



## **NAVAL ARCHITECTURE – TECHNOLOGIST (NATY 2021)**

### **Preamble**

The Canadian Technology Standards (CTS) are a collection of learning outcomes for Canada's engineering technology and applied science profession at the technician and technologist level.

### **Stakeholders**

The CTS may be utilized by accreditation bodies, provincial professional associations, educational institutions, government agencies, industry and others for the purposes accreditation, certification and other applications.

### **Educational Programs**

The Naval Architecture CTS is relevant to programs including, but not limited to, marine vessels and structures design, and marine vessels modification or refit at the at the technologist level.

### **Learning Outcomes**

This CTS list Discipline Learning Outcomes (DLO) which describe the significant and essential learning that students have achieved and can reliably demonstrate at the time of graduation. Each DLO has a number of Learning Outcome Indicators (LOI), which are examples illustrating, defining and clarifying the level of performance expected. The list of LOI is not comprehensive and there may be other indicators which can be used to assess achievement of learning outