

Westlawn Institute of Marine Technology

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Yacht & Boat Design Program Course Objectives and Syllabi

Course # Module 1 Principles of Small Craft Naval Architecture

Course # Module 1 Objectives

When the student has mastered the program material, he/she will be able to:

1. Describe the design spiral
2. Comprehend and discuss the basic laws of flotation and describe the basic physical laws which state how various propulsion systems work.
3. Solve basic algebraic, geometric, and trigonometric problems after completing this math review.
4. Discuss the meaning of a set of hull lines, calculate displacement using Simpsons Rule or the Trapezoidal Rule, locate the center of buoyancy of a hull, and compute wetted surface, and perform a weight study and locate a hull's center of gravity.
5. Discuss and apply the concepts involved regarding the nature of frictional, residual and wind resistance and be able to make recommendations to reduce resistance. Calculate righting arms and righting moments at any angle of heel, analyze stability curves, and comprehend the principles of trim and flotation.
6. Create and prepare presentation drawings and proposals for new yachts.
7. Use the required drafting instruments to properly draw lines, curves fair sweeps and other figures needed to draw working plans and apply what you have learned to draw an outboard-profile elevation and general-arrangement plan.
8. Create and draw and fair a complete set of hull lines, prepare a table of offsets, and a set of hydrostatic calculations for a hull lines drawing.
9. Obtain a passing grade on a series of written examinations demonstrating that the student attained the required knowledge in the subjects presented in this course and can apply the knowledge to correctly answer the questions and problems presented in the examinations.

Course # Module 1 Goals

The overarching goals of this course are to enable students to:

1. Analyze the meaning of a set of hull lines and to calculate the various physical characteristics that describe a boat.
2. Discuss and break down the nature of frictional and residual resistance and be able to make recommendations to reduce resistance.
3. Describe the mechanisms involved in transverse metacentric stability and dynamic stability and acquire a comprehension of the principles trim and flotation.

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4. Develop the skills required for manual marine drafting.
5. Draw and fair a complete set of hull lines
6. Obtain a passing grade on a series of written examinations demonstrating that the student attained the required knowledge in the subjects presented in this course and can apply it to correctly answering exam questions and problems

This course prepares the student to work as an apprentice to yacht and boat designers with production boat building companies or at firms engaged in private practice while continuing his/her studies. It is the prerequisite to course # Module 2.

Course # Module 1 Syllabus

LESSON 1: Introduction to Yacht Design

1. The Growth of Recreational Boating and the Designers Place in the Industry
2. The Yacht Designer and the Design Process
3. Basic Laws of Flotation
4. Basic Laws of Propulsion
5. Propulsion Methods
6. Preliminary Sketching
7. Drawing Examples

LESSON 2: Basic Mathematics (Review)

1. Introduction
2. Fractions
3. Percentage, Ratio, & Proportion
4. Systems of Measurement
5. Measuring Instruments
6. Elements of Algebra
7. Elements of Geometry
8. Essentials of Trigonometry
9. Descriptive Terms for Basic Hull Measurement

LESSON 3: Introduction To Hydrostatics 1

1. Introduction
2. Integration Rules
3. Displacement
4. Center of Buoyancy
5. Wetted Surface
6. Center of Gravity
7. Coefficients of Form
8. Curve of Areas

LESSON 4: Review

Topics in lessons 1, 2 and 3

LESSON 5: PRINCIPLES OF RESISTANCE

1. Basic Fluid Characteristics

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2. Frictional Resistance
 - a. Boundary Layer
 - b. Reynolds Number
3. Residual Resistance
4. Wind Resistance
5. Resistance Peculiar to Sailboats
6. Metacentric Analysis
7. Resistance and Powering
8. Calculating Frictional Resistance
9. Estimating Displacement Requirements for Displacement Boats

LESSON 6: Stability 1 - Transverse Stability

1. Introduction
2. Principles of Transverse Stability
3. Hull Design Factors that Influence Transverse Stability
4. Initial Stability Calculations
5. Heeled Stability
6. Curves of Statical Stability
7. Sea States
8. Dynamic Stability

LESSON 7: Design Practicum - Preliminary Sketching

1. Employ a segment of the design spiral to solve a typical design office problem.
2. Explore several alternatives in order to arrive at the best solution.
3. Present best solution graphically in the form of a preliminary sketch.

