International ROV Curriculum Focused on 2-Year Colleges

Topics of Study

Draft 2

How the International ROV Curriculum Topics are organized.

The ROV topics of study are divided into three groups:

Additionally there are three levels and each topic area is assigned to a particular level.

- **Level 1**: General course work that could be offered at most colleges.
- **Level 2**: More specialized course work that requires higher levels of equipment & training.
- **Level 3**: Highly specialized ROV coursework, requiring significant equipment support.

Foundational Topics: Math

Level		Math
1		Whole numbers
1		Fractions
1		Decimal fractions
1		Percent's
1		Graphing
1		Measurement
1		Signed numbers
1		Unit Conversions
1		Algebraic operations
1		Linear equations
1		Signed numbers
1		Solutions of linear equations
1		First, second and third order equations
1		Solving single variable equations
1		Solving multiple variable equations
1		Applications of linear equations
1		Graphs and equations
1		Systems of two equations
1		Factoring
1		Algebraic fractions
1		Solutions of quadratic equations
1		Introduction to geometry
1		Trigonometric functions
1		Vectors
1		Review of Fundamental Algebra
1		Trigonometric Functions
1		Operations Involving Algebraic Expressions
1		Operations Involving Fractional Algebraic Expressions
1		Exponents and Radicals: The Quadratic Formula
1		Logarithms
1		Systems of Linear Equations and Determinants
1		Functions
1		Analytic Geometry
1		Algebra Operations and Complex Numbers
1		The Derivative

Foundational Topics: Communication Skills

		Communication Skills
1		Communication Process
1		Technical Writing
1		Technical Writing Fundamentals
1		The Strategy of Technical Reporting
1		Informal Report Writing
1		Semi-formal/Formal Report Writing
1		Technical Abstract Writing
1		Incident Reports
1		Technical Reading
1		Technical Definitions and Descriptions
1		Technical Reading, Specifications
1		Technical Reading, Regulations
1		Technical Reading, Equipment Manuals
1		Technical Reading, Company Brochures
1		Technical Speech
1		Reporting Technical Information Orally
1		Delivering Process Presentations
1		Delivering Formal Reports
1		Effective Utilization of Audio and Visual aids
1		Job Search
1		Resumes
1		Letters of Application, Cover Letters
1		Interview Process
1		Employment related correspondence
1		Effective Communication through computer applications
1		Word Process, Spreadsheet, Presentation, Drawing
1		Email, Video Conferencing

Foundational Topics: Science

		Science
1		The Nature of Physics
1		Motion and Vectors
1		Dynamics
1		Work, Energy, and Power
1		Properties of Matter
1		Wave Motion
1		Fluid Mechanics
1		Heat

Technical Topics: Safety

		Safety
2		Introduction to Safety
2		- Workers' rights, employer responsibilities and how to file a complaint
2		- Workers' attitude and safety
2		Managing Safety and Health
2		Injury and Illness Prevention Programs,
2		Job site inspections, accident prevention programs.
2		Walking and Working Surfaces, including slip & fall protection
2		Exit Routes, Emergency Action Plans, Fire Prevention Plans, and Fire Protection
2		Personal Protective Equipment
2		Materials Handling and Material Safety Data Sheets
2		Workplace Hazardous Materials Information System
2		Chemical Hazards
2		Labeling
2		Confidential Information
2		Hazard Communication
2		Hazardous Materials
2		Permit-Required Confined Spaces
2		Lockout / Tag out
2		Machine Guarding
2		Welding, Cutting, and Brazing
2		Introduction to Industrial Hygiene and Blood borne Pathogens
2		Fall Protection
2		Powered Industrial Vehicles
2		Stored Energy Safety
2		Electrical
2		Hydraulic & Pneumatic
2		Mechanical
2		Water Safety
2		Personnel Safety around water
2		Protective Equipment
2		Ground Fault Detection and Water
2		Electrical Safety
2		Contributing Factors of Electrical Accidents
2		Recognized Hazards of Electrical Work
2		Responsibilities of Employers and Employees
2		Six Step Procedure to Achieve an Electrically Safe Work Condition
2		Lockout/Tag out Principles and Procedures
2		Temporary Protective Grounding
2		Establishing Shock Protection Boundaries
2		Arc Flash Hazard Analysis
2		Personal and Other Protective Equipment Selection for Low and High Voltage Tasks
2		Alerting Techniques
2		Working Near Overhead Lines
2		Hazards associated with high voltage electricity
2		Arc Flash
2		Electrocution
2		Proper use of personal protective equipment (PPE)
2		Specific requirements for each voltage level
2		Types of PPE required
2		Recommended ratings for safety glasses, gloves, shoes, clothing and equipment
2		Arc Flash Hazards

