Fishes of the Philippines 5. Burgess, Warren and Axelrod. Pacific Marine Fishes. Books 1 and 2 6. Clark, John. Coastal Ecosystem Management, A Technical Manual for the Conservation of Coastal Zone Resources 7. Gulland, J.A. The Fish Resources of the Ocean 8. Horden Jones, F.R. Fish Migration 9. Judd, S. Inshore Fishing Its Skills, Risks, Rewards 10. Nakamura, H. Tuna Distribution and Migration 11. Schroeder, R. Philippine Shore Fishes 12. Rothschild, B. Global Fisheries 13. Vous, Gilbert L. Cephalopods of the Philippine Islands 14. Zvereva, A. Geographical and Seasonal Variability of Marine Plankton

Course Name	CAPTURE FISHERIES
Course Description	Overview of Philippine Capture Fisheries (Municipal and Commercial) Classification of Fishing Gears; Materials for Fishing Gear Development of Fishing Gear Technology
	1. To know principles of fish capture and processes

Objectives	2. To identify and describe all fishing gears 3. To design, construct and maintain selective and appropriate fishing gears and methods 4. To know principles of fish capture and processes
Units for Lecture and Laboratory	5 units (3 units lec; 2 units lab)
Contact Hours per Week	9 hrs/wk (3 hrs lec; 6 hrs lab)
Prerequisite	Mathematics
Lecture Topics	1. Boat rigging and deck arrangement 2. Fish behavior towards fishing gear 3. Fishing Gear Types 4. Materials 5. Calculations 6. Responsible Fishing Operations 7. Selectivity 8. Ghost Fishing and Discards
Laboratory Topics	1. Gear Design and Construction 2. Model Experiments
Equipment	1. Line Gears and Fishing Nets 2. Traps 3. Test tanks
Textbooks And References	1. Bollis, L., Zadunaisky, J. and Gilles, R. Toxins, Drugs and Pollutants in Marine Animals 2. Bongis, Paul. Marine Plankton Ecology 3. Briggs, J. Marine Zoogeography 4. Cushing, H. Fisheries Biology: A Study in Population Dynamics 5. Demographic Change in Coastal Fishing Communities and Its Implications for the Coastal 6. Dyer, K. Estuaries: A Physical Introduction 7. Dunbar, M. J. Marine Production Mechanism 8. Friednick, A. Marine Biology 9. Gulland, J.A. The Management of Marine Fisheries 10. Gulland, J. A. The Fish Resources of the Ocean 11. Handbook on Selected Fishing Gears of the Philippines. BFAR 12. Harry Everhant, W., et.al. Principles of Fishery Science 13. Hedrick, Philip. Population Biology 14. Jones O. Biology and Geology of Coral Reef 15. Kinee. Marine Ecology I (Part I) 16. Koers, Albert W. International Regulation of Marine Fisheries 17. Kreuzer, Rudolf. Fishery Products 18. Laevastu T. and Hela I. Fisheries Oceqnography 19. Lagler, K., Bardach, J. and Miller, R. Ichthyology: The Study of Fishes 20. Lasker, R. Marine Fish Larvae 21. Lieth, H. and Whittaker, R.H. Primary Productivity of the Biosphere 22. Longhurst, A.R. Analysis of Marine Ecosystem 23. Marshall, N.B. Aspects of Marine Zoology 24. May, R.M. Theoretical Ecology 25. Moiseev, P.A. The Living Resources of the World Ocean 26. Nybakken, J. Marine Biology, An Ecological Approach 27. Peel Brahtz, J.F. Coastal Zone Management: Multiple Use with Conservation 28. Royce, William F. Introduction to the Fishery Sciences 29. Smith, D. A Guide to Marine Coastal Plankton and Marine Invertebrate Larvae 30. Tait, R.V. Elements of Marine Ecology 31. Vander Spoel S. and Heyman, R. A Comparative Atlas of Zooplankton

Course Name	POST-HARVEST FISHERIES
Course Description	Principles, methods and developments in fish handling on board fishing boats, preservation/processing, value addition, quality control, packaging,

	plant management and marketing of fish and fishery products.
Objectives	1. To understand the principles and methods in different post-harvest technologies 2. To develop the skills in the different processing methods 3. To apply the principles of quality control, packaging and marketing of fish and fishery products
Units For Lecture And Laboratory	5 units (3 units lec; 2 units lab)
Contact Hours Per Week	9 hrs/wk (3 hrs lec; 6 hrs lab)
Prerequisite/Co-Requisite	Microbiology, Analytical Chemistry
Lecture Topics	1. Traditional Methods a. Salting b. Drying c. Smoking d. Pickling/Marinating 2. Non-Traditional a. Less temperature (chilling, freezing) b. Thermal processing c. Mince fish processing d. Use of additional value additives e. Quality control packaging/marketing
Laboratory Topics	Experiment activities on traditional PHT and Non-Traditional PHT
Equipment	1. Salting Vat (Concrete) 2. Dryer (Artificial) or Solar Dryer 3. Smokehouses with trays 4. Kitchen Utensils/Measuring spoons and cups 5. Refrigerator 6. Freezers 7. Freezing Thermometer 8. Pressure Cooker 9. Can Sealer 10. Processing tables 11. Sensory table or booth (this could be improvised) 12. Microbiology glasswares 13. Packaging Materials 14. Plastic Sealer 15. Thermocouples 16. Tin Containers, Glass Jars 17. pH meter 18. Salinometer
Textbooks And References	1. Albastro, Estrella. Thermal Processing, Establishment of a Minimum Processing Requirement for Foods 2. Desrosier, N. The Preservation of Foods 3. Freezing Preservation of Foods Vols. 1-4 4. Hermes J.E. Fish Processing Technology in the Tropics. 1998, 2004 5. Hermes, J.E. Quality Assurance for Aquatic Products

Course Name	METEOROLOGY
Course Description	Elements of Weather - forecasting methods and techniques as applied to fisheries investigation
Objectives	1. To understand the climate of earth, the result of a complex interplay between living organisms, geologic processes, the oceans, and the atmosphere 2. To comprehend the different hydrologic cycle 3. To understand the techniques in predicting future hydrometeorological events
Units For Lecture And Laboratory	3 units
Contact Hours Per Week	3 hrs lec/wk
Prerequisite/Co-Requisite	Mathematics, Chemistry