LESSON 8: Stability 2 - Longitudinal Stability

1. Trim and Flotation
 - a. Change in level flotation
 - b. Immersion Calculations
2. Longitudinal Stability
 - a. Longitudinal GM
 - b. Longitudinal Moment of Inertia of Waterplane
3. Calculations for Change of Trim
 - a. Moment to trim 1 inch (or 1 centimeter)
 - b. Correcting out of trim conditions
4. Design Considerations
 - a. Variable Loads
 - b. Comfort Zones
 - c. Roll Period
5. Dynamics
 - a. Pitching
 - b. Heel and Trim in Sailboats
 - c. Pitchpoling, Chine Walking, Porpoising
 - d. Trim Tabs

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LESSON 9: Review

Topics lessons 1 thru 8 as needed to clarify concepts or methods

LESSON 10: Introduction To Marine Drafting

1. Design/Graphics/Communication
 - a. The design Process Revisited
 - b. Where do ideas come from?
 - c. Level 1, 2, 3, and 4 design phases
 - d. Sketching
2. Drawing Instruments and Media
 - a. Equipment and Materials List for Manual Drafting
 - b. Drafting Tables
 - c. Pencils and leads
 - d. Media
 - e. Scales and Planimeters
 - f. Ships Curves, splines, and Spline Weights
3. Layout of Sheets and Scales
4. Lettering
5. Practical Exercises
6. Computer Aided Drafting

LESSON 11: Drawing Of Hull Lines

1. The meaning of a Set of Lines
2. Relative Importance of Various Lines
3. V-Bottom hulls
4. Round Bottom Hulls
5. Layout
6. Drawing the Designed Waterline
7. Sketching in the Section Lines
8. Purpose of Diagonals
9. Buttocks
10. The Fairing Process
11. The Offset Table
12. Parallel Buttock Principle
13. Form and Proportion
14. A working Procedure for Drawing a Set of Lines
15. Hull Line Examples
 - a. Contemporary High Speed Deep-V planing hull
 - b. 42' Medium Displacement Sailing Yacht
 - c. 43' Sportfisherman
 - d. 22' Contemporary V-Bottom Runabout
 - e. 13.7m IMS Cruiser/Racer
16. Computer Aided Yacht Design Tutorial

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LESSON 12: Course # Module 1 Comprehensive Examination

1. Solve practical problems in hydrostatics.
2. Create and draw a preliminary set of hull lines based on established criterion.
3. Create and draw a finished set of hull lines and table of offsets based on the preliminary work-up

Course # Module 2 Boat and Yacht Design

Course # Module 2 Objectives

After completing this course, the student will:

1. Comprehend and demonstrate by examination the interrelations between hull and superstructure elements as they relate to form, This lesson also examines the interrelationship of various hull and superstructure elements in order to develop a design sense as it applies to form, proportion, balance, and styling.
2. Be able apply ergonomic principles in planning accommodations in order to design comfortable, attractive, safe, and utilitarian interiors.
3. Comprehend and demonstrate by examination the physical principles involved in planing and describe how a typical planing hull behaves, Be able to select hull design parameters for efficient planing mode operation, and make performance predictions and speed calculations.
4. Design a popular size and type V-bottom planing powerboat.
5. Comprehend and demonstrate by examination the theoretical and practical aspects of sail propulsion and discuss various sailing rigs and the sails that make up a typical inventory, comprehend and analyze sailing yacht lines and compute and apply design ratios. Be able to calculate sail area and evaluate a boat's power to carry sail, and be able to design a properly balanced sail plan and analyze and correct problems in existing boat sail-plan balance.
6. Be able to calculate required ballast and properly size mast and rigging.
7. Create and prepare plans and calculations for a popular size cruising or racing multihull vessel.
8. Prepare preliminary sketches and calculations for a specific design task; analyze a proposed boat on the basis of ergonomics as well as proper hull form for the intended service; prepare the following working drawings based on the preliminaries: Lines, Outboard Profile, Arrangement, Inboard Profile, and Joiner Sections, prepare a set of specified hydrostatic calculations from the faired lines and prepare a performance prediction
9. Obtain a passing grade on a series of written examinations demonstrating that the student attained the required knowledge subjects presented in this course and can apply it to correctly answering exam questions and problems