2		Description of Arc Flash hazards
2		Minimum safe distances
2		Available energy calculations
2		OSHA and NFPA Regulatory policy requirements
2		Lockout/Tag out
2		Minimum approach distances
2		High Voltage Test Equipment
2		Proper usage is volt/ohm meters
2		Megohm testing
2		Ground fault detection equipment
2		Creating a plan for high voltage servicing
2		Required components
2		Recommended components
2		Plan implementation
2		Specific Hazards
2		Working on capacitors, stored energy
2		Installation and use of ground cables
2		Testing energized circuits
2		High Voltage Rescue
2		Energized co-worker rescue considerations
2		Inclusion in the high voltage plan
2		**First Aid/CPR/AED**
		Each of the items in this section, based upon Governing Regulatory Agency of work performed USA: National Electrical Code (NEC) published by National Fire Protection Association (NFPA)

Technical Topics: CAD & Blueprint Reading

		CAD & Blueprint Reading
1		Drafting Fundamentals
1		Applied Geometry
1		Orthographic Projection
1		Sectional Views
1		Dimensioning
1		Tolerances
1		Detail and Assembly Drawings
1		Notes and Specifications
1		Bill of Materials
1		Working Drawings
1		Abbreviations and Symbols
1		Production and Processes
1		Welding Symbols
1		Piping Drawings
1		Electrical Drawings
1		Hydraulic Drawings
1		Fasteners
1		3d to 2d drawings
1		Automation & Animation of Designs
1		Design Simulation

Technical Topics: Electrical

		Electrical
1		Ohm's Law, electrical circuit theory
1		Electrical diagrams, symbols, and nomenclature
1		Electrical characteristics, polarity, electron flow, voltage drops, power loss.
1		Basic Ohm's Law formulas
1		Series circuits / diagrams
1		Series circuits; wiring, measurements and proper operation
1		Parallel circuits / diagrams
1		Parallel circuits; wiring, measurements and proper operation
1		Combination circuits / diagrams
1		Combination circuits; wiring, measurements and proper operation.
1		Troubleshooting techniques
1		Voltage Sources
1		Parallel and series sources.
1		Addition and subtraction of voltages.
1		Comparison of meter readings and theory.
1		Power Supply
1		Cells and Batteries
1		DC Supply & AC Supply
1		Basic measurements
1		Current limits
1		Fixed and variable outputs
1		Testing instruments and Tools
1		Testing instruments used in the electrical industry
1		Ohmmeter
1		Voltmeter
1		Ammeters, in-line and clamp-on
1		Watt meter
1		Oscilloscope
1		Proper tool management
1		Safety procedures when using various types of testing equipment and tools
1		Selection of proper testing equipment
1		Assessing calculated and measured values
1		Test equipment and proper usage
1		Conductors used in the electrical industry
1		Conductors types
1		Ampacity of conductors, proper sizing
1		Insulation types, materials, effect of heat on insulation.
1		Application of Chapter 9 / Tables of National Electrical Code
1		Voltage drop in conductors
1		Temperature effects on electrical conductors
1		De-rating of electrical conductors
1		Copper vs. aluminum conductors
2		High voltage cables and insulation
2		Conduit system types and materials used in the electrical industry
2		Installation and wiring methods
2		Splicing methods and techniques
2		Electrical Circuits & Regulatory Agency requirements
2		National Electrical Code minimum requirements
2		Overcurrent device selection
2		Wire/Conductors
2		Wire Measurement devices