Lecture Topics	1. Art and science of meteorology 2. Greenhouse effect and global warming 3. Heat balance and seasons 4. Convection and Archimedes' Principle 5. Coriolis force 6. Air masses and related weather 7. Weather forecasting 8. Satellite forecasting 9. Typhoons and Monsoons 10. Global warming 11. Hydrologic cycle
Textbooks And References	1. Battan, L.J. Fundamentals of Meteorology. 1979. Englewood Cliffs. New York. 2. Hammer, N.J. Hydrology of Water Resources. 1981. John Wiley and Sons. New York. 3. Moran, J.M. and Morgan, M.D. Meteorology: The Atmosphere and the Science of Weather. 1989. McGraw Hill. New York

Course Name	FISHERIES LAWS
Course Description	Laws, regulations, policies and orders affecting fisheries
Objectives	1. To know the laws, regulations, policies and orders affecting fisheries 2. To familiarize themselves with the current fishery laws 3. To apply the laws in the sustainable fisheries development
Units For Lecture And Laboratory	3 units
Contact Hours Per Week	3 hrs lec/ wk
Prerequisite/Co-Requisite	None
Lecture Topics	1. Philippine fishery laws 2. Fisheries Administrative Orders (FAO's) 3. Municipal Ordinances
Textbooks And References	1. R.A. 8435. Agriculture and Fisheries Modernization Act 2. R.A. 8550. Fisheries Code of 1998 3. BFAR FAO's

Course Name	SEMINAR
Course Description	Recent developments and other technological advancements in fisheries
Objectives	To familiarize themselves with the recent developments and technological advancements in fisheries
Units For Lecture And Laboratory	1 unit
Contact Hours Per Week	1 hr lec/wk
Prerequisite/Co-Requisite	Senior Standing

Course Name	RESEARCH DESIGN AND METHODOLOGIES
Course Description	An Introduction to scientific research and application of appropriate statistical tools to fishery research
Objectives	1. To develop proper work attitude in research 2. To learn how to prepare research proposals with appropriate research designs 3. To appreciate the relevance of statistical reasoning to fishery research and apply appropriate statistical tools 4. To acquire basic skills in the use of statistical software and in the interpretation of statistical result 5. To appreciate the need to publish
Units For Lecture And Laboratory	3 units
Contact Hours Per Week	5 hrs/wk (2 hrs lec; 3 hrs lab)
Prerequisite/Co-Requisite	Introduction to Statistics
Lecture Topics	1. Choosing a research problem 2. Literature search

	3. Experimental designs and appropriate statistical analysis 4. Data gathering 5. Manuscript writing and publication
Laboratory Topics	1. Computer session for selected softwares if computers are available 2. Interpretation of statistical results 3. Case examples of research design and analysis a. Aquaculture b. Capture Fisheries c. Aquatic Ecology d. Post-Harvest e. Fish Biology
Equipment	Computer and printer
Textbooks and References	1. Alberts B. & Shine K. 1994. Scientists and the Integrity of Research Science 266:1660-1661. 2. Day RA. 1994. How to Write and Publish a Scientific Paper. 4th ed. Oryx Press, Phoenix. 3. Freund JE & Simon GA. 1997. Modern Elementary Statistics. 9th ed. Prentice-Hall International, Inc., Singapore 4.Glover T & Mitchell K. 2002. An Introduction to Biostatistics. McGraw-Hill, USA. 5.Gomez KA & Gomez AA. 1984. Statistical Procedures for Agricultural Research. 2nd ed. John Wiley & Sons, Inc., Singapore. 6.Quin GP & Keough MJ. 2002. Experimental Design and Data Analysis for Biologists. Cambridge University Press, Cambridge. 7.Sokal RR & Rohlf FJ. 1995. Biometry: The Principles and Practice of Statistics in Biological Research. 3rd ed. W.H. Freeman and Company, New York. 8. Zar, J.H. Biostatistical Analysis. 1974 Prentice-Hall, Inc., N.J., USA. 619 pp.

B. ELECTIVE COURSES

Course Name	FISHERY PRODUCT ANALYSIS
Course Description	Principles and methods of physico-chemical and microbiological analysis of fish and fishery products
Objectives	1. To apply the principles and methods of product analysis 2. To identify and perform appropriate analytical methods for a specific fish/fishery product
Units for Lecture and Laboratory	3 units; (2 units lec; 1 unit lab)
Contact Hours per Week	5 hrs/wk (2 hrs lec; 3 hrs lab)
Pre-requisite	Microbiology, Analytical Chemistry
Lecture Topics	General methods of analysis of fish/fishery products
Laboratory Topics	Evaluation of fish/fishery product 1. Sensory 2. Chemical • Proximate composition, titrable acidity, TMA, TVN, Fiber/Carbohydrate, K-Value, histamine • Oil strength, rheological properties • Colorimetric method 3. Microorganisms of health significance • TPC, Fungal count, Coliform, MPN, Salmonella, S. aureus, Vibrio, etc.
Equipment	1. Proximate composition analysis apparatuses • Kjeldahl apparatus • Crude fiber analyzer • Crude fat analyzer • Oven

	2. Titration set-up 3. Histamine analysis apparatus 4. Flourometer 5. Spectrophotometer 6. Glasswares 7. Microbiological equipment
Textbooks And References	1. AOAC, Official Methods of Analysis. 2003 AOAC International, Washington DC. 2. Birch, G.G. and Lindley, M.G. Interaction of Food Components. 1986. Essex, England:Elsevier Applied Science Publishers, Ltd. 3. Davidek, J.J. Velisek and Pokorny J. Chemical Changes During Food Processing. 1990. Aricem: Czechoslovak Medical Press. 4. Richardson, T. and Finley, J.W. Chemical Changes in Food During Processing. 1985. Westport, Conn.:AVI Publishing Co., Inc. 5. Ross, T. and Summer, J. A Simple Spread-Shet Based, Food Safety Management Tools. 2002. International Life Sciences Institute (ILSI) Europe, Brussels, Belgium. 6. USFDA . Bacteriological Analytical Manual 2003. AOC, International, Washington, DC.

