

**Format CO
COURSE OUTLINE**

Introduction to Marine Science

Course Title

SC190

Dept. & Course No.

I. COURSE DESCRIPTION:

The purpose of this course is to provide an overview of the marine environment. It introduces general theory and principles in marine science covering the biological, chemical, geological and physical characteristics of the marine environment. Laboratory investigations of selected topics in the course content, which also include the use of scientific method, measurement, laboratory apparatus, and safety procedures, are an integral part of this course.

II. SEMESTER CREDITS:

4

III. CONTACT HOURS PER WEEK:

3

3

6

Lecture

Lab

Total

IV. PREREQUISITE: SC109 and SC120

V. STUDENT LEARNING OUTCOMES:

Upon completion of this course, student will be able, with 65% accuracy, to:

1. Describe evidence regarding the origin of the inhabitants of the Pacific Islands; summarize the exploration of the Vikings, including their settlement in North America.
2. Explain the importance of the voyages of Captain James Cook; discuss the significance of the Challenger Expedition; and describe how and why WWI and WWII were so important to the expansion of oceanography.
3. Explain the mechanism of submersibles and how they have increased our ability to explore the deep ocean.
4. Summarize scientific theories which explain the origin of the universe, our solar system, and the evolution of planet Earth—its composition and structure.
5. Discuss the origin of the Earth's ocean and how it is related to the origin of the Earth's atmosphere; explain the dynamics of ocean salinity over time
6. Describe the characteristics of living things and list the order in which they evolved
7. Summarize the following theories and describe supporting evidences, from both continents and oceans: Continental Drift, Sea Floor Spreading, and Plate Tectonics
8. Describe the three types of plate boundaries, identify sea floor features related to these boundaries, and include real-world examples
9. Compare and contrast features of passive and active

VI. COURSE CONTENT:

A. Introduction

1. History of Oceanography
 - a. Early Evidence of Ocean Travel
 - b. Development of Ocean Science
 - c. Twentieth Century Oceanography

B. Beginning of the Universe, Earth, and Life

1. Origin of the Universe
2. Origin of Our Solar System and Earth
3. Evolution of Earth's Structure and Composition
4. Origin of Ocean and Atmosphere
5. Origin of Life

C. Formation and Evolution of the Ocean Floor

1. Continental Drift
2. Theory of Plate Tectonics
3. Marine Geological Features
4. Marine Sediments

continental margins—continental shelf, continental slope, continental rise, submarine canyon, deep-sea fan, abyssal plains, volcanic peaks (abyssal hill or sea knolls), and ocean trench; relate these features to plate tectonics.

10. Describe the major features of the mid-ocean ridge: hydrothermal vents, oceanic ridges, oceanic rises, fracture zones, and transform faults; relate these features to plate tectonics
11. List the four types of marine sediments, explain their general composition, sources, and their main locations
12. Describe the structure and geometry of the water molecule, including bonds between hydrogen and oxygen atoms in a molecule of water and bonds between water molecules
13. Describe the following properties of water: surface tension, dissolving power, heat capacity, latent heat of melting and evaporating, and transparency to light
14. Describe seawater composition, distribution of salt in the ocean, and determine salinity seawater.
15. Describe the relationship between water's salinity and the following water properties: heat capacity, density, temperature of maximum density, freezing point
16. Describe effects of the following on seawater density: temperature, salinity, pressure, and combined effects of temperature and salinity
17. Identify the different types of ocean layering, and define pycnocline, thermocline, and halocline.
18. Explain how vertical structure of the ocean affects propagation of sound waves and light transmission
19. Describe the physical properties of the atmosphere including its composition, temperature, density, water vapor content, pressure, and movement
20. Summarize Earth's heat budget and explain why the atmosphere is heated primarily by re-radiation from Earth rather than by direct radiation from the Sun. Include in your discussion the greenhouse effect, greenhouse gases concentrations in the atmosphere and their relative contributions to global climate.
21. Explain how the Coriolis Effect influences moving objects in the Northern and Southern hemispheres, and discuss why the effect increases with increased latitude.
22. Explain how and why the atmosphere moves and describe the characteristics of Earth's major wind belts and boundaries;
23. Outline the global wind belts and boundaries on a world map and describe what controls them.
24. Diagram and discuss the Ekman spiral, Ekman

