**Course title:** Physics and Chemistry of the Oceans

**Instructor:** Taka Ito

**Text (required):** *Ocean Dynamics and the Carbon Cycle*, By R. G. Williams and M. J. Follows, Cambridge University Press, 2011.

**Reference text (optional):** *Atmosphere, Ocean and Climate Dynamics*, by J. Marshall and A. Plumb, Academic Press, 2008

**Prerequisite:** Calculus II (MATH 1502), Intro Physics II (PHYS 2212), and Chemical Principles II (CHEM 1212K)

**Course Overview:** The objective of this course is to provide a broad view of the oceans for advanced undergraduate and graduate students interested in marine sciences. The course material covers fundamental principles of physical, chemical and biological oceanography, focusing on the basic processes and mechanisms at work in the oceans including equation of motion in rotating frame of reference, carbonate chemistry, air-sea gas transfer, photosynthesis and respiration. These concepts are applied to illustrate large-scale ocean circulation and biogeochemical cycling of gas and nutrient tracers. Physical demonstrations and observational data are used to develop physical insights.

**Evaluation:** homework (20%), 2 mid-term exams (25% each) and final exam (30%)

**Outline**

Week 1-3: *Observational backgrounds,* kinematics, tracer transport fundamentals

Week 4-5: *Fluid dynamics fundamentals*, equation of motion in rotating frame

**Midterm exam 1**

Week 6-7: *Biogeochemical fundamentals*, photosynthesis and respiration, nutrients and carbon cycling, gas transfer, chemical equilibrium

Week 8-10: *Atmosphere-ocean climate system*, atmospheric gen circ, Ekman, gyres, Sverdrup, WBCs, subduction, ACC, ocean eddies.

**Midterm exam 2**

Week 11-14: *Large-scale physical-biogeochemical processes*, seasonal bloom, nutrient cycles in oligotrophic gyres, polar ecosystem, HNLC, iron

Week 15-16: *Global synthesis*, thermohaline circulation, carbon pump theory, the fate of anthropogenic carbon, glacial CO2 problem

**Final exam**