Course # Module 2 Goals

As overarching goals of this course, students will:

- Demonstrate a comprehension of the various elements that go into designing of the outboard profile (side elevation), and be able to apply ergonomic principles in planning interior accommodations,
- Be able to make a performance prediction for a high speed planing power boat and estimate trim angle, wave making resistance, frictional resistance, and required shaft horse power.
- Demonstrate ability to solve complex design problems by creating and drawing plans with the required calculations for sailboats, planing boats, and multihulls.

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This course prepares the student to work as an assistant to a yacht and boat designer with production boat building companies, or at firms engaged in private practice while continuing his/her studies. It is also the prerequisite to course # Module 3 (the third of four courses in the Yacht & Boat Design sequence).

Course # Module 2 Syllabus

LESSON 13: Profiles (Yacht Exteriors)

1. Profiles
 - Utility, Function, and Regional Design Influences
 - Recent Influences
 - Trends
2. Sheerlines
3. Three Dimensional Effects
4. Freeboard
5. Overhangs
6. Superstructure
7. Spars and Rigging
8. Visual Phenomena
9. Typical Examples

LESSON 14: Interior Design

1. Identifying Information Relevant to the Yacht Interior
2. Space Planning for the Yacht Interior
3. Lighting the Yacht Interior
4. Construction Methods and Materials for the Yacht Interior

LESSON 15: Design Practicum – Exterior And Interior Design

Prepare the following Drawings for both an approximately 35' (10.7m) LOA sailboat and a 35' (10.7m) LOA powerboat:

1. A set of lines
2. Outboard Profile and Arrangement
3. Inboard Profile
4. Joiner Sections at specified locations

LESSON 16: High Speed Power Boats

1. Basic Principles
2. Hull Characteristics which Affect Planing Performance
3. Speed Calculations
4. Spray Rails
5. Outdrives, Surface Propellers, and Rudders
6. Performance Prediction
7. Other Types of High Speed Hulls
8. Lines Plans

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LESSON 18: Sailboat Design, Part 1

1. Theory Of Sails
2. Sailing Rigs
3. Power to Carry Sail
4. Designing a Sail Plan
5. The affect of lead and other factors on performance.
6. Sailing yacht lines.

LESSON 19: Sailboat Design, Part 2

1. Ballast requirements
2. Design of Mast and other spar
3. Standing and running rigging design
4. Design of tangs and chainplates

LESSON 20: Design Practicum

Prepare specified Plans and Calculations and data sheet for a:

1. 44" LOA ketch
2. Day sailer between 16' and 18' LOA

LESSON 21: Multihull Design

1. Hull form
2. Longitudinal distribution of volume
3. Windward performance
4. Sails and rigging
5. Habitability
6. Construction
7. Mechanical systems
8. Power catamarans
9. Multihull Design Practicum / Preparation of plans and calculations

LESSON 22: Course # Module 2 - Final Exam

Comprehensive Design Practicum consisting of:

1. Project analysis for a 50' powerboat
2. Preliminary sketches and calculations for the boat for instructor approval.
3. Working drawings and calculation based on approved preliminaries.