Course Name	FISH GENETICS AND BREEDING
Course Description	Application of the theories and principles of genetics to aquaculture
Objectives	1. To apply the principles of genetics as it relates to aquaculture 2. To estimate genetic parameters 3. To design a breeding program for a particular aquaculture species
Units for Lecture and Laboratory	3 units (2 units lec; 1 unit lab)
Contact Hours per Week	5 hrs/wk (2 hrs lec; 3 hrs lab)
Prerequisite	Statistics (Introduction to Statistics)
Lecture Topics	1. Principles of Qualitative & Quantitative Genetic 2. Hardy-Weinberg Equilibrium 3. Sex Determining Mechanism 4. Methods of Selection 5. Estimation of Genetic Parameters 6. Broodstock Management 7. Designing a Breeding Program 8. Biotechnology in Aquaculture 9. Preservation of Fish Genetic Materials
Laboratory Topics	1. Color Inheritance in Selected Fishes 2. Karyotyping in Selected Fishes 3. Breeding of Selected Fishes 4. Sex Determining Mechanism
Equipment/ Facilities	1. Tanks 2. Aquaria 3. Ponds 4. Microscope
Textbooks And References	1. Becker, Walter A. Manual of Quantitative Genetics (Fourth Edition). 1984. Academic Enterprises, Pullman, Washington. 190 pp. 2. Benzie, J.A.H. (Ed.). Genetics in Aquaculture VII. 2002. Elsevier Science Publishers, Amsterdam. 519 pp. 3. Crow, J.F. and Kimura, M. An Introduction to Population Genetics Theory. 1970. 4. Falconer, Douglas Scott. Introduction to Quantitative Genetics (Third Edition). 1989. Longman Scientific & Technical. 438 pp. 5. Gall, Graham A.E. and Chen, Hongxi. (Eds.). Genetics in Aquaculture IV. 1993. Elsevier Science Publishers, Amsterdam. 331 pp. 6. GIFT Technology Manual 2004. Sun Printers, Penang, Malaysia.

	56 pp. 7. Hartl, D.L. and Clark, A.G. Principles of Population Genetics. 1989. Henderson, Charles R. 1984. Application of Linear Models in Animal Breeding. University of Guelph. 423 pp. 8. Kapuscinski, Anne R. and Jacobson, Lawrence D. Genetic Guidelines for Fisheries Management. 1987. Minnesota Sea Grant, Minnesota. 66 pp. 9. King, Robert C. and Stansfield William D. A Dictionary of Genetics. 1990. Oxford University Press, New York. 406 pp. 10. Kinghorn, B., Vander Werf, J. and Ryan, M. (Eds). Animal Breeding: Use of New Technologies. The Post Graduate Foundation in Veterinarian Science of the University of Sydney. 308 pp. 11. Li, Ching Chun. Path Analysis - A Primer. 1986. The Boxwood Press, Pacific Groove, California. 347 pp. 12. Lutz, C. Greg. Practical Genetics for Aquaculture. 2001. Fishing News Books. 235 pp. 13. Tave, Douglas. Genetics for Fish Hatchery Managers. 1986. AVI Publishing Company, Inc., Westport, Connecticut. 299 pp. 14. Tave, Douglas. Selective Breeding Programmes for Medium-sized Fish Farms. 1995. Rome, FAO. 122 pp. 15. Van Vleck, L. Dale, Pollak, E. John and Oltenacu, E.A. Branford. Genetics for Animal Sciences. 1987. W.H. Freeman and Company, New York. 391 pp. 16. Weir, Bruce S. Genetic Data Analysis. 1990. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts. 377 pp. 17. Williams, George C. Adaptation and Natural Selection. 1966. Princeton University Press, Princeton, New Jersey. 307 pp 18. Williams, George C. Natural Selection. 1992. Oxford University Press, New York. 208 pp.

Course Name	MARICULTURE
Course Description	Application of principles and methods of aquaculture in marine waters
Objectives	To apply the principles and methods of aquaculture for sustainable and responsible mariculture
Units for Lecture and Laboratory	3 units (2 units lec; 1 unit lab)
Contact Hours per Week	5 hrs/wk (2 hrs lec; 3 hrs lab)
Prerequisite	Aquaculture
Lecture Topics	1. Opportunities and issues in commercial mariculture activities in the world 2. Site Selection 3. Species Evaluation 4. Mariculture Facilities & Equipment 5. Nursery Systems and Management 6. Growout systems and Management 7. Feeds and Feeding Management 8. Disease Prevention and Management 9. Sustainable Practices in Mariculture 10. Monitoring Environment Safety Parameters
Laboratory Topics	1. Construction of Mariculture Facilities and Equipment 2. Sampling and Growth Assessment 3. Monitoring of Environmental Quality 4. Zoning and Site Selection
Equipment/Facilities	1. Model cage facility 2. Water quality test kit 3. Current meters 4. Soil samplers 5. Water samplers 6. Diving gears

	7. Boat 8. Facilities for monitoring harmful organisms
Textbooks And References	1. Babaran, R.P., Ingles, J. A., Flores, N.C. Añasco, R.T. Martinez and Zamayla, M.E. 1997.The Mangrove Ecosystems of Guimaras Province, pp. 91-157. *In*: Babaran, R. P. and J. A. Ingles (eds.). Philippine Coastal Marine Habitats at Risk: A case study of Guimaras Inland. Institute of Marine Fisheries and Oceanology, University of the Philippines in the Visayas; UP Center for Integrative and Development Studies; and the University of the Philippines Press, Diliman, Quezon City. 2. Bagarinao, T. Ecology and Farming of Milkfish. SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines, 1999, 171 pp. 3. FAO. Management and Utilization of Mangrooves in Asia and the Pacific, Environment Paper 3, Food and Agriculture Organization of the United Nations, Rome, Italy, 1982, 160 pp. 4. Ong, J.E. Mangrooves and Aquaculture. Ambio:1982,11(5):p. 252-258. 5. Melana, J. Atachue III, Yao, C.E, Edwards, R., Melana, E.E. and Gonzales. Mangroove Management Handbook. 2000. Department of Environment and Natural Resources, Manila, Philippines through the Coastal Resource Management Project, Cebu City, Philippines. 96 pp. 6. NAMRIA. Predicted7 Tides and Current Tables. 2000. Oceanography Division, National Mapping and Resources Information Authority. DENR 7. Bureau of Fisheries and Aquatic Resources. 1998. R.A. 8550. Philippine Fisheries Code of 1998, BFAR, Department of Agriculture, Manila

Course Name	FISH HEALTH MANAGEMENT
Course Description	Identification, prevention, control of disease-causing organisms and other factors, and treatment of affected commercially important farmed species
Objectives	1. Identify organisms and other factors causing diseases to farmed species 2. Recommend preventive and control measure 3. Establish a management regime to maintain fish health
Units for Lecture and Laboratory	4 units (2 units lec.; 2 units lab)
Contact Hours per Week	8 hrs/wk (2 hrs lec; 6 hrs lab)
Prerequisite	Ichthyology, General Microbiology, Aquaculture
Lecture Topics	1. Basic Principles of Fish Health Management 2. Common Health Problem and Causes 3. Major Causal Organism of Fish Diseases 4. Fish Diagnostics 5. Approaches to Prevention and Control 6. Issues and Concerns on Fish Health Management 7. Environmental Factor
Laboratory Topics	1. Review of Fish Anatomy 2. Identification of Causal Organisms 3. Diagnostics 4. Prevention and Control
Equipment/Facilities	1. Microscope 2. Dissecting set 3. Haemacytometer 4. Water Quality Analysis Kit 5. Salinometer/Refractometer 6. pH meter 7. Secchi disc
Textbooks And References	1. Inglis, V. et. Al (eds.). Bacterial Diseases of Fish. 1993 2. Kabata, Z. Parasites and Diseases of Fish Cultured in the Tropics.