Technical Topics: Electrical

2		Identification of wire gauge, insulation types and correct usage.
2		Line ladder diagrams as applied to electrical circuits.
2		Conversion of schematic diagrams to line ladder diagrams.
2		Wiring circuits directly from line ladder diagrams.
2		Usage of solid-state electronic components.
1		Magnetism and Electromagnetism
1		Nature of Magnetic Fields
1		Lentz's Law
1		Electric current and generated fields
1		Interaction of magnetic fields
1		Electromotive Force principles
2		DC Generators
2		Parts and operation of DC Generator
2		Left Hand Rule for generators
2		Neutral Plane and magnetic field distortion
2		Industry standard generator connections
2		Output voltage characteristics of each type of generator connection
2		Comparison of generator outputs
2		Maintenance and troubleshooting common generator problems
2		DC Motors
2		Parts and operation of DC Motor
2		Right Hand Rule for motors
2		Counter Electromotive Force and relation to motors
2		Industry standard motor connections
2		Torque, locked-rotor current, speed/load characteristics
2		Motor installation techniques
2		Motor Overcurrent protection
2		Maintenance and troubleshooting common motor problems
2		DC Motor Controls
2		Introduction to symbols and ladder diagrams
2		Field control and field loss protection circuits
2		Low voltage starting circuits
2		Reversing controls, interlock controls
2		Safety Interlocks
2		Motor overload and overcurrent protection
2		Dynamic and mechanical breaking methods
2		AC Power Distribution
2		AC single-phase/three-phase distribution.
2		Application of load demand factors and requirements per the Regulatory Agency
2		Capacitance and Inductance in Alternating Current Circuits
2		Describe the inductance and capacitance in an alternating current circuit.
2		Compute inductive reactance and inductance, capacitive reactance and capacitance.
2		Describe the relationship of voltage and current in a pure inductive circuit.
2		Describe the relationship of voltage and current in a pure capacitive circuit.
2		Compute values for inductors connected in series and parallel.
2		Compute values for capacitors connected in series and parallel.
2		Describe reactive power (VARs).
2		AC Circuit Analysis
2		Resistive-Inductive-Capacitive Series Circuits
2		Resistive-Inductive-Capacitive Parallel Circuits
2		For each type of AC Circuit perform the following:
2		Define power factor.

Technical Topics: Electrical

2		Calculate values of voltage, current, apparent power, reactive power, impedance, resistance, inductive reactance, capacitive reactance and power factor in the AC circuit
2		Compute the phase angle for current and voltage in the AC circuit.
2		Describe vectors and plotting electrical quantities using vectors.
2		Describe the operation of a parallel resonant circuit.
2		Compute values and correct power factor for an AC motor.
2		Three-Phase Circuits
2		Describe the differences between three phase & single phase systems and voltages.
2		Describe the characteristics of three phase Wye and Delta systems.
2		Compute voltage and current values for balanced three phase Wye and Delta circuits.
2		Compute voltage & current values for unbalanced three phase Wye and Delta circuits.
2		Describe and apply proper electrical code articles for three phase systems.
2		Single Phase Transformers
2		Describe the different types of transformers
2		Compute values of voltage and current for single phase transformers.
2		Compute voltage and current values for balanced single phase three wire circuits.
2		Compute voltage and current values for unbalanced single phase three wire circuits.
2		Describe transformer polarity.
2		Describe and apply properelectrical code articles for transformers.

Technical Topics: Electronics

		Electronics
2		Electronic Fabrication and Repair
2		General Workshop Safety Procedures
2		Basic Hand tools Used in Electronic Repair and Fabrication
2		Soldering and Desoldering Techniques
2		Circuit Wiring Techniques
2		Cable Formation and Connectors
2		Schematic Diagrams and Component Identification
2		Board fabrication
2		Through hole circuit repair & fabrication
2		Surface Mount Technology (SMT) repair
2		Introduction to Electronic Components
2		Resistors and Capacitors
2		Diodes, LEDs and SCRs
2		Transistors, Bipolar, MOSFET and IGBT
2		Operational Amplifier Circuits
1		Introduction to Digital Circuits
1		Combinatorial Logic
1		Logic Families
1		Programmable Logic Arrays
1		Sequential Logic
1		Review of Circuit Basics
1		Ohms Law
1		Series, Parallel and Combination Circuits
1		Voltage, Current and Resistance Measurements
1		Introduction to Electronics Control
1		Electronic DC Motor Control
1		Basic Speed Control
1		Pulse Width Modulation (PWM)
1		Direction control with a H-Bridge
1		Braking
1		Power Supplies
1		Linear Voltage Regulators
1		Switched Mode Power Supplies (SMPS).
1		Power Electronics.
2		AC Motor Control and Variable Frequency Drive (VFD) Fundamentals
2		Torque, Speed and Horsepower
2		Principles of Operation
2		Operating Conditions
2		Drive configuration
2		Types of Inverters
2		VFD Components and Operation
2		Input converter
2		DC bus filter
2		Output Inverter
2		Controller
2		VFD Controller Programming
2		VFD System Troubleshooting
2		Gathering information
2		Verifying operation
2		Isolation and elimination of systems
2		Testing