Course # Module 3 Boat and Yacht Construction

Course # Module 3 Objectives

After completing this course students will:

1. Describe the properties of the various species of wood used in boat building, and determine the species of choice for a particular application and discuss methods of preventing decay.
2. Calculate the scantlings, prepare the construction drawings, and prepare the table of weights and center of gravity location for a wooden boat.
3. Know the properties and uses of the reinforcement fibers and material forms in current use in FRP boat building, know the purposes and properties of resin systems, additives, and gel-coats, know what forms core materials are available in, and understand how sandwich construction is used to increase resistance to bending in FRP structures, comprehend and describe the process of plug and mold construction, comprehend and describe the building processes such as hand layup, spray molding, and vacuum bagging, be able to create and prepare drawings showing how FRP components are assembled.
4. Define the plate spans, define the loads, define the maximum allowable deflection, size stringers and frames, size the hull plating, size deck and roof, plating, determine the laminate schedule for hull and deck, and determine scantling weights for a fiberglass boat.
5. Create and prepare a set of plans and specified calculations for a fiberglass boat and analyze fiberglass boat structure.
6. Describe the modular concept, balanced work stations, and component feed systems, and use the following recording methods: Drawings, patterns, cutting lists, incorporate transportation and shipping requirements into your planning, and design components so that they will be compatible with the mass production concept and production line requirements.
7. Know the advantages and disadvantages of marine aluminum, be able to specify the alloy best suited for various structural members, know the principle configurations that are commercially available, comprehend and explain how galvanic corrosion effects aluminum hulls and be able to recommend and specify methods to prevent or mitigate this problem, be able to specify surface finishing systems, be able to analyze, calculate and specify scantling of structures for welded and riveted boats, comprehend and specify the methods used to construct aluminum boats and be able to prepare working construction drawings for aluminum powerboats and sailboats.
8. Describe the basic hardware components needed for CAD. Describe which programs are used for CAD in boat design and for what purpose, describe the general sequence of steps and processes used to design a boat employing CAD. Understand and discuss basic concepts in practical applications using AutoCAD. Create a basic CAD detail drawing to precise CAD-drawing specifications to demonstrate mastery of the CAD software and CAD drawing procedures.
9. Successfully complete a design practicum by preparing specified plans and

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calculations for a 48-ft. LOA sport fishing boat.

Course # Module 3 Goals

As overarching goals of this course students will:

- Have the extensive knowledge of wooden boat construction and be able to create and produce the working construction drawings for wooden boats,
- Create and prepare plans for a fiberglass boat including all structural and hydrostatic calculations.
- Create and prepare plans and calculations for a popular-size aluminum power boat.

This course prepares the student to work as a junior yacht or boat designer with production boat building companies, or at firms engaged in private practice while continuing his/her studies. It is also the prerequisite to course # Module 4 (the final courses in the yacht and boat design sequence).

Course # Module 3 Syllabus

LESSON 23: Wood Boat Construction

1. Properties of Wood
2. Fastenings and Adhesives
3. Keel Assemblies
4. Framing
5. Planking
6. Deck Framing
7. Decking
8. Deck Joinery
9. Interior Joinery
10. Miscellaneous Details
11. Scantlings

LESSON 24: Design Practicum – Wood Construction

Students will demonstrate their knowledge of wooden boat construction by performing all specified design tasks needed to select the materials, calculate the scantlings and produce the working construction drawings for a specified boat. Drawings shall consist of a construction profile, frame and beam plan, and 3 construction sections.

LESSON 25: Fiberglass Boat Construction - Part I

1. Introduction (What is Fiber Reinforced Plastic?)
2. Materials used for Boat Construction
3. Production Applications of Fiberglass & Resin Systems
4. Construction
5. Freedom and Limitations in Styling
6. Physical and Mechanical Properties of Materials
7. Assembly of Fiberglass Reinforced Plastic Components and Secondary Structures

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LESSON 26: Fiberglass Boat Construction - Part II - Design Of Laminates

1. Introduction
2. Defining Loads
3. Sizing the Frames
4. Sizing the Hull Plating
5. Sizing the Deck Plating
6. Developing the Laminate Schedule

LESSON 27: Design Practicum – Fiberglass Construction

Students will demonstrate their knowledge of fiberglass boat construction by drawing specified plans to proper scale for a fiberglass sail boat. Drawings shall include lines, sailplan, outboard profile and deck plan, inboard profile and arrangement, and construction profile, plan, and sections. Prepare all specified calculations including stability, sail, mast and rigging, and fiberglass structure analysis and specification.