	1985. Taylor and Francis, London. 318 pp. 3. Meyer, F.P. et al. A Guide to Integrated Fish Health Management in the Great Lakes. 1983. 4. Roberts, R.J. (ed.). Fish Pathology. 1978. 5. Sindermann, C.J. Disease Diagnosis & Control in North American Marine Aquaculture. 1977. Elsevier Science Publishing Company Inc. Amsterdam, the Netherlands. 342 pp.

Course Name	FRESHWATER AQUACULTURE
Course Description	Application of principles, culture methods and developments in commercially important freshwater organisms
Objectives	To apply the principles and methods of aquaculture for sustainable and responsible freshwater aquaculture
Units for Lecture and Laboratory	3 units (2 units lec.; 1 unit lab)
Contact Hours per Week	5 hrs/wk (2 hrs lec; 3 hrs. lab)
Prerequisite	Aquaculture
Lecture Topics	1. Opportunities and Issues in Freshwater Aquaculture 2. Species Evaluation and Site Selection 3. Freshwater Aquaculture Facilities & Equipment 4. Culture of Food Fish and Ornamental Species and Management Practices • Nursery • Growout • Seed sourcing 5. Culture systems • Polyculture • Monoculture • Integrated farming system 6. Disease Prevention and Management 7. Sustainable Practices in Freshwater Aquaculture 8. Monitoring Environment Safety Parameters
Laboratory Topics	1. Pond preparation/proper positioning and installation of cages and pens 2. Fish stocking 3. Fertilization 4. Feeds and feeding 5. Fish stock sampling 6. Water quality assessment 7. Harvesting techniques
Equipment/Facilities	1. Ponds Tanks 2. Fish measuring board 3. Weighing Balance 4. Seine nets 5.Tubs 6. Hapa 7. Blowers 8. Tanks 9. Oxygen meter 10. Scoop nets
Textbooks And References	1. Eguia, R.V., Eguia, M.R.R., Basiao, Z.U., Simpleng Gabay sa Pagtitilapya: Pagpapaanak o Pagpaparami ng Tilapya. Aquculture Extension Manual No. 23. 2001. Aquaculture Department. Southeast Asian Fisheries Development Center (SEAFDEC), Tigbauan, Iloilo, Philippines. 2. Eguia, R.V., Eguia M.R.R., Tilapia Farming in Cages. Aquaculture Extension Manual No. 36. 2004. Aquaculture Department. Southeast Asian Fisheries Development Center (SEAFDEC), Tigbauan, Iloilo, Philippines.

	3. Dela Cruz, C.R., Lightfoot, C., Costa-Pierce, B.A., Carangal, V.R., Bimbao, M.A. (eds.) Rice-Fish Research and Development in Asia. 1992. International Center for Living Aquatic Resources Management (ICLARM) Conf. Proc. 24. 457 pp. 4. Garcia, L.M.B. (ed.) Responsible Aquaculture Development in Southeast Asia. 2001. Proc. of the Seminar-Workshop on Aquaculture Development in Southeast Asia, 12-14 October 1999. SEAFDEC, Tigbauan, Iloilo City. 274 pp. 5. Guerrero, R.D. Introduction to Fish Culture in the Philipines. 1981. Philippine Education Co., Inc., Q.C., Philipines. 69 pp. 6. Guerrero, R.D. A Guide to Tilapia Farming. 1997. Aquatic Biosystems, Bay, Laguna, Phil. 70 pp. 7. Guerrero, R.D. Tilapia Farming in the Philippines – A Success Story. 1994. APAARI Publication. FAO Regional Office for Asia & the Pacific, Bangkok. 15 pp. 8. Guerrero, R.D. (eds.). 100 Years of Philippine Fisheries and Marine Science. 1998. PCAMRD, Los Banos, Laguna. 210 pp. 9. Lannan, J.E., Smitherman, R.O., Tchobanglous, G. (eds.). Principles and Practices of Pond Aquaculture: A State of the Art Review. 1983. USAID Collaborative Research Support Program (CRSP) in Pond Dynamics/Aquaculture. Oregon State University, USA. 10. Mair, C.M. and Abella, T.A. (eds). Technoguide on the Production of Genetically Male Tilapia. 1997. Freshwater Aquaculture Center, Central Luzon State University, Science City of Munoz, Nueva Ecija, Philippines. 67 pp. 11. Pillay, T.V.R. Aquaculture: Principles and Practices. 1990. Fishing News Books. London. 575 pp. 12. Stickney, R.R. Principles of Aquaculture. 1994. John Wiley & Sons, Inc., New York. 502 pp.

Course Name	HATCHERY MANAGEMENT
Course Description	Fundamentals and techniques of fish breeding and propagation, hatchery and nursery operation and management of commercially important finfishes and invertebrates
Objectives	1. To breed and propagate finfish and invertebrates 2. To develop and manage broodstocks and seeds 3. To spawn, rear larvae and operate nursery/hatchery
Units for Lecture and Laboratory	3 units (2 units lec; 1 unit lab)
Contact Hours per Week	5 hrs/wk (2 hrs. lec;3 hrs. lab)
Prerequisite	Aquaculture
Lecture Topics	1. Fish Reproductive Biology 2. Broodstock Management 3. Natural and Artificial Breeding 4. Larval Rearing 5. Seed Production and Nursery Operation 6. Staffing and Operations of Hatchery and Facilities 7. Management Aspects: Record Keeping etc.
Laboratory Topics	1. Broodstock Selection, Handling and Conditioning 2. Production of Larval Food 3. Spawning Techniques 4. Nursery Operations 5. Hormone Augmentation (Sex Reversal Techniques)
Equipment/ Facilities	1. Aquaria 2. Tanks 3. Ponds 4. Hapas and Cages 5. Artificial Incubators 6. Hatchery shed/building

