1. Course number and title
   ORE 680 Ocean engineering and resilience in a changing climate

2. Credits and contact hours
   3 credits, two 1.25-hour sessions per week.

3. Instructor's or course coordinator's name
   Justin Stopa

4. Textbooks
   Textbooks: None
   Reference books:
   a. Latest IPCC Report; Currently: IPCC, 2013: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp, doi:10.1017/CBO9781107415324.
   b. Marine climate and climate change: storms, wind waves, and storm surges; Weise, R., Von Storch, H., 2010 doi:10.1007/978-3-540-68491-6
   c. Statistical analysis in climate research, Hans von Storch and F. W. Ziers, 1999; DOI:10.2307/2669798
   d. Data analysis methods in physical oceanography 3rd edition, William J. Emery and Richard E. Thomson, 2014
   e. Understanding Sea-level Rise and Variability; Edited by J. Church, P. l. Woodworth, 2010; Blackwell Publishing
   f. Coastal Engineering Manual – Part II, US Army Corps of Engineers, 2006, PDF version online: http://chl.erdc.usace.army.mil
   g. Waves in Oceanic and Coastal Waters, by LH. Holthuijsen, Cambridge University Press, 2007.
   h. The Urban Ocean: The interaction of cities with water, by Alan F. Blumberg and Michael S. Bruno, 1st edition, Cambridge University Press, 2018, ISBN-13: 978-1316642207

5. Specific course information
   a. Course content: The changing ocean conditions (e.g. waves and sea levels) relevant to the resilience of practical ocean engineering problems and applications.
   b. Prerequisite:
      i. Fluid mechanics or consent
      ii. ORE607 Wave Mechanics or consent
      iii. Probability and statistics or consent
      iv. Programming or consent
   c. Designation: Elective

6. Specific goals for the course
   a. Specific learning outcomes include:
      i. Understand the impacts of climate change within the ocean. Understand the importance of oceans within the climate, everyday life, and our resilience.
      ii. Evaluate past and current research related to ocean observations, wave climate, and sea level.

iii. Formulate and develop frameworks or practical methods to apply (statistical) techniques and quantify uncertainties associated with extreme wave and sea-level conditions.

iv. Evaluate the current practices and recommendations set forth by government agencies in the United States (USACE, FEMA, USGS) and abroad.

v. Investigate how climate changes associated with waves and sea levels will affect ocean engineering designs now and in the future.

7. Brief list of topics to be covered
   a. Climate Change - Mechanisms causing climate change and responses that impact our atmosphere, oceans, and ecosystems, secular versus interannual variability, initiatives and efforts to standardize datasets and practices (GOOS, GLOSS, GLOBEC, OOPC, WCRP, OBIS), relevance for ocean engineers (design vs operating conditions)
   b. Multi-decadal Observational Wave Datasets and Uncertainties - Buoys, satellite observations (altimetry and SAR), voluntary observing ships, wave hindcasts & reanalysis, seismic noise
   c. Statistical Methods - stationary processes (inter-annual variability and trends), extremal statistics, probabilistic modeling
   d. Sea-level Rise and Uncertainties - sea level data sources (tide gauges & satellite altimetry), regional characteristics, multi-source contributions: land-subsidence, Antarctic & Greenland meltwater, thermal expansion, etc.
   e. Existing Guidelines - from NOAA, USACE, and IPCC including relevance for Hawaii and low-lying islands
   f. Predictions and Projections - Extrapolation techniques, statistical vs dynamical projections