D. Physical and Chemical Properties of Water

1. Physical and Chemical Properties of Freshwater
 - a. Structure of Water Molecule
 - b. Unique Properties of Water

2. Physical and Chemical Properties of Seawater
 - a. Salinity
 - b. Density
 - c. Thermal Properties

E. Atmospheric Circulation and Ocean Currents

1. Atmospheric Circulation

- transport, and Ekman currents
25. On a base map of the world, plot and label the major ocean currents involved in the surface circulation gyres of the oceans; identify warm and cool currents, and indicate currents that are western intensified. Superimpose the major wind belts of the world on the gyres and describe the relationship between wind belts and currents.
 26. Describe density-driven thermohaline (deep-water) circulation.

2. Ocean Circulation

27. Discuss several different ways in which waves form. Explain how most ocean waves are generated.
28. Describe the formation and evolution of wind-generated waves. Include in your discussion the origin, movement across open water, and its termination when it breaks or releases its energy, either in the open ocean or against the shore.
29. Draw a diagram of a simple progressive wave and label the crest, trough, wavelength, wave height, and still water level.
30. Calculate the following characteristics of a wave: velocity, wavelength, steepness, period, and frequency
31. Describe how constructive and destructive interference affect wave
32. Describe the physical changes that occur in waves as they approach shore and break. Use examples to differentiate wave refraction, wave diffraction, and wave reflection
33. Describe seiches, tsunamis, and internal waves

F. Waves and Tides

1. Waves

34. Explain the causes of tides and discuss the importance of tides.
35. Draw the positions of the Earth-Moon-Sun system during a complete monthly tidal cycle. Indicate the conditions experienced on Earth, the phases of the Moon, the time between those phases, and syzygy and quadrature.
36. Diagram the Earth-Moon system's orbit about the sun. Label the positions on the orbit at which the Moon and Sun are closest to and farthest from Earth, stating the terms used to identify them. Discuss the effects of the Moon's and Earth's positions on Earth's tides.

2. Tides

37. Describe the adaptations that marine organisms have that allow them to live in the ocean.
38. Describe factors that affect primary production; describe measurement process involved in primary production
39. Summarize the three important biogeochemical cycles in the marine ecosystem: carbon, nitrogen, and phosphorus cycles
40. Compare biological productive of polar, temperate,

G. Life in the Sea

1. Adaptations of Organisms to the Marine Environment

2. Biological Production in the Oceans

- and tropical regions of the oceans. Consider seasonal changes, the development of thermocline, the availability of nutrients, and solar radiation.
41. Identify and describe the factors that control the distribution of marine organisms. Include in the discussion the influence of depth, latitude, and salinity on the distribution of organisms in the marine environment.
 42. Describe the key characteristics of three major domains of life—archaea, bacteria, and phytoplankton—and give examples from each domain that are key players in the primary production of the ocean environment
 43. Explain the ecological challenges faced by phytoplanktons
 44. Describe the different methods of studying phytoplanktons and measuring primary productivity
 45. Compare the macroscopic algae in terms of color, maximum depth in which they grow, common species, and size
 46. Differentiate between seaweeds and seagrasses.
 47. Characterize microscopic zooplankton, describe the three most important groups of microscopic zooplanktons (radiolarians, foraminifers, & copepods).
 48. Characterize macroscopic zooplankton, describe the important groups (planktonic mollusks, ctenophores, chaetognaths, appendicularians and salps, and ichthyoplanktons).
 49. Describe major characteristics and general biology of some of the common benthic and nektonic marine invertebrates, including evolution of body structures, locomotion, excretion, feeding, and reproduction
 50. Describe the major characteristics of and general biology of the three classes of fish and give examples of each: Jawless Fishes, Cartilaginous Fishes, Bony Fishes
 51. Discuss the following general biological processes and behaviors of marine fishes: respiration, osmoregulation, propulsion, shoaling and schooling, feeding, reproduction, growth and mortality, and migration.