	7. Aeration system 8. Fry Collectors 9. Electric Generator 10. Fish Graders 11. Fish transport equipment and accessories 12. Refractometer 13. Compound Microscope
Textbooks And References	1. Bromage, N.R. and Roberts, R.J. Broodstock Management and Egg and Larval Quality. Blackwell Science Inc., Osney Mead, Oxford, England. 426 pp. 2. Corre, V. L. Milkfish Broodstock Management and Fry production in Tanks 3. Eguia, R.V., Eguia, M.R.R., Basiao, Z.U. Simpleng Gabay sa Pagtitilapya: Pagpapaanak o Pagpaparami ng Tilapya. 2001. Aquaculture Extension Manual No. 23. Aquaculture Department. Southeast Asian Fisheries Development Center (SEAFDEC), Tigbauan, Iloilo, Philippines 4. Emata, Marte and Garcia. Management of Milkfish Broodstock 5. Jhingran, V.G. and Pullin, R.S.V. A Hatchery Manual for the Common Chinese and Indian Major Carps. 1985. Asian Development Bank and the International Center for Living Aquatic Resources management. Philippines. 191 pp. 6. Lee, Su, Liao. Finfish Hatchery in Asia 7. Piper, P.G., McElwain, I.B., Orme, L.E., McCraren, J.P., Fowler, L.G. and Leonard, J.R. Fish Hatchery Management 1986. United States Department of the Interior Fish and Wildlife Service. Washington, D.C. 516 pp. 8. Primavera, J.H. Sugpo (Penaeus monodon) Brookstocks 9. Tave, D. Genetics for Hatchery Managers .2nd ed.. 1992. Van Nostrand Reinhold, New York. 430 pp. 10. SEAFDEC. Artificial Fertilization and Hatching of Milkfish or Sabalo Eggs 11. SEAFDEC. Handbook for the Training Course in Small-Scale Hatchery and Nursery Operations

Course Name	BRACKISHWATER AQUACULTURE
Course Description	Biological and culture potential of marine and brackishwater commercially important fishes & invertebrates. Present Status of mariculture and coastal aquaculture in the world; abiotic and biotic nature of coastal waters and environments; design of culture systems, with emphasis on cage and pen culture systems; economic analysis of production and profitability of brackishwater aquaculture
Objectives	To know and apply the principles and methods of brackishwater aquaculture
Units for Lecture and Laboratory	3 units (2 units lec; 1 unit lab)
Contact Hours per Week	5 hrs/wk (2 hrs. lec; 3 hrs. lab)
Prerequisite	Aquaculture
Lecture Topics	1. Culture Systems 2. Commercially Important Finfishes & Invertebrates 3. Coastal Waters and Environment 4. Status of Coastal & Mariculture in the World 5. Seed Supply 6. Pest and Predator Control 7. Production Management 8. Fertilization

Laboratory Topics	1. Culture Structure 2. Water Quality Analysis 3. Water Management
Equipment/Facilities	1. Pond 2. Aeration System 3. Feeders 4. Water Analysis Kit 5. Refractometer 6. DO meter
Textbooks And References	1. Baliao, D.D., M.A. de los Santos, E.M. Rodriguez, and R.B. Ticar. Grouper Culture in Brackishwater Ponds. 1998. Aquaculture Extension Manual No.24. Aquaculture Department, Southeast Asian Fisheries Development Center. Tigbauan, Iloilo, Philippines. 17 pp 2. Pillay, T.V.R. Aquaculture: Principles and Practices. 1990. Fishing News Books. London. 575 pp. 3. Stickney, R.R. Principles of Aquaculture. 1994. John Wiley & Sons, Inc., New York. 502 pp.

Course Name	AQUACULTURE ENGINEERING
Course Description	Application of engineering principles in aquaculture: site selection, survey methodology, designs, constructions, installation, operation and maintenance of aquaculture facilities
Objectives	1) To apply engineering principles to aquaculture 2) To design plan and lay-out an efficient, economical, environment friendly aquaculture facility
Units for Lecture and Laboratory	3 units (2 lec; 1 lab)
Contact Hours per Week	5 hrs/wk (2 hrs. lec; 3 hrs. lab)
Prerequisite	Plane Trigonometry, Physics, Aquaculture
Lecture Topics	1. Definition/Scope of Aquaculture Engineering 2. Site Selection and Survey (land soil and water investigations) 3. Design of Seed Production Facilities (land and water-based) 4. Design of Grow-Out Facilities (ponds, pens/cages, raceways, etc) 5. Construction, Operation and Maintenance of Aquaculture Facilities and Equipment
Laboratory Topics	1. Measurement of Distance (Pacing, Taping and Transit) 2. Measurement and Mapping of Land Areas as Fishpond Sites (Regular and Irregular Shape) 3. Differential and Profile Leveling 4. Topographic Mapping (Contour Leveling) 5. Measurement of Stream Water Current and Discharge 6. Soil Sampling and Texture Determination
Equipment/Facilities	1. Surveying equipment (transit, compass, etc.) 2. Global Positioning System (GPS) 3. Drafting/drawing table and accessories 4. Current meter 5. Soil analysis equipment (pH meter, soil)
Textbooks And References	1. Dela Cruz, Catalino R. Fishpond Engineering: A Technical Manual for Small-Scale and Medium Scale Coastal Fish Farms in Southeast Asia. SCS Manual No. 5, South China Sea Fisheries Development And Coordinating Programme, Manila 2. Huguenin, J. and Colt, J., Design and Operating Guide for Aquaculture Seawater System 3. Lawson, T.B., Fundamentals of Aquaculture Engineering 4. Morales, A.P. and Marquez, E.B., Philippine (BFAR) Freshwater Aquaculture Extension Training Manual, Vol. II: Fishpond Engineering 5. Yoo, Kyung H. and Boyd, Claude E., Hydrology and Water Supply for

	Pond Aquaculture 6. Wang, J. K. Techniques for Modern Aquaculture 7. Wheaton, F.W., Aquaculture Engineering