LESSON 28: Fiberglass Boatbuilding – Production Methods

1. Introduction and Scope
2. Recording Methods
3. Design for Transportation
4. The Mass Production Concept
5. Computer Aided Manufacture (CAM)

LESSON 29: Aluminum Yacht Design And Construction

1. Introduction and General Considerations
2. Marine Aluminum Alloys and their Uses
3. Construction Methods
4. Special Design Features
5. Corrosion and Electrolysis
6. Finishes and Finishing Systems
7. Scantlings and Structural Calculations
8. Specifications
9. Design Practicum / 48' custom aluminum sportfishing boat.

LESSON 30: Introduction To Computer Aided Yacht Design

1. Overview of General Concepts in CAD
2. Description of Hardware Required for CAD
3. Description of Software used for CAD in the Marine Industry
4. Understanding of Basic Concepts in Practical Applications of AutoCAD
5. Detailed Directions, Suggestions, and Hints for AutoCAD Use
6. Understanding of Setting Up AutoCAD drawings
7. Explanation of Important AutoCAD Commands and Tools
8. Explanation of Advanced AutoCAD Formatting and Object Properties
9. Practical AutoCAD Drawing Review and Test

LESSON 31: Module 3 Comprehensive Examination

Students will demonstrate knowledge of aluminum construction methods by preparing calculations and construction plans for a 48' sportfishing boat of aluminum construction: Proposition: A client has engaged your firm to design their new aluminum sport fishing boat. In addition to the list of specifications for power and interior accommodations, the boat is to have a flying bridge steering station and a second steering station in the cockpit. The cockpit shall be designed specifically for sport fishing with all necessary amenities. You are to prepare all specified plans and calculation including aluminum scantlings.

Course # Module 4 Marine Systems Engineering

Course # Module 4 Objectives

After successfully completing this course students will:

1. Describe the basic operation of gasoline and diesel engines, interpret the data contained in marine engine performance curves, analyze a boat's propulsion requirements, select and specify the main propulsion machinery as well as related sub-systems, design the installation of propulsion machinery and related sub-systems.
2. Comprehend and describe how a marine propeller works, identify the various parts of a propeller, and describe their function, analyze a boat's propulsion requirements, estimate horsepower requirements and boat speed, select the correct propeller for a particular boat, determine correct size of propeller shafting.
4. Understand electrical system requirements for sailboats and powerboats including, fundamentals, bonding and grounding, battery powered systems, generators, shore power wiring and circuit protection, galvanic corrosion, and be able to design electrical systems for yachts containing both AC and DC components.
5. Specify and be able to incorporate the following marine systems and equipment into a design: steering, refrigeration, water systems, bilge pumps, sanitation systems, fuel systems, cooking stoves, environmental control, navigation lights, deck equipment, and firefighting equipment.
6. Be able to discuss the function of specifications and the relationship between specifications and plans, and be able to write a clear, concise and complete set of specifications.
7. Describe the aspects of setting up a private yacht or boat design practice and the duties and responsibilities of a staff designer employed by a production boat building company.
8. Successfully pass the final design thesis by proposing, and preparing complete working plans, calculations, and specifications for two boats—a sailboat and a powerboat. The theses will demonstrate that the student has acquired the full range of knowledge and skills required to design complete boat designs, including all analysis and conceptual design, all detail working drawings and calculations and specifications.

Course # Module 4 Goals

As overarching goals of this course students will:

- Select and specify the main propulsion machinery as well as related sub-systems, design the installation of propulsion machinery and related sub-systems.
- Properly size a propeller and shaft and design its installation.
- Learn what the requirements of a good marine electrical system are, and how to design such a system.
- Specify systems and equipment required for navigation, sanitation, safety, and comfort.
- Be able to write a set specifications describing all the details of a vessels design

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- Be able develop a design thesis (practicum) that is judged acceptable by the faculty in demonstrating a mastery of all the subject matter contained in all four courses/modules.

This is the final course in a four-course sequence. Passing this course indicates that the graduate is prepared perform the duties of a professional yacht and boat designer starting at the entry level with production boatbuilding companies, or independent yacht design firms engaged in private practice.

Course # Module 4 Syllabus

LESSON 32: Propulsion Systems Part 1 – Marine Engines

1. The Gasoline Engine
 - a. 2-Stroke and 4-Stroke Cycles
 - b. Timing
 - c. Ignition
 - d. Throttle
 - e. Cooling System
 - f. Lubrication
 - g. Electric System
2. Diesel Engines
 - a. 2-Stroke and 4-Stroke Cycles
 - b. Comparing Gasoline to Diesel
 - c. Lubrication
 - d. Cooling System
3. Power Curves
4. Sterndrives and Outboards
5. Instruments
6. Installation Problems
7. Fuel System Regulations

LESSON 33: Propulsion Systems Part 2 – Propellers and Rudders

1. The Propeller in Theory
2. Calculations for Speed Determination
3. Propeller Determination (Calculation and Specification)
4. Propeller Shafting
4. Rudder in Theory
5. Types of Rudders
6. Rudder Stock Size Calculation and Specification

LESSON 34: Marine Electrical Systems

1. Definition of Terms
2. Graphic Symbols
3. Basic Circuits and Calculations
4. Bonding, Grounding and Lightning Protection
5. Battery Powered Systems – Engine-Propelled Boats
6. Calculation DC Loads

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7. Shore Power Systems (AC)
8. Electrical Wiring and Circuit Protection
9. Galvanic Corrosion
10. Sailboat Electric Systems
11. Electric System Regulations

LESSON 35: Systems and Equipment

1. Steering Systems
2. Marine Refrigeration
3. Water Systems
4. Bilge Pumping and Cockpit Drainage
5. Sanitation Systems
6. Fuel Systems
7. Marine Stoves
8. Ventilation/Environmental Control
9. Air/Conditioning
10. Navigation Lights
11. Deck Equipment
12. Firefighting Systems

LESSON 36: Specifications

1. Example Specifications and Related Drawings
2. Guidance on Writing Specifications

LESSON 37: Professional Practice

1. Getting Started
 - a. Establishing Goals
 - b. Finances
 - c. Personal Responsibilities
 - d. Insurance
 - e. Establishing a Design Office.
2. Marketing
 - a. Introduction
 - b. Advertising
 - c. Former Employers
 - d. Design Reviews
 - e. News Letters
 - f. Visiting Builders
 - g. Memberships
3. Contracts
 - a. Protecting Preliminary Work
 - b. Contracts
 - c. Conceptual Design Contracts
 - d. Royalty Contracts
 - e. Vessel Inspection
 - f. Designer Recognition

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- g. Legal Council
- h. Payment
- 4. Financial Management
 - a. Bookkeeping and Accounting
 - b. Taxes
- 5. The Boating Industry Designer
 - a. Organizational Structure
 - b. Job Responsibilities
 - c. Related Responsibilities
 - d. Advantages and Disadvantages

LESSON 38: Four-Module Design Thesis

The student is to prepare two complete boat designs, one power and one sail, one in aluminum and the other in fiberglass. Detailed proposals for both designs are presented to the instructor for review and approval. Upon approval, the student completes both designs, including all structural, stability, speed and powering, weight and hydrostatic calculations, complete detailed working drawings, electric system specifications and overall specifications. In order to graduate, the student must demonstrate a strong grasp of all the aspects of design taught throughout all four modules at a professional or near professional level.