The Ocean Science and Engineering Area seeks to advance research and education to better understand, protect, and utilize the oceans, which cover more than 70% of the earth’s surface and provide the primary avenue for international commerce and the projection of military power. Operating in the ocean is demanding because of the hostile wave environment, extreme pressures, and the limited ability to sustain high data-rate communications. The ocean interior is under-sampled both temporally and spatially and therefore forecasting the ocean environment is challenging.

Acoustics, Instrumentation, Sensing, Marine Robotics and Ocean Predictions

Ocean acoustics is an enabling technology for defense, fisheries evaluation, robotics and communications. Acoustical waves are the only waves that can propagate in any direction through the water column; they can be used to communicate, detect objects, map ocean features, and as a means of underwater “vision”. Acoustical methods are also used for anti-submarine warfare, harbor protection, and mine detection for national defense. Sonar technology enables long-distance observations in the ocean and requires deep knowledge of both acoustics and signal processing.

Autonomous underwater vehicles, equipped with advanced sensors, have become a powerful tool for ocean exploration and monitoring. MIT and the MIT/WHOI Joint Program are leading centers for developing this new technology and educating the new generations of vehicle designers. New major initiatives by NSF, ONR, NRF and the Offshore Industry to develop underwater observatories, new persistent surveillance systems, and autonomous sub sea oil producing systems, have generated a pressing need for new robotic systems and manipulators, smart sensors and uncertainty predictions.

Faculty & Research Staff
Asada, Baggeroe, Barbastathis, Chryssostomidis, Hover, Lermusiaux, Leonard, Makris, Milgram, Patrikalakis, Peacock, Schmidt, Slocum, Slotine, Techet, Triantafyllou, Youcef-Toumi; Balasuriya, Cho, Curcio, Haley, Leslie

WHOI Staff Camilli, Duda, Feijoo, Foote, Gawarkiewicz, Grosenbaugh, Lavery, Lynch, Pratt, Preisig, Price, Singh, Stanton, Tyack, White, Yoeger

Subjects 2.065, 2.066, 2.089, 2.12, 2.166, 2.167, 2.22, 2.29, 2.612, 2.671, 2.681, 2.682, 2.683, 2.684, 2.685, 2.686, 2.687, 2.688, 2.689, 2.706, 2.707, 2.710, 2.717
Naval systems are expensive, high-technology structures. An aircraft carrier is the most complex self-standing man-made system on earth. Our Naval Construction Program, which is over 100 years old, educates naval officers, providing a comprehensive education in designing naval systems. Every major class of ships launched by the US Navy has had an MIT graduate directing it. New directions and changes in current defense needs, combined with funding constraints, require novel thinking, involving, for example, interchanging platform payloads, configurability by mission, and cost savings; concepts that students practice in a series of design courses.

**Faculty & Research Staff**
Chryssostomidis, Parks, Vandiver, Wierzbicki

**Subjects**
2.016, 2.163, 2.164, 2.20, 2.23, 2.24, 2.27, 2.29, 2.671, 2.684

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### Hydrodynamics

Hydrodynamics is a core discipline of the Ocean Science and Engineering Area. The ocean plays a dominant role in controlling the climate and can be used for transportation or to extract substantial resources. Ships, which support 95% of the world’s commerce, and offshore structures that provide a substantial portion of the world’s oil, operate in a random, dynamic environment: gigantic rogue waves can break the largest structures; smaller but still powerful waves can provide renewable energy, wind energy over the ocean is largely untapped, wave breaking and spray formation affect our climate, because they control the exchange of energy, chemicals, and gases between the atmosphere and the ocean. Designing ultra-fast ships, reaching speeds of 100 knots, would revolutionize world trade; yet we need to understand and control these same hydrodynamic mechanisms before this becomes possible. Thousands of marine risers carry oil and gas from offshore wells to the surface; they vibrate constantly and may fatigue as flow-structure interaction mechanisms cause vortex formation and unsteady loads. A comprehensive curriculum provides a powerful education for future ocean engineers and naval architects to design the ships and structures of the future.

**Faculty & Research Staff**
Milgram, Sclavounos, Techet, Triantafyllou, Yue; Liu, Hendrickson

**Subjects**
2.016, 2.163, 2.164, 2.20, 2.23, 2.24, 2.27, 2.29, 2.671, 2.684

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### Structural Mechanics & Dynamics

Ocean structures and vessels are often very large and complex systems. Wave loads in severe storms are huge compared to unsteady loads in other systems, such as airplanes and cars. As a result, designing and fabricating more efficient and higher-performing structures, such as offshore platforms, supertankers, trans-oceanic cables, and deep submersibles, capable of supporting these huge loads in a cost-effective manner is a very challenging engineering task. We provide a comprehensive curriculum for students to study the structural mechanics of vessels, sources of stress, the behavior of a range of materials, and the basic mechanisms of crashworthiness.

**Faculty & Research Staff**
Chryssostomidis, Parks, Vandiver, Wierzbicki

**Subjects**
2.060, 2.080, 2.081, 2.082, 2.085, 2.23, 2.24, 2.821

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### Design, Naval Construction & Engineering

Naval systems are expensive, high-technology structures. An aircraft carrier is the most complex self-standing man-made system on earth. Our Naval Construction Program, which is over 100 years old, educates naval officers, providing a comprehensive education in designing naval systems. Every major class of ships launched by the US Navy has had an MIT graduate directing it. New directions and changes in current defense needs, combined with funding constraints, require novel thinking, involving, for example, interchanging platform payloads, configurability by mission, and cost savings; concepts that students practice in a series of design courses.

**Faculty & Research Staff**
Chryssostomidis, Frey, Harbour, Hover, Keenan, Marcus, Milgram, Patrikalakis, Sclavounos, Slocum, Triantafyllou

**Subjects**
2.017, 2.019, 2.067, 2.080, 2.081, 2.082, 2.084, 2.154, 2.611, 2.701, 2.702, 2.703, 2.704, 2.705, 2.706

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### Undergraduate

The Bachelor of Science in Mechanical and Ocean Engineering - [Course 2-OE](#).

### Graduate

Graduate study in Ocean Engineering can lead to the following degrees: Master’s of Science in Ocean Engineering; Master’s of Science in Naval Architecture and Marine Engineering; Master’s of Science in Oceanographic Engineering, Master’s of Science in Transportation with depth concentration in Ocean Systems Management and Doctor of Philosophy; or Doctor of Science. Unless otherwise noted, all degrees are granted by the Department of Mechanical Engineering.