Course Name	FISH STOCK ASSESSMENT
Course Description	Methods in assessing the size and status of fish stock
Objectives	1.To collect and record fishery and biological data 2.To use data bases for storage, analysis and retrieval of fisheries data 3.To analyze interpret and draw conclusion from data collected
Units for Lecture and Laboratory	3 units (3 units lec)
Contact Hours per Week	3 hrs lec/wk
Prerequisite	Ichthyology, Math, Calculus, Statistics
Lecture Topics	1. Population Models 2. Survey Methods 3. Fish Base and Other Data Bases
Textbooks And References	1. Bell, Susan S.; Mc Coy, Earl D. & Mushinsky, Henry R. Habitat Structure 2. Burgess, Warren & Axelrod, Herbert Computation and Interpretation of Biological Statistics of Fish Population 3. Caswell, Hal Matrix Population Models 4. Computer Programs for Fish Stock Assessment 5. Demographic Change in Coastal Fishing Communities And Its Implications For The Coastal Environment 6. Delsman, H.C. Fish Eggs & Larvae From The Java Sea 7. Dudley, B. Mathematical & Biological Interrelations 8. Dunbar, M. J. Marine Production Mechanism 9. Eddie, G. Engineering, Economics & Fisheries Management 10. Fagerstorom, J. The Evolution of Reef Communities 11. Falconer, R.A. & Goodwin,P. Hydraulic & Environmental Modelling of Coastal, Estuarine & River Water 12. FAO Fisheries Tech. Paper: Introduction to Tropical Fish Stock Assessment Manual 1 Per Spiere 13. Forbes, S.T., Nakker, O. Manual of Methods for Fisheries Resource Survey and Appraisal (FAD) 14. Forstner-Wittman Metal Pollution in the Aquatic Environment 15. Giam, C.S. & H.K., Dou, M. Strategies and Advanced Techniques for Marine Pollution Studies: Mediterranean Sea 16. Gulland, J.A. Fish Population Dynamics 17. Johannses, C. & Sanders, J. Remote Sensing for resource Management 18. King, M. Fisheries Biology, Assessment and Management. 1995. Fishing New Books, Blackwell Science Ltd., London. 341 pp. 19. Levin, S. Lecture Notes in Biomathematics 20. Mariscal, R.N. Experimental Marine Biology 21. Megrey, et. al. Computers in fisheries Research 22. Nakamura, H. Tuna Distribution & Migration 23. Palmer, M.H. & Brown Joan Advances in Water Modelling and Measurement Ocean Circulation 24. Pauly, D. Fish Population Dynamics in Tropical Waters: A Manual For Use With Programmable Calculators 25. Pauly, D. Length Based Method in Fisheries Research 26. Pauly, D. & Martosubroto, P. Baseline Studies of Biodiversity: the Fish Resources of Western Indonesia 26. Platt, T. Mann, K. et.al. Mathematical Models in Biological Oceanography 27. Peel Brahtz, J. F. Coastal Zone Management: Multiple Use with Conservation 28. Ricker, W.E. Computation and Interpretation of Biology Statistics of

	Fish Populations 29. Siman, L. Thomas, A. et. al. Applied Mathematics Ecology 30. Growth and Regulation of Animal Population 31. Welcomme, R.L. Inland Fisheries Ecology and Management. 2001.FAO/Fishing News Books Blackwell Science, Osney Mead, Oxford. 376 pp. 32. Winberg, G. Methods for the Estimation of Production of Aquatic Animals

Course Name	MARINE MACHINERIES
Course Description	Operation and maintenance of marine as part of operation of marine engines, machineries and equipment in fishing vessels
Objectives	1.To be knowledgeable on the basic and operating principles of marine machineries 2.To implement simple maintenance procedures
Units for Lecture and Laboratory	3 units (3 units lec)
Contact Hours per Week	3 hrs lec/wk
Prerequisite	Mathematics, Physics
Lecture Topics	1. Principles of Operation Marine Engines 2. Fish Finding Operations 3. Fish Finding and Acoustic Instrumentation 4. Fishing Gear Machineries and Support Equipment
Textbooks And References	1. Czekaj, D. Engineering Applications: Hydraulics for Small Fishing Vessels. FAO Fisheries Technical Paper. 296. Rome, FAO 1989, 179 p. 2. London, D. Briggs & Stratton Small Engine Care and Repair: A Step-by-Step Guide To Maintaining Your Small Engine 3. Roth, A.C. Small Gas Engines: Fundamentals Sevice; Trouble Shooting, Repair, Applications 4. Urick, R.J. Principles of Underwater Sound

Course Name	NAVIGATION AND SEAMANSHIP
Course Description	Principles in navigation and application of marine rules and regulations of the road, seamanship skills and SOLAS
Objectives	1. To read nautical charts, accurately fix position and course direction for both coastal and off-shore waters 2. To operate a GPS for navigation 3. To apply the principles of seamanship
Units for Lecture and Laboratory	3 units (2 units lec; 1 unit lab)
Contact Hours per Week	5 hrs/wk (2 hrs lec; 3 hrs lab)
Prerequisite	Algebra, Trigonometry
Lecture Topics	1. Coordinate systems and maps 2. Plotting and position fixing 3. Coastal and celestial navigation 4. Seamanship
Laboratory Topics	1. Chart reading 2. Plotting 3. Coastal navigation 4. Celestial navigation 5. GPS
Equipment	1. Charts 2. Compass 3. Rulers 4. Triangles 5. Sextant

	6. GPS 7. Binoculars 8. Semaphore 9. Ropes and Tackles
Textbooks And References	1. Aizawa, et.al. Fishes Trawled Off Suriname and French Guianna 2. Blake, Gerald Maritime Boundaries and Ocean Resources 3 Berteax, H.O. Buoy Engineering 4. Cornell & Hoffman American Merchant Seaman's Manual 5th ed. 5. Datz,I.M. Power Transmission and Automation for Ships and Submersibles 6. Fin, D.B. Mechanization of Small Fishing Craft 7. Flores, E. Illustration of Japanese Fishing Boat & Fishing Gear 8. Iversen, E.S. Farming The Edge Of The Sea 9. Libert, L.; Maucorps, A. et. al. Mending of Fishing Nets 10. Merrit, J.H. Refrigeration of Fishing Vessels 11. Oliver, R.C. Trawlermen's Handbook 12. Pike, D. Fishing Boats and their Equipment 13. Rousmaniere, J. A Glossary of Modern Sailing Terms 14. Traung, Jan-olof Fishing Boats of the World 1 & 3 15. Traung FAO Fishing Boats of the World 16. Turpin, Edward A. & McEwen, William A. Merchant Marine Officer's Handbook