Technical Topics: Electrical Control Systems

		Electrical Control Systems
2		Electromagnetic Contactors & Relays
2		Makeup of contactors and relays.
2		Operating characteristics of control devices.
2		Introduction to time delays and resistor/capacitor time constants
2		Full Voltage Control of a DC Motor
2		Delayed Start of a DC Motor
2		Start Stop Jog of a DC Motor
2		Forward Reverse Control of a DC Motor
2		Time Delay Relays
2		Resistor/Capacitor time constants
2		Time delays and starting motors under loads
2		Flywheel effects
2		Friction and dynamic braking of motors
2		Control Relay use and development of Start/Stop/Jog Control systems
2		Use of auxiliary control devices, sensor, switches and interlocks.
2		Safety in motor control circuits
2		Wiring methods and industry standards for control wiring
2		Timing diagrams as applied in Control Systems
2		Timing logic
2		On Delay Timers
2		Off Delay Timers
2		One Shot Timers
2		Multi-Function Timers
2		Sequential control circuits
2		Troubleshooting motor control techniques
2		Developing a troubleshooting plan
2		Testing methodology
2		Documentation of test results

Technical Topics: Automation Controllers

Automation Controllers (Microprocessors and Programmable Logic Controllers)		
2		Control System Basics
2		Analog Signals and Control
2		Digital Input and Output
2		High Speed Counters
2		Motor and Motion Control
2		Network Connection
2		Digital Communications Systems
2		Data Transfer & Fiber Optics
2		Shielding, Grounding and Transmission Line Techniques
2		Automation Controller Types and Power Supplies
2		Programming Methods
2		Robot Control Software
2		Ladder Diagrams & Relay Type Instructions
2		C++ or other high level language
2		Programming Concepts
2		Memory Organization and Numbering Systems
2		Control Instructions
2		Input / Output Instructions
2		Timers and Time delay programming, On delay, Off delay
2		Counter Programming - The usage of counters, Up, Down and cascading counters.
2		Programming Logic concepts of AND, OR, NOT, NOR.
2		Programming Math and Data Manipulation
2		Addition, subtraction, multiplication, division, and higher level math functions.
2		Data manipulation including data transfer, compare, and modification.
2		Controller System Installation and Troubleshooting
2		Installation, Troubleshooting, grounding, voltage variations and surges,
2		Preventative maintenance of control systems.
2		Human Machine Interface (HMI)
2		Monitoring & Controlling processes
2		Types of HMI devices
2		Using a PC as a HMI device
2		Basic Process Control – The Control Loop
2		Measurement
2		Comparison
2		Adjustment
2		Process Control Terminology
2		Process Variable, Set point
2		Measured variables, Manipulated variables
2		Error, Offset, Load disturbance
2		Control Algorithm
2		Manual Control
2		Automatic Control
2		Closed and Open Control Loops
2		PC operation and repair
2		Terminology
2		Operating Systems
2		Basic system components
2		Communication methods
2		RS232, RS422, RS485
2		Industrial Ethernet

Technical Topics: Electrical Code & Regulations

		Electrical Code & Regulations
2		Electrical code introduction.
2		Installation, general requirements.
2		Wiring and protection.
2		Branch circuits.
2		Branch circuit, feeders and service load calculations.
2		Electrical services.
2		Over current protection.
2		Wiring methods.
2		Conductors for general wiring.
2		Cabinets and cut out boxes.
2		Outlet, pull and junction boxes.
2		Type AC Cable.
2		Switches.
2		Receptacles, cord connectors and plugs.
2		Switchboards and panel boards.
2		Lighting fixtures, lamp holders and lamps.
2		Comparison of International standards for outlets, adapters, voltages and frequencies
		Each of the items in this section, based upon Governing Regulatory Agency of work performed
		USA: National Electrical Code (NEC) published by National Fire Protection Association (NFPA)
		Canada: Canadian Electrical Code (CE code) published by Canadian Standards Association (CSA)
		Germany: DIN VDE (German Institute for Standardization) published by DIN-Norms
		Mexico, Costa Rica, Venezuela and Colombia: NFPA National Electrical Code as in USA
		IEC 60364 is used as a basis for electrical codes in many European countries
		UK: British Standard BS 7671
		Australian/New Zealand: Standard AS/NZS 3000:2007 Wiring Rules.
		France: NF C 15-100 (fr) is used for low voltage installations
		Belgium: RGIE (fr) (Réglement Général sur les Installations Électriques)
		Others: Include as they are identified