3. Distribution of Marine Organisms

H. The Primary Producers

1. Phytoplankton
 - a. Archaea
 - b. Bacteria
 - c. Eukaryotic phytoplankton
2. Macroalgae
 - a. Green algae
 - b. Red algae
 - c. Brown algae
3. Seagrasses

I. Zooplanktons

1. Microscopic zooplanktons
2. Macroscopic zooplanktons

J. Marine Invertebrates

1. Benthos
 - a. Sponges
 - b. Sea anemones and corals
 - c. Bryozoa, phoronids, and brachiopods
 - d. Platyhelminthes, nemertians, and nematodes
 - e. Polychaete worms
 - f. Benthic mollusks
 - g. Echinoderms
 - h. Arthropods
2. Nektonic
 - a. Cephalopod molluscs

K. Fishes

1. 3 Classes of Fish
 - a. Agnatha (Jawless Fishes)
 - b. Chondrichthyes (Cartilaginous Fishes)
 - c. Osteichthyes (Bony Fishes)
2. General Biology of Marine Fishes

L. Marine Environments

52. Describe some adverse conditions of rocky intertidal zones, identify some organisms' adaptations to some of those adverse conditions, and identify the conditions that seems to be the most important in controlling distribution of life
53. Explain how estuaries originate, describe the four classes of estuaries based on origin, and described the four types of estuaries differentiated based on the way freshwater and seawater mixes
54. Identify and characterize the two most important coastal wetlands (salt marshes & mangrove forests) and explain why coastal wetlands are important
55. Describe conditions necessary for coral growth and coral reef formation, and explain the importance of coral reefs.
56. Describe the conditions of the deep-sea environment, and identify the types of biocommunities that exist on the deep-ocean floor.
57. Explain why global distribution of marine reptiles is restricted to the tropical latitudes
58. Describe the general biology of marine reptiles, sea birds, and marine mammals.
59. Describe the adaptive significance of salt glands and uric acid secretion for reptiles and birds feeding at sea.
60. Summarize the history of whaling and describe technological advances that enabled whalers to harvest whales at previously unprecedented rates; discuss international efforts to protect whales
61. Explain the primary features of the law of the sea treaty
62. Describe some of the problems with world fisheries and fisheries management
63. Summarize the key concepts of fishery science
64. Describe the characteristics of marine organisms that are favored in mariculture; explain the ecological and economical benefits of the aquaculture of marine species
65. Explain how marine pollution is defined; identify the main types of marine pollution; describe what people can do to prevent marine pollution; and discuss laws governing pollution in marine waters
66. Explain how global climate change, and depletion of ozone layer affect life in the ocean

1. Intertidal Zone
2. Estuaries
3. Salt Marshes
4. Mangrove Forests
5. Coral Reefs
6. Deep-sea Environment

M. Marine Reptiles, Birds, and Mammals

1. Marine Reptiles
2. Sea Birds
3. Marine Mammals
4. Whaling

N. Marine Fisheries and Aquaculture

1. Trophodynamics
2. Commercial Fisheries
3. Principles of Fishery Science
4. Current Status & Management of Fisheries
5. Marine Aquaculture

O. Human Impacts

1. Marine Pollution
2. Global Climate Change

VII. MATERIALS AND EQUIPMENT:

- A. Laboratory and related equipments
- B. Standard Classroom equipments
- C. Laptop
- D. Digital Projector
- E. White screen

- F. TV / VCR / DVD
- G. Underwater video/still camera

VIII. TEXTS AND REFERENCES:

Required Textbooks for Students:

Townsend, David W. Oceanography and Marine Biology: An Introduction to Marine Science. Sunderland, Massachusetts: Sinaur Associates, Inc., 2012

IX. METHODS OF INSTRUCTION:

A. 70% Traditional Classroom

- 1) All lectures
- 2) All laboratory sessions
- 3) All tests & quizzes
- 4) Symposium