Course Name	FISHING SYSTEMS
Course Description	The principles and methods of fishing boat and gear design and construction
Objectives	1. To develop models of different fishing systems 2. To translate ideas into workable designs
Units for Lecture and Laboratory	3 units (2 units lec; 1 unit lab)
Contact Hours per Week	5 hrs/wk (2 hrs lec, 3 hrs lab)
Prerequisite	Mathematics
Lecture Topics	1. Review of Fishing Systems 2. Design Spiral 3. Fishing Gears Design 4. Fishing Boat Design 5. Fish Processing Facility Design 6. Culture Systems Design
Laboratory Topics	1. Gear Construction and Design 2. Model Experiments
Equipment	1. Fish Finder 2. GPS 3. Test tank 4. Computer
Textbooks And References	1. Allsopp, WHL Fishery Development Experiences 2. Baranov, G. Selected Works on Fishing Gear Vol. 3 3. Bradson, Peter Fishermen's Handbook 4. Connel, J.J. Advances in Fish Science & Technology 5. Cushing, D.H. Key Papers on Fish Population 6. Eddie, G.C.; Chaplain, P.D.; Kerr, N.M.; Waterman, J.J. The Stern Trawler 7. FAO Catalogue of Fishing Gear Designs 8. FAO Modern Fishing Gear of the World 2 9. Fishing Techniques Book 4 – 5 10. Flores, E. Fish Finding Purse Seining & Aimed Trawling 11. Flores, E. Illustration of Japanese Fishing Boat & Fishing Gear 12. Fridman, H. Circulation of Fishing Gear Designs 13. Gorner, John Modern Deep Sea Trawling Gear 14. Gorner, John Pelagic and Semi-Pelagic Trawling Gear

	15. Gorner, John How to Make and Set Nets 16. Homabe; Hamuro; Ogura Squid Jigging From Small Boats 17. Homabe, Motot, Hamuro, Chikamass & Ogura, Michio Squid Jigging from Small Boats 18. Judd, S. Inshore Fishing Its Skills, Risks, Rewards 19. Klust, Gerhard Fiber Ropes for Fishing Gear 20. Klust, Gerhard Netting Materials for Fishing Gear 21. Kristjonsson, Hilmar Modern Fishing Gear of the World 3 22. Libert, L.; Maucorps, A. et.al. Mending of Fishing Nets 23. Litaka, Y. Fishing Gear Technology 24. Nomura, M. et. al. Fishing Techniques 25. Oliver, R.C. Trawlermen's Handbook 26. Sainsbury, M. Industrial Fishery Technology 27. Sternin, V.G. Electricity Fishing: Theory and Practice 28. Thomson, D. Pair Trawling and Pair Seining 29. Von Brandt, A. Fish Catching Methods of the World 30. Yami Ben, M. Tuna Fishing With Pole And Line 31. Yami Ben, M. Fishing With Light

Course Name	FISH PROCESSING PLANT MANAGEMENT
Course Description	Organization and management of a fish processing plant, including waste management
Objectives	To discuss and apply the essential elements of a fish processing plant management
Units for Lecture and Laboratory	3 units (3 units lec)
Contact Hours per Week	3 hrs/wk lec
Prerequisite	Post-Harvest Technology
Lecture Topics	1. Basic Components and Principles of Plant Management a. Personnel Organization and Management b. Fish Processing Plant Lay-Out c. Unit Operations 2. Integrated Plant Survey and Assessment for Total Quality Management and Compliance with Laws and Standards 3. Fish Processing Plant Hygiene and Sanitation
Equipment	Access to a fish processing plant
Textbooks And References	1. Connell, J.J. Control of Fish Quality. 1975. The Whitefriars Press Ltd., London and Tonbridge. 2. Ibarra, P.I. Meat Processing for Small and Medium Scale Operations. 1993. UPCA. 3. Jouve, J.L., Stringer, M.F. and Baird-Parker, A.C. Food Safety Management Tools. 1998. International Life Sciences Institute (ILSI) Europe. Brussels, Belgium. 4. Stansby, M. Industrial Fishery Technology. 1963. Robert E. Krieger Publishing Co., Inc.

Course Name	MINOR FISHERY PRODUCTS AND BY-PRODUCT PROCESSING
Course Description	Principles and methods of utilizing minor fishery products and by-product processing
Objectives	1.To discuss the principles and methods of processing minor fishery products and by-products 2. To produce minor fishery products and by products
Units for Lecture and Laboratory	3 units; (2 units lec; 1 unit lab)
Contact Hours per Week	5 hrs/wk (2 hrs lec; 3 hrs lab)
Prerequisite	Microbiology, Post-Harvest Fisheries, Biochemistry

Lecture Topics	1. Distribution and Abundance of Minor Fishery Products and By-Products 2. Principles and Methods of Processing Minor Fishery Product and By-Products 3. Packaging, Storage and Marketing of Minor Fishery Product and By-Products
Laboratory Topics	1. Extraction of Marine Natural Products 2. Fish-Meal Products and By-Product Utilization 3. Processing of Aquatic Invertebrates 4. Waste, By-Catch and By-Product Utilization
Equipment	1. Marine Colloid Extraction Apparatus 2. Dryer 3. Double steamer 4. Grinder 5. Vertical cutter
Textbooks And References	1. Carpio, E.V. Engineering for Food Technologists. 2000. UPLB Publishing Center, UP Los Baños College, Laguna 2. Espejo-Hermes, J. Fish Processing Technology in the Tropics. 1998. Tawid Publications, Q.C., Philippines 336 pages. 3. Fellows, P. Food Processing Technology, Principles and Practices. 1988. Ellis Horwood Limited. West Sussex, England. 4. Qiason, S.N. and Ang, J.O. Indigenous Fermentations Theory and Practice. 1994. Phoenix Publishing House, Inc. Quezon City.

Course Name	FOOD ENGINEERING
Course Description	Applications of food engineering principles to fish processing operations
Objectives	1. To identify units of operations in processing fish and fishery products 2. To solve mass/energy balance problems in fish processing operations 3. To discuss the mechanism of heat transfer 4. To observe and appreciate the application of food engineering principles in a fish processing system
Units for Lecture and Laboratory	3 units (3 units lec)
Contact Hours per Week	3 hrs/wk (3 hrs lec)
Prerequisite	Post-Harvest Fisheries
Lecture Topics	1) Units of Operations 2) Dimensions and Units of Measurements 3) Material Balance in Fish Processing Systems 4) Energy Balance 5) Flow of Fluids 6) Heat Transfer 7) Design of Fish Processing Systems
Textbooks And References	1. Batty C. and Folkman S. Food Engineering Fundamentals. 1983. John Wiley and Sons 2. Brennan, J.G. et al. Food Engineering Operation. 1990. Elsevier Applied Science. London 700 pp. 3. Carpio, E.V. Engineering for food Technologist. 2000 UPLB 316 pp. 4. Heldman, D.R. Food Process Engineering. 1975. AVI Westport Connecticut 401 pp. 5. Sigh P. and Heldman D. Introduction to Food Engineering 2nd ed. 1993. Academic Press 499 pp. 6. Toledo, Romeo Fundamentals of Food Process Engineering. 1991. 2nd Ed. Van Nustrand Reinhold, New York.

