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Course Outline for GEOL 12

INTRODUCTION TO OCEANOGRAPHY

Effective: Fall 2010

I. CATALOG DESCRIPTION:
GEOL 12 — INTRODUCTION TO OCEANOGRAPHY — 3.00 units

Introduction to the oceans, the history of oceanic science, instrumentation and exploration; marine geology including plate tectonics and shoreline processes; physical and chemical properties of sea water; causes and effects of currents, tides, and waves; introduction to the basic types of marine life, the basic marine habitats and ecosystems; distribution of marine resources and the Law of the Sea.

3.00 Units Lecture

Grading Methods:
Pass/No Pass

Discipline:

	MIN
Lecture Hours:	54.00
Total Hours:	54.00

II. NUMBER OF TIMES COURSE MAY BE TAKEN FOR CREDIT: 1

III. PREREQUISITE AND/OR ADVISORY SKILLS:

IV. MEASURABLE OBJECTIVES:

Upon completion of this course, the student should be able to:

1. explain the scientific method; and to be able to differentiate facts from theories;
2. discuss and explain the history of oceanic science, instrumentation and exploration;
3. recognize basic marine geography and identify the location of the oceans and major seas of the world and their relative areas;
4. explain and discuss the common theories regarding the formation of the Earth, its atmosphere, oceans and internal layers;
5. discuss the evolution of Plate Tectonic Theory in the history of oceanic science;
6. analyze and discuss the evidence for Plate Tectonics and to apply plate tectonics to the interpretation and analysis of basic marine geologic features including sea floor spreading, subduction, fracture zones, etc.;
7. recognize and identify basic sea floor geomorphology and basic bathymetric features; including ridges, trenches, shelf, slope, rise, abyssal plains, seamounts, guyots, submarine canyons, etc.;
8. explain and discuss sonar and sea-floor seismic reflection interpretation and calculations; including depth to the bottom of the ocean and thickness of sea floor strata;
9. identify and explain basic sea floor geology; including the basic types and origins of marine sediments;
10. explain and identify reef and limestone formation; including barrier reefs, fringing reefs and atolls;
11. interpret basic island geology based on an island's plate tectonic and latitudinal location;
12. explain and discuss the variations in temperature, density, and salinity of selected regions of the oceans; and to discuss and analyze the effects these factors have on the distribution of marine life forms;
13. discuss and explain the basic physics of seawater; including color and light, refraction, sound, density, pressure with depth, etc.;
14. explain and discuss the formation and effects of waves, tides, and currents;
15. explain the fundamentals of the formation and processes of beaches, reefs, bays, and estuaries;
16. recognize the morphology of the basic types of sea life;
17. identify and explain the basic oceanic habitats and ecosystems and how marine life cope with the physics and chemistry of seawater; including cetacean sonar, osmoregulation, the Deep Scattering Layer, etc.

V. CONTENT:
- A. Introduction
  1. The History of Oceanic Science
     - a. Exploration and discovery of the Oceans.
     - b. Oceanic instrumentation; history and development
  2. Geography and Basic Facts of the oceans and seas
     - a. Areal % of globe
     - b. Major oceans and seas
     - c. Depth; maximum and average
  3. Basic Oceanic Units and Systems
     - a. Fathoms
     - b. Leagues

c. Knots
d. Nautical miles
e. Latitude and longitude

B. Formation of the Earth and the Universe
1. Concept of Theory vs. Fact
2. The Scientific Method
3. The Big Bang
4. The formation of the Solar System
5. The formation of the Earth's
a. Early crust, continents and ocean floors
b. Early mantle and core
c. Lithosphere and asthenosphere
d. Early atmosphere
e. Early oceans (where did the water come from?)
f. How did seawater become salty?

C. Plate Tectonics
1. Evidence for and evolution of Plate Tectonic Theory
a. Evidence for Continental Drift
1. Continents as jigsaw puzzle
2. Fit along continental shelves
3. Evidence from rocks
4. Evidence from fossils
5. Evidence from paleoclimates
6. Evidence from mountain ranges
b. Ocean Floor evidence & discoveries
1. Bathymetry: Mid-Oceanic Ridge (MOR)
2. Magnetic stripes
3. Apparent Polar Wandering
4. 1968 Deep Sea Drilling Project
5. Ocean floor rocks too young
6. 90% of sediment missing
7. MOR is a volcano
8. MOR is rifting
c. Sea Floor Spreading
2. Impact of Plate Tectonic Theory to the fundamentals of global geologic interpretations
a. Three Types of Plate Edges and their geologic features: volcanoes, earthquakes, etc.
1. Convergent
2. Divergent
3. Transform
b. Hot Spots
c. Identification and analysis of global geologic features using Plate Tectonic Theory
1. Trenches
2. Mountains
3. Volcanoes
4. Earthquakes
5. Plate edges
d. Theories of Driving Mechanisms for Plate Tectonics
1. Mantle Convection, etc.
2. Discussion of Theory vs. Fact in science
e. Crustal deformation and mountain building
f. Supercontinents and Plate Tectonic reconstructions