B. 30% Non-traditional (Online)

- 1) One hour weekly for assignments
- 2) Online and research

X. METHODS OF EVALUATION:

A. Grade Components

Participation	10%
<ul style="list-style-type: none"> • Participation in lecture and lab discussions & investigations • Completing assignments on a timely manner 	

Tests & Quizzes	15%
<ul style="list-style-type: none"> • Unit tests • Chapter quizzes 	

Reports of Lab Investigations	25%
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Scientific Report of Research (Library or Field Investigation)	15%
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Oral Presentation of Research Findings	10%
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Final Exam, cumulative	25%
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B. Grading Scale

Percent	Letter Grade
90 - 100%	A
80 - 89%	B
70 - 79%	C
65 - 69%	D
0 - 64%	F

**Form NC-2
TASK LISTING SHEET**

SC 190 Introduction to Marine Science
Course No. & Title

Credits:

<u>3</u>
Lecture

<u>1</u>
Lab

<u>48</u>
Total Lab hrs

LAB TASKS

TOTAL HRS /
SLO

1. **(SLO #1 & 3) CONSTRUCT A HISTORICAL TIMELINE OF SIGNIFICANT EVENTS IN THE HISTORY OF OCEANOGRAPHY**
 - a. Construct a timeline on the major events in the historical development of marine science or oceanography
 - b. Conduct library and web search on modern technology that have contributed to advancements in the field of oceanography such as Remotely Operated underwater Vehicles (ROVs), and remote sensing using satellites 3
 - c. Conduct library and web search on the top 10 leading oceanographers and/or marine biologists of the 21st century. Describe their contributions and summary of significant research or discovery.
2. **(SLO #8 & 9) PROFILING OF THE DEEP OCEAN FLOOR:**
 - a. Use data collected from contour maps of the ocean floor and construct a computer-generated profile of the ocean floor of the Pacific Ocean basin and Atlantic Ocean basin. (preferably using Microsoft Office Excel)
 - b. Identify the different features of each ocean floor: continental shelf, continental slope, continental rise, submarine canyon, deep-sea fan, abyssal plains, volcanic peaks (abyssal hill or sea knolls), and ocean trench 3
 - c. Compare and contrast the features visible on the floor of the Pacific and Atlantic ocean basins
3. **(SLO #11) MATERIALS OF THE SEA FLOOR:** Observe the different types of sediments, determine calcium carbonate of different sediment samples, observe the diversity in sand size and relate this sorting to an indication of maturity, ability to support life, and the potential for erosion. 3
4. **(SLO #12-16) COMPARATIVE STUDY OF SEAWATER:** Analyze different parameters (temperature, density, salinity, pH, conductivity) of sea water from different locations (open ocean, estuary, river or lake) using tap water and/or distilled water as controls 3
 - a. Compare and contrast data from each test site.
 - b. Present analysis of data on a graph and report findings on similarities and/or differences in terms of the different parameters tested
5. **(SLO #23-25) CORRELATING MAJOR WIND BELTS AND SURFACE CURRENTS**
 - a. Outline the global wind belts and boundaries on a world map and describe what controls them.
 - b. Diagram and discuss the Ekman spiral, Ekman transport, and Ekman currents
 - c. On a base map of the world, plot and label the major ocean currents involved in the surface circulation gyres of the oceans; identify warm and cool currents, and indicate currents that are western intensified. Super impose the major wind belts of the world on the gyres and describe the relationship between wind belts and currents. 3
6. **(SLO #29, 30, 35, 36) WAVES AT SEA** Closely examine a wave and its identifying characteristics
 - a. Observe effects of wind speed on wind-generated waves
 - b. Draw a diagram of a simple progressive wave and label the crest, trough, wavelength, wave height, and still water level. 3
 - c. Collect data and calculate the following characteristics of a wave: velocity, wavelength, steepness, period, and frequency
7. **(SLO #35, 36) TIDES & CURRENTS** Demonstrate ability to use a tide table, graphing high and low tides in a calendar month, identify three types of tides and the cause of tidal variations, and identify the fluctuation in tidal current velocity as it relates to the duration of tides. 3
 - a. Use a tide table of the area to construct a graph of low and high tides for 30