Course Name	PRODUCT DEVELOPMENT AND VALUE ADDITION
Course Description	Concepts and methods of product development and value adding in traditional and non-traditional fish and fishery products including packaging, shelf life determination and test marketing
Objectives	1. To apply the principles of product development 2. To develop value added products
Units for Lecture and Laboratory	3 units (2 units lec; 1 unit lab)
Contact Hours per Week	5 hrs/wk (2 hrs lec; 3 hrs lab)
Prerequisite	Post-Harvest Technology
Lecture Topics	1. Product Concepts 2. Product Optimization 3. Packaging and Shelf-Life Determination 4. Cost Analysis of Value Added Products 5. Test Marketing
Laboratory Topics	Sample Product Development
Equipment	1. Fish processing equipment 2. Meat bone separator 3. Ice makers 4. Vertical cutter 5. Vacuum packaging equipment 6. Refrigerator and Freezer 7. Water activity meter 8. Moisture analyzer
Textbooks And References	1. Burgess, G.H.O., Cutting, C.L., Lovern, J.A. Waterman, J.J. Fish Handling and Processing. 1967. Chemical Publishing Co., Inc. 2. Espejo-Hermes, J. Fish Processing Technology in the Tropics. 1998. Tawid Publications, Q.C., Philippines. 336 pp. 3. Fellows, P. Food Processing Technology Principles and practices. 1988. Ellis Horwood Limited. West Sussex, England. 4. NSDB. Milkfish (Bangos) as Food, Handling, Freezing and Processing of Milkfish. 1978. National Science Development Board.

Course Name	POST-HARVEST HANDLING AND LOW TEMPERATURE PRESERVATION
Course Description	Principles and techniques of handling, chilling, freezing and cold storage of fish and other fishery products including handling and transport of live fish
Objectives	1. To apply the concepts and principles of post-harvest handling 2. To develop skills in post-harvest handling and low temperature preservation of fish and other fishery products
Units for Lecture and Laboratory	5 units (3 units lec; 2 units lab)
Contact Hours per Week	9 hrs (3 hrs lec; 6 hrs lab)
Prerequisite	Post-Harvest Fisheries
Lecture Topics	1. Fish as a Raw Material including Fish Composition 2. Post Mortem Changes of Fish and Fishery Products 3. Handling and Marketing of Live and Fresh Fish 4. Principles and Methods of Low Temperature Preservation 5. Biochemical Changes of Cold Stored Products 6. Parameters for Assessment of Frozen Products
Laboratory Topics	1. Handling of Live and Fresh Fish 2. Heat Transfer 3. Types of Cooling Systems 4. Types of Containers and Packaging Materials 5. Icing Techniques 6. Physico-Chemical Parameters of Iced/Chilled Fish 7. Glazing of Cold Stored Fish
Equipment	1. Freezer and Refrigerator

	2. Ice Maker 3. Container and Packaging Materials 4. Digital Freezing Thermometer 5. Glasswares 6. pH meter
Textbooks And References	1. Alabastro, E.F. Establishment of Thermal Processes for Food Products. 1987. UP College of Home Economics. 2. Alabastro, E.F.Thermal Processing of Philippine Foods Metal Containers. 1981. Technical Bulletin #1, NSDB-UP Project # 7402. 3. Espejo-Hermes, J. Fish Processing Technology in the Tropics. Tawid Publications, Q.C., Philippines, 336 pp. 4. Robinson, K.K. Microbiology of Frozen Foods. 1985. Elsevier Applied Science, New York. 5. Stuart, Thorne. Development in Food Preservation. 1989. Elsevier Applied Science.

Course Name	UTILIZATION OF SEAWEEDS AND ALGAE
Course Description	Utilization of seaweeds and algae for industry and direct human food; principles and methods of handling and processing, quality assurance and marketing
Objectives	1.To familiarize the students on the economic uses of seaweeds and algae 2.To be able to apply the principles and methods of processing seaweeds 3.To develop a product using local seaweed
Units for Lecture and Laboratory	5 units (3 units lec; 2 units lab)
Contact Hours per Week	9 hrs/wk (3 hrs lec; 6 hrs lab)
Prerequisite	Aquatic Resources, Post-Harvest Fisheries
Lecture Topics	1. Status of the seaweed industry in the Philippines 2. Composition of seaweeds and algae 3. Utilization of seaweeds and algae ▪ Direct human consumption; local and foreign ▪ Sources of colloids: applications in food industry, culture media, etc. ▪ Sources of pharmaceuticals/medicine, cosmetic ingredients, neutricals, food additives, etc. ▪ Raw materials for nata de coco and vinegar production ▪ Production of hormones and fertilizers 4. Principles and methods of handling, processing and value adding, quality assurance, packaging and standards 5. Standardization of the handling, preservation, and storage procedures for raw seaweed 6. Marketing and current issues
Laboratory Topics	1. Handling, transport and processing of Caulerpa, Codium, Porphyra, Gracilaria, Euchema, Hydroclathrus, Halymenia, etc. as food 2. The Spirulina Industry 3. The colloid industry: Extraction of agar, carrageenan, alginic acid, etc. 4. Application of colloids 5. Preparation of an herbarium of seaweeds and algae of economic importance 6. Field trip to seaweed farms and processing plants

Equipment	1. Kitchen equipment 2. Chest Freezer 3. Gelometer 4. Double Boiler 5. Grinder 6. Dryer 7. Wooden Freezer 8. Molding Trays 9. Colloid Cutter 10. Heat Sealer 11. Vacuum packing machine 12. Access to microbiology and chemistry laboratories
Textbooks And References	1. Hurtado-Ponce Extraction of Agar-agar 2. Santos, Gertrudes Processing of Gracilaria 3. Tanikawa, E. Marine Products of Japan. 1971. Tokyo: Koseisha-Koseidaku Company 4. Tressler & Lemon Marine Products of Commerce