1. Course Number and Title
   ORE 330, Mineral & Energy Resources of the Sea

2. Credits and contact hours
   Two 1.25-hour sessions per week. Course is 3 credits.
   It can fulfill the undergraduate diversification requirements for a physical science course.

3. Course Coordinator's Name
   Cross listing with OCN 330

4. Textbooks and/or Other Reading Material
   a. *Cronan, D.S. (1999). Handbook of Marine Mineral Deposits. CRC Press*
   b. *Cronan, D.S. (1980). Underwater Minerals. London: Academic Press*

5. Specific Course Information
   a. Hard material and petroleum origins, exploration and exploitation. Renewable and non-renewable resource distribution. Political and scientific constraints. This course looks at the large range of energy and mineral resources in the sea and the engineering challenges to fully developing them for critical future human needs.
   b. Prerequisites: ORE 202 or OCN 201, or consent. (Cross-listed as OCN 330)
   c. Designation: Elective, not specifically part of the ORE Master's program.

6. Specific Goals for the Course
   a. Upon successful completion of ORE 330, the student should be able to:
      i. Understand the various types of marine minerals, their mode of formation and their importance geologically and economically.
      ii. Understand the various options for deriving energy from the ocean and the potential advantages and disadvantages of each.
      iii. Understand the legal, environmental, economic and technical difficulties in extracting minerals and energy from the ocean.
   b. Student Outcomes: (1) Fundamentals. (4) Problem formulation. (6) Communication. (7) Ethical & professional responsibility. (9) Research and experimentation. (10) Constant learning.

7. Topics Covered
   a. The coming problem of peak resource utilization, Parts I (Population & Fossil Fuels) & II (Minerals)
   b. Mid-ocean ridges, basins and trenches, their basic features
   c. Overview of submarine hydrothermal systems
   d. Origins of high and low-temperature hydrothermal deposits
   e. Recycling of ocean crust and the 'Geostill Concept'
   f. Chemistry of hydrothermal vents and polymetallic sulfides
   g. Introduction to Ocean Energy
   h. Oil and gas deposits; Future oil provinces
   i. Oil and Gas: Resources & politics of oil & gas, oil spills & oil spill recovery
   j. Methane hydrates as future natural gas resources
   k. OTEC (Ocean thermal energy conversion)

l. Wind power
m. Wave power
n. Current and tidal power
o. Energy futures, hydrogen, fuel cells
p. Placer deposits
q. Fresh water and desalination
r. Geology of ferromanganese crusts and nodules
s. Chemistry of crusts and chemical variability with age
t. Platinum and phosphorite-rich layers: Seawater vs. extraterrestrial sources
u. Phosphorite deposits, their formation and mining potential
v. Mining technology for manganese nodules, crusts and sulfides
w. Marine minerals development - Legal and environmental issues
x. Marine minerals as possible economic deposits, world metal markets