- consecutive days with the date and time on the horizontal axis and the heights of tide on the vertical axis, and predict moon phases and determine the type of tide occurring.
- b. Calculate tidal frequency (amount of time between high and low tides) and tidal range (difference in heights between high and low tides) for a selected day of the month
 - c. Obtain a tidal current table that shows slack water times from your local weather station and determine points during the tide cycle where the maximum and minimum current velocity occur.
8. **(SLO #44, 47, 48) COLLECTION AND IDENTIFICATION OF PLANKTONS**
- a. Conduct a plankton tow, collect and preserve planktons from different aquatic and marine habitats (river, estuary, lagoon, protected bay at the rock islands, and open ocean) 3
 - b. Observe the planktons under a microscope, sketch the different samples viewed, and identify.
9. **(SLO #45, 46) COMPARISON OF PIGMENTS IN GREEN, BROWN, AND RED MACROALGAE**
- a. Collect different species representative of each of the different macroalgae
 - b. Identify, rinse, and prepare herbarium collection. Make sure to prepared proper labels and include collector's name, date and location of collection with genus identification 3
 - c. Use paper chromatography method, separate pigments from one green, one brown, and one red algae sample
 - d. Extract chlorophyll from algae samples, and use spectrophotometer to determine absorption spectrum for the chlorophyll extracted
10. **(SLO #49, 50) COMPARATIVE ANATOMY OF DIFFERENT MARINE ORGANISMS AND THEIR SPECIAL ADAPTATIONS**
- a. Perform the following dissections to compare anatomical structures and identify any specialized organs or features 9
 - a. Fish: Cartilaginous & Bony
 - b. Mollusca: Bivalvia & Cephalopoda
 - c. Arthropoda: Crustacea
 - d. Echinodermata: Asteroidea & Holothuroidea
11. **(SLO #52, 54 – 56, 62, 63) QUANTITATIVE ENVIRONMENTAL SURVEYING METHODS AND TECHNIQUES:** Select a marine environment study site that encompassing a rocky intertidal community, seagrass and soft sediment community, to a coral reef and/or hard bottom community and conduct a survey to determine the type of substrate and abundance and density of key species (seagrass, algae, corals and other invertebrates to be determined by instructor, fish) present in the area
- a. Identify and evaluate site to be surveyed by conducting a qualitative survey of the area using an underwater video camera 6
 - b. Locate and set GPS coordinates of study site
 - c. Give a general description of study site and construct a species list of the area
 - d. Conduct a quantitative survey using different accepted methods and techniques currently used by researchers
 - e. Calculate density and abundance of each species
 - f. Analyze data on graphs
 - g. Construct a database of all quantified data
 - h. Prepare a scientific report, reporting findings of your survey
12. **(SLO #63, 65, 66) SCIENTIFIC REPORT WRITING** Applying the most recent MLA writing guidelines, prepare scientific reports field investigations conducted this semester
- a. Submit scientific reports for all investigations completed this semester 3
 - b. Submit a scientific research paper on a marine science issue of your choice or expand on one of the field investigations conducted. Paper must be at least 5 pages long. You must use at least 3 different types of references that must be approved by course instructor.
13. **(Class Presentation)** Give an oral presentation of research project, not to exceed fifteen minutes and answer questions from audience. Format of presentation to be determined by course instructor. 3

COURSE LEARNING OUTCOMES
SC190 Introduction to Marine Science
PALAU COMMUNITY COLLEGE

During the course experience, the **course learning outcomes (CLOs)** will be assessed through the use of signature assignments. A rating scale will be used to determine the students' proficiency level of each CLO using specifically aligned assignments. The numerical ratings of 4, 3, 2, and 1 are not intended to represent the traditional school grading system of A, B, C, D, and F. The descriptions associated with each of the numbers focus on the level of student performance for each of the course learning outcomes listed below.