D. Marine Geomorphology and Geology
1. Mid-Oceanic Ridge system
a. Central rift valley; graben
b. Fracture zones
c. Volcanic activity
d. Seismic activity
e. East Pacific Rise vs. the Mid-Atlantic Ridge
2. Trenches
3. Continental Shelf, Slope, Rise and Abyssal Plain
a. Underlying bedrock composition
b. Correlation with sea level changes
c. Sediment composition and size
d. Turbidites
e. Graded bedding
4. Submarine Canyons
a. Correlation with sea level changes and the geology of the continental shelves
5. Seamounts and Guyots
6. Aseismic Ridges; including the 90 East Ridge

E. Sea Floor Geology
1. Oceanic Crust
a. Four Basic Layers
1. Marine sediments
2. Pillow basalts
3. Sheeted dikes
4. Gabbros
5. Obduction and ophiolites
6. Genesis and formation of the four major layers at the MOR
b. Hydrothermal Vents
1. Mineral composition and geologic formation
2. Marine life communities and chemosynthesis
3. Applications to theories of the formation of life on earth
2. Seismic Reflection and Refraction
a. Determining the depth of the ocean from real echo sounding records
b. Interpretation of Sea Floor Seismic Refraction Records
1. Identification of and calculation of the water depth
2. Identification of sea floor sediments and bedrock
3. Calculation of sea floor sediment thickness
3. Seamounts, Guyots and Oceanic Volcanoes
a. Shield Volcanoes

1. Hot spots and the mid-oceanic ridge
2. Basaltic, mafic lava
3. Type of eruptions and types of volcanic features

b. Composite Volcanoes
1. Subduction zones/trenches
2. Sialic/felsic lavas; rhyolite and andesite
3. Type of eruptions and types of volcanic features

c. Cinder Cones
1. Type of eruptions and types of volcanic features

F. Marine Sediments
1. Clastics (lithogenic/terrigenous)
a. Conglomerate
b. Sandstone
c. Mudstone
2. Biogenic (biogenous)
a. Oozes; calcareous and siliceous
b. Oil and gas formation and probable locations
c. Microplankton
1. Chemistry of shell; SiO_2 or $CaCO_3$
2. Phytoplankton or zooplankton
3. Diatoms
4. Radiolarians
5. Coccolithophores
6. Foraminifera
7. Dinoflagellates
8. Chalk and the White Cliffs of Dover
9. Other microplanton at the instructor's discretion

d. Limestone
1. $CaCO_3$
2. Aragonite
3. Coquina
4. Chalk
5. Reaction to weak hydrochloric acid
6. Softer than glass (hardness less than 5.5)

e. Chert
1. SiO_2
2. Harder than glass (hardness greater than 5.5)

3. Precipitated (hydrogenous)
a. Manganese nodules
b. Black smoker chimney sulfides
c. Evaporites
d. Carbonates; including Tufa Towers
e. Chert
f. Phosphorous Nodules
g. Glauconite Green Sands
4. Cosmic (cosmogenous) = meteorites
5. Continental Margin vs. Deep Sea Sediments and Sedimentation Processes
6. Carbonates
a. Origin; biological or precipitated
b. Coral Reefs
1. Formation and growth of a coral reef (mitosis)
2. Formation and establishment of new coral reefs (meiosis)
3. Environmental requirements
4. Basic types of coral reefs
a. Fringing reefs
b. Barrier reefs (including the Great Barrier Reef)
c. Atolls

c. The Calcium Carbonate Compensation Depth
1. Deposition of limestone on the ocean floor

G. Shoreline Geology
1. Wave Erosion
a. Refraction
b. Sea cliff retreat
c. Wave base and wave-cut terraces and marine terraces
2. Beaches
a. Origin and genesis of different types of beach sand
b. Longshore transport
c. Groins, jetties and breakwaters
d. Beach engineering
1. Case study: Santa Barbara
e. Spits, baymouth bars, tombolos, barrier islands
3. Comparison of coastlines
a. Atlantic and Pacific Coastlines
b. Emergent and submergent coastlines
c. Active and passive plate tectonic margins and coastlines
4. Estuaries, Bays and Salinity
a. Estuarine circulation and stratification
b. Mediterranean circulation
5. Deltas
6. Wetlands