Technical Topics: Fluid Power

	Fluid Power	
1		Fluid Power Concepts
1		Force, Pressure, Area, Volume, Flow, Work and Power
1		Boyle's Law, Charles' Law
1		Forces due to Fluids in Motion
1		Drag
2		Fluid Power Safety
2		Safety Standards
2		Potential Hazards and Personal Protective Equipment (PPE) Required
2		Fluid Power Chemical Hazards, Long & Short Term Exposure Hazards
2		Stored energy and accumulators
2		Energy lockout, Zero Energy State
2		Hoses and the leakage dangers
2		Spill Preparedness
2		Hydraulic System and Schematics
2		Fluids
2		Fluid Types
2		Filtration, Dryers & Contamination Control
2		Proper Handling and Spill Mitigation
2		Pumps and Compressors
2		Types of Pumps and Compressors
2		Efficiency Calculations
2		Pump and Compressor Maintenance and Troubleshooting
2		Hoses, Conduits and Fittings
2		Tubing, Hose, Pipe
2		Hose Routing & Termination
2		Safety Factors and Industry Standards
2		Fittings
2		Connections & Testing
2		Environmental Danger Due to Leaks & Unplanned Releases
2		Seals and Packing
2		Actuators
2		Cylinders, Motors, Rotary Actuators, Linear Actuator
2		Actuator Maintenance and Troubleshooting
2		Directional and Proportional Control Valves
2		Single and two-stage valves
2		Three, four and five-stage valves
2		Sizing Valves
2		Electric Valve Operators
2		Pressure Control
2		Flow Regulators
2		Pressure Regulators & Pressure Relief Valves
2		Reporting Requirements
2		Leaks and Reporting
2		Environmental Exposure & Damage
2		Governmental Fines for Leaks and Spills
2		Troubleshooting
2		Tracing flow paths and schematics
2		Isolating and eliminating potential problem sources
2		Developing test plans
2		Testing documentation

Technical Topics: Machine Design & Fabrication

		Machine Design & Fabrication
2		Manufacturability & Serviceability
2		Tolerances, Quality and Quality Control
2		Surface Finishes
2		Surface Coatings, Ceramic, Anodizing, Plating
2		Snap-Rings
2		O-rings
2		Bushings
2		Bearings
2		Metrology
2		Hand Tools and Wrenches; Proper Selection & Usage
2		Selection, Care and the Use of Files
2		Drills and Drill Presses
2		Selection and the Use of Taps and Dies
2		Nondestructive Testing Methods
2		Introduction to Machine Tools; Mill, Lathe, CNC
2		Introduction to 3d Printing
2		Welding Methods
2		Welding & Machine Safety; Exposure Hazards
2		Terms & Symbols - Basic Fabrication Print Reading
2		Oxygen-Acetylene Cutting
2		Electrode Selection
2		Welding Processes & Welding Positions
2		Electric Arc Welding Processes
2		Plasma & Water Jet Cutting

Technical Topics: Fiber Optics

		Fiber Optics
2		Multi-mode
2		Single-mode
2		Terminology
2		Splicing & Termination
2		Fiber Optical Safety
2		OTDR - Optical Time Domain Reflectometer
2		Optical Mux
2		Optical Rotary Joint

Advanced Topics: ROV Materials

		ROV Materials
3		Classification of ROV metals (Stainless Steels, Aluminum, and Titanium)
3		Identification of ROV Metals
3		Properties of ROV Metals
3		ROV Optical Materials
3		ROV Floatation Materials
3		Other ROV Materials
3		Piping; Routing & Forming
3		Metallurgy; Cathodic Protection & Corrosion

Advanced Topics: ROV Operations

		ROV Operations
2		**Intro to ROV (IMCA R 004 Rev.3)**
2		ROV Classifications
2		ROV Tasks
2		ROV Tools
2		Environmental Considerations
2		ROV Operations
2		Equipment Cert. & Maintenance
2		Personnel
2		Responsibilities
3		***Underwater Acoustic Applications***
3		***Introduction to ROV Systems***
3		***ROV Operations***
3		***ROV Maintenance***
3		Deck Checks
3		Electrical system
3		Hydraulic system
3		Tether/Umbilical
3		Maintenance logging
3		***Launch and Recovery Systems or LARS***
3		**ROV Ship Interaction**
3		***ROV Pilot Training***
3		Start-up and shut-down procedures
3		Launch and recovery
3		Hold position
3		Basic navigation
3		Tether management
3		Dive Logging
3		Observation tasks
3		Search and recovery task
3		Deployment Platforms
3		***ROV Simulator Training***
3		Launch and recovery
3		Hold position
3		Basic navigation
3		Sonar Navigation
3		Tether management
3		Basic Oil and Gas Operations
3		Dive logging
3		Video logging
3		***Work Term - Remotely Operated Vehicle***

Level	Description of Levels
1	General course work that could be offered at most colleges
2	More specialized course work that requires higher levels of equipment & training
3	Highly specialized ROV coursework, requiring significant equipment support