KNOWLEDGE OUTCOME RATING SCALE:

4—Accomplished 3—Competent 2—Developing 1—Beginning

CLO #1—KNOWLEDGE IN PHYSICAL OCEANOGRAPHY: Student demonstrates knowledge of basic physical oceanography concepts

4	Perform all of the following tasks with 90% accuracy or better: explain the historical development of oceanography; discuss the use of oceans as a source of food and energy; explain the formation of ocean basins and their geological features; identify and describe sources of sediments and their distribution in world oceans; explain causes and effects of water's unusual properties; examine the dynamic interaction between the atmosphere and ocean; identify and describe factors affecting the distribution of marine organisms; explain impacts of marine pollution on marine life; apply appropriate survey skills to investigate sources of pollution in the ocean, its impact on marine life, and generate a management plan to reduce pollutants in the ocean.
3	Complete all of the all of the above with 70-89% accuracy
2	Complete all of the above with 65-69% accuracy
1	Complete all of the above with less than 65% accuracy

CLO #2—KNOWLEDGE IN MARINE BIOLOGY: Student demonstrates knowledge of basic marine biology concepts

4	Perform all of the following with 90% accuracy or better: describe characteristics of living things; describe the adaptations that marine organisms have that allow them to live in the ocean; describe factors that affect primary production in the ocean; identify and describe the factors that control the distribution of marine organisms in the different marine habitats; describe major characteristics and general biology of some of the common planktons, algae & seagrasses, benthic and nektonic marine invertebrates, cartilaginous and bony fishes, common marine reptiles & mammals, and sea birds. Include in discuss the evolution of body structures, specialized organs, locomotion, excretion, feeding, and reproduction.
3	Complete all of the above with 70-89% accuracy
2	Complete all of the above with 65-69% accuracy
1	Complete all of the above with less than 65% accuracy

CLO #3—SCIENTIFIC INVESTIGATION: Student designs an experiment to investigate a marine habitat and able to determine appropriate scientific techniques in field investigations to answer a question, gather and analyze data, and report findings.

4	Perform all of the positive features of proficiency in scientific investigation by completing all of the following: research question(s) and goals(s) of investigation are original, reflecting an in-depth knowledge of content area, and consider an issue(s) that previous student investigations did not address; review of background information provided considers both confirmatory and disconfirmatory evidence of ideas, and refutes competing explanations of findings; procedures or method of investigation was sufficient to answer all research questions and reflects a sophisticated understanding of investigative processes; analysis strategy has depth and may consider material from content areas outside of main focus of questions and goal(s) of project; provides a convincing conclusions drawn from current investigation; proposed generalized statements related to area of investigation (demonstrates an understanding of theory as well as how to apply it beyond the current project)
3	Complete all of the above with 70-89% accuracy
2	Complete all of the above with 65-69% accuracy
1	Complete all of the above with less than 65% accuracy

CLO #4—RESEARCH SKILLS (WRITTEN COMMUNICATION): Students actively learn outside of the classroom and demonstrates ability to conduct research

4	Exhibit ability to perform all of the following tasks with 90% accuracy or better: locate, select, and prioritize appropriate literature and other sources outside of the classroom to analyze and examine a question or solve a problem; correctly interprets information; analyzes information, creatively propose original ideas to mitigate the problem and future prevention strategies, and draws conclusion based on research; written scientific paper integrates presently accepted MLA writing guidelines
3	Complete all of the above with 70-89% accuracy
2	Complete all of the above with 65-69% accuracy
1	Complete all of the above with less than 65% accuracy

Competency #5 KNOWLEDGE SHARING (ORAL COMMUNICATION), and/or KNOWLEDGE APPLICATION: Student shares knowledge to diverse audience presenting results of investigation to a local audience and engages in community activities to promote awareness of the research and/or other marine science issues at the local level.

4	Demonstrate ability to complete all of the following tasks with at least 90% accuracy: presentation covers in-depth all of the required contents with details and localized examples; all information is organized in a logical and clear way; project includes basic information that audience gain a comfortable understanding of the topic; presentation demonstrates creativeness and inventiveness of student; student voluntarily engages in community activities to promote awareness of a marine science issue or participates in field investigation to find solutions to local marine science issue.
3	Complete all of the above with 70-89% accuracy
2	Complete all of the above with 65-69% accuracy
1	Complete all of the above with less than 65% accuracy