H. Island Geology
1. Volcanic
a. Basalt/shield volcanoes and the MOR and Hot Spots
b. Composite/sialic volcanoes and subduction zones
2. Limestone, Keys, Cayes, Atolls and Blue Holes
3. Barrier Bars/Barrier Islands
4. Continental/Sialic Islands on continental shelves, or tectonically separated from continents
5. More Complicated Islands (e.g., Japan and New Zealand)

I. Seawater Physics and Chemistry & The Effects on Marine Life
1. The Water Molecule

a. Structure and geometry
b. Polarization
c. Surface tension
d. Universal Solvent

2. Density of Water compared to air 800:1
    a. Effects on marine life
    b. Pelagic vs. benthic
    c. Buoyancy: 3-D environment
    d. Sessile animals common
    e. Pelagic plants
3. Heat Capacity
    a. Onshore and Offshore Breezes
4. Water Density Anomaly
    a. Ice Floats
    b. Density of Ice = 90% Density of Liquid Water
5. Light & Color
    a. Reflection
    b. Absorption
        1. By wavelength
        2. Why does tropical seawater appear blue to someone underwater?
    c. Color of ocean and productivity and content of the water
        1. Clear
        2. Clear and blue
        3. Murky green
        4. Brown
        5. Red tides
    d. Visibility: horizontal and vertical
    e. Light zones: euphotic, disphotic, aphotic
    f. Provinces
        1. Neritic
        2. Oceanic
            a. Epipelagic
            b. Mesopelagic
            c. Deep scattering layer
            d. Bioluminescence
            e. Eye sensitivity
            f. Abyssopelagic, bathypelagic and hadal zones
            g. Productivity
            h. Type of life and adaptations
    g. Refraction
        1. Normal
        2. Magnification
        3. Refraction ray diagrams
6. Temperature & Density
    a. Changes with depth
    b. Thermocline & pycnocline
    c. Mixing barrier, upwelling and biological productivity with latitude
7. Buoyancy
    a. Archimedes Principle
    b. Plimsoll lines
8. Pressure
    a. Changes with depth
    b. Calculation of pressure at depth
    c. Diving physics
        1. Decompression sickness (DCS) = the bends
        2. Nitrogen narcosis
    d. Marine life adaptations to pressure changes: swim bladders
9. Salinity
    a. Average salinity of seawater
    b. Parts per thousand
    c. Constancy of Composition
    d. Changes with depth
    e. Haloclines
    f. Changes with latitude
    g. Sea ice formation
    h. Osmoregulation
10. Sound
    a. Why is sound often more useful underwater than in air?
    b. Speed of sound in water
    c. Determining directions to sound sources underwater
    d. Shadow zone (afternoon effect)
    e. SOFAR channel
    f. Marine life adaptations
        1. Lateral lines
        2. Cetacean sonar

J. Wind Patterns and Causes
1. What causes wind? (air movement)
    a. Convection
    b. Coriolis effect
2. The Major Wind Belts
3. Cyclones, Hurricanes and Typhoons
4. Weather Fronts on weather maps

K. Oceanic Circulation
1. Horizontal Circulation
    a. Gyres
    b. Ekman Spiral
    c. Geostrophic currents
    d. Westward intensification
    e. The major ocean surface currents
        1. Atlantic

2. Pacific
3. Antarctic
    a. Polar Easterlies: East Wind Drift
    b. Antarctic Circumpolar Current: West Wind Drift
4. Indian
    a. Seasonal monsoons

2. Vertical Circulation
    a. Wind-induced; upwelling and downwelling
    b. Thermohaline

L. El Nino
M. Waves
1. Deep water waves
2. Wave anatomy
3. When does a wave break?
4. When does a wave 'feel' the bottom?
5. Fully developed sea
6. Fetch
7. Swell
8. Surface waves
9. Body waves
10. Tidal waves
11. Bow waves
12. Interference
13. Standing waves
14. Rogue waves
15. Surf
16. Wave refraction

N. Tides
1. Typical tidal ranges and periods
2. Basic theories and causes of the tides
3. Relationships and correlations with the phases of the moon
4. Types of tides:
    a. Diurnal, semi-diurnal and mixed
    b. Spring and neap tides
5. Tides in Narrow Bays
6. Tidal Bores

O. Tsunamis
P. Marine Life
1. Identification/familiarity with the morphology of the basic types of marine life
2. Common Marine Habitats and Ecosystems
3. Understanding of how different types of marine life cope with life in seawater

Q. Oceanic Resources
1. Rock and Mineral Resources
2. Biological Resources
3. Water Resources
4. Physical/Other Resources (energy, commerce, recreation, etc.)

R. Law of the Sea

VI. METHODS OF INSTRUCTION:

A. **Lecture** -
B. **Discussion** -
C. CD-ROM images and animations
D. Textbook and textbook CD-ROM
E. **Demonstration** -
F. Video clips
G. Internet
H. 35mm and powerpoint slides

VII. TYPICAL ASSIGNMENTS:

A. Read Chapters 1 thru 4. Look up the vocabulary words in these chapters and complete online Vocabulary Quiz
1. Use the textbook glossary and index, the Geologic Dictionaries available in the Science Center, and Internet search engines such as Google.

B. Marine Life Homework: learn to identify the basic types of marine life from photos and video clips. The major in-class exams will include marine life photo identification.
C. Complete the Study Guide questions for Exam 2.
D. Locate the following oceanic features, islands and locations and learn how to find them on geomorphic maps; for example, the Marianas Trench and the Challenger Deep, the East Pacific Rise, the 90 East Ridge, Easter Island, the Monterey Submarine Canyon, the Great Barrier Reef, the Maldives, the Galapagos, the Falkland Islands, the Sandwich Islands, etc. Use the textbook CD-ROM, the maps in the textbook and the Internet – National Geographic Map Machine and Google Image searches.
E. Read Chapter 15 in the textbook.
1. Look up all vocabulary for this chapter.
2. Learn to identify the geomorphic features in this chapter in satellite images and regular aerial and ground photos.
3. Make sure that you understand the basic geologic processes discussed in this Chapter.
4. Complete the questions in the Study Guide that refer to the topics in this chapter.

F. Research Paper. Submit a 5-10 page 12-point paper on a geologic topic approved by the instructor.
G. Presentation. Create and present a 5-10 minute presentation on a geologic topic approved by the instructor.

VIII. EVALUATION:

A. **Methods**

1. Other:
    a. Homework – includes vocabulary, marine geography, marine life identification, and textbook material not covered in class presentations
    b. Quizzes and Midterms– includes short answer, multiple choice, and essay questions; includes photo interpretation and identification of oceanic features and marine life, identification and interpretation of oceanic features from geomorphic maps
    c. On-Line Quizzes and/or Essays – may use the textbook website quizzes and/or Blackboard Quizzes – online quizzes are at the discretion of the instructor
    d. Term Paper or Student Presentations (instructor's option)

e. Final examinations – comprehensive, similar layout to quizzes and midterm examinations

B. **Frequency**

1. Homework can be assigned daily, weekly or all at the beginning of the term or only as needed, at the discretion of the instructor
2. Quizzes will be given daily, weekly, bi-weekly or at the discretion of the instructor
3. Quizzes/Midterms/Final Exam/Term Paper – at least 3 or 4 total. For example, there may be 2 midterms, one final exam and one term paper. Or, there may be 4 on-line quizzes, 3 in-class midterms and one in-class final exam.
4. The comprehensive Final Exam will be given at the end of the semester on the day specified in the campus Final Exam schedule.

IX. TYPICAL TEXTS:

1. Garrison, T. (2008). *Oceanography with Infotrac* (6th ed.). Pacific Grove, California: Brooks-Cole Publishers.
2. Thurman, H.V. and Trujillo, A.P. (2004). *Introductory Oceanography* (10th ed.). Upper Saddle River, New Jersey: Prentice-Hall Publishers. .
3. Thurman, H.V. and Trujillo, A.P (2008). *Essentials of Oceanography, with CD-ROM,* (8th ed.). Upper Saddle River, New Jersey: Prentice-Hall Publishers.
4. D. Sverdrup, K.A, Duxbury, A.C. and Duxbury, A.B. (2008). *An Introduction to the World's Oceans* (9th ed.). San Francisco, California: McGraw-Hill Publishing.

X. OTHER MATERIALS REQUIRED OF STUDENTS:

A. A. Access to the internet and computers, through the LPC Computer Center, or access to a personal computer at home with an internet connection B. A small booklight for taking notes while slides and CD-ROM visuals are discussed in class C. A set of colored pencils D. Study guides as made available by the instructor