

Underwater ROV Lesson Plan

Lesson Target

Course: CTE: IET Core
Grade Level(s): 9th, 10th, and 11th Grades
Time Required: 8-10 weeks in the computer lab and shop (up to 40 hours)
Delivery: Delivered as an IET Core Unit
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Objective

By the end of this unit students will be able to design, manufacture, and pilot an Underwater ROV.

Hawaii Standards

The following Hawaii CTE IET Standards are being met: **1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1, 3.2, 4.1, 4.2, 4.4, 5.1, 5.2, 5.3, 6.1, 6.2, 7.1, 7.2, 8.1, 8.2, 8.3, 9.1, 9.2, 9.3, 10.1, 10.2.**

The following GLOs (General Learning Outcomes) are being met: **1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 3.1, 3.2, 3.3, 3.4, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 5.4, 5.5, 6.1, 6.2, 6.3, 6.4, 6.5.**

Pre-requisite Knowledge

The student must have the following pre-requisite knowledge to start this lesson:

- ✓ Drawing: An ability to draw mechanical and electrical parts/assemblies to accuracy is required.
- ✓ Geometry: Understanding measurement, fractions, decimals, and basic geometric shapes.
- ✓ Computer: Open, Close, File, Save, Print. Backup of files to floppy or CD-RW. Menu operation, command operation, mouse, and keyboard operation. Starting a software application, resizing windows, text entry, mouse entry.

Pre-requisite Lessons

Students must have individually completed lessons in the following activities before starting to design, build, and pilot the underwater ROV. Please see the specific lesson plans on each (The total pre-requisite lesson plan delivery time is: 15 Weeks: 6 weeks in the shop and 8 weeks in the technology lab).

- ✓ Word Processing Students are to complete the lesson on word processing so that they can professionally compose their final ROV project report (1 week, 3-4 hours).

- ✓ Presentations Students are to complete the lesson on presentation creation so that they can verbally deliver their final ROV project report (1 week, 3-4 hours).
- ✓ Spreadsheets Students are to complete the lesson on spreadsheet creation so that they can complete a spreadsheet of the ROV parts and cost analysis (1 week, 3-4 hours).
- ✓ Mechanical Drawing Students are to complete the mechanical drawing lesson and therefore be able to complete simple 2D mechanical drawings to scale accuracy. Drawings in CAD are optional (2 weeks, 7-8 hours).
- ✓ ROV Physics Students are to successfully complete the ROV physics lesson which is to cover buoyancy, hydraulic pressure, mass/density, center of mass and buoyancy, drag in fluids, propulsion, center of thrust, and material science (2 weeks, 7-8 hours).
- ✓ ROV Design Students are to successfully complete the ROV design lesson (1 week, 3-4 hours).
- ✓ Electronics Design Students are to optionally complete a lesson on electronics design using schematic capture and PCB layout software (1 week, 3-4 hours).
- ✓ Shop Safety Students are to complete the shop safety assessment before handling any tools (1 week, 3-4 hours).
- ✓ Electronics Students are to complete the lesson on basic electronics and electronic assembly (2 weeks, 7-8 hours).
- ✓ Manufacturing Students are to demonstrate successfully the skills in measuring, drilling, sanding, cutting, gluing, soldering, wiring, water proofing, circuit testing, and shop organization (3 weeks, 7-8 hours).

Materials Required

- Build Your Own Underwater ROV book (Bohm and Jensen)
- Computers with Internet access
- Productivity software (Word, Powerpoint, Excel)
- Optional: Schematic capture and PCB layout software
- Optional: CAD software
- Mechanical drawing supplies
- Shop tools and supplies (see spreadsheet list)
- ROV supplies (see spreadsheet list)
- Competition supplies (see spreadsheet list)
- Student transportation
- Competition venue (pool)

Lesson Activities

- Lesson 1: Propulsion assembly and test
 - Students are to manufacture and assemble their propulsion system, mounts, and optional cowling.
 - Students are to test their underwater propulsion systems (motor, sleeve, and propeller), document their findings, and select the best design for the competition missions.
 - Propulsion system complete, covers pitch, yaw, and roll, forward, side, and up/down motion.

- Lesson 2: Electrical system assembly and test
 - Students are to construct their electrical system for the ROV, including the onboard junction box, wiring to all three thrusters, optional wiring to video and lights, surface control box, switches, and the tether system (30 feet in length).
 - Students are to test the operation of their electrical system insuring that all components operate effectively.
 - Electrical system, wiring, and tether complete.

- Lesson 3: ROV Structure/frame and buoyancy system assembly
 - Students are to complete their ROV structural and buoyancy system, designing the ROV to float before it sinks.
 - Students are to complete attachments for propulsion, optional camera, optional lighting, tether, electrical box, and buoyancy compensation system (weights and positive buoyancy device and tether buoyancy).
 - ROV structure/frame complete with all systems (Electrical, propulsion, buoyancy, tether, and optional visual guidance system).

- Lesson 4: ROV Buoyancy and Maneuverability test
 - Students are to test the ROV buoyancy and maneuverability in a small water venue. Adjustments to propulsion, buoyancy, and electrical systems are to be completed and documented in preparation for competition.
 - ROV buoyancy and maneuverability complete.

- Lesson 5: Competition
 - Students are to learn to pilot their ROVs for the competition missions
 - Students are to compete in each of the ROV missions (TBD)

- Lesson 6: Project Presentation
 - Students are to complete a 5-page electronic presentation on the ROV activity, to include text, graphics, pictures, and optionally animation/video.
 - The presentation is to include: design goals and rationale, manufacturing results, test results, cost spreadsheet and BOM/PL,

competition results, skills gained, lessons learned, suggestions for future improvements, and reflection/conclusion.

- Lesson 7: Final Report
 - Students are to complete a 5 to 10 page electronic report on the ROV activity
 - The report is to include: Abstract, design goals and rationale, manufacturing results, test results, cost spreadsheet and BOM/PL, competition results, skills gained, lessons learned, suggestions for future improvements, and reflection/conclusion.

Multiple Intelligences Coverage

This multifaceted unit will provide differentiated instruction by addressing the following cross-section of multiple learning styles (Gartner) through specific activities:

<i>Activities</i>	<i>Verbal / Linguistic</i>	<i>Naturalistic</i>	<i>Visual / Spatial</i>	<i>Intrapersonal</i>	<i>Interpersonal</i>	<i>Logical / Mathematical</i>	<i>Bodily / Kinesthetic</i>	<i>Musical / Rhythmic</i>
ROV Physics			X			X		
ROV design			X			X		
Shop safety			X				X	
Electronics		X	X			X	X	
Manufacturing skills			X			X	X	X
Propulsion assembly and test			X		X	X	X	
Electrical system assembly and test			X		X	X	X	
Structure assembly and test			X		X	X	X	
Buoyancy and maneuverability			X		X	X	X	
Competition (Piloting)	X	X	X	X	X	X	X	
Project presentation	X		X	X	X	X	X	
Project Report	X			X	X	X		

Assessment

Assessment will be done both formatively and summatively. Formative assessment will be done throughout the evaluation of designs in progress, and direct observation of skills and teamwork. The summative assessment will be delivery of the actual ROV, the success in competition, the final presentation and report. The student work

will be graded based upon the activity criteria/checklist and the rubrics provided. Pre- and Post- online assessments on terminology, safety, skills, materials, ROV Physics, and the design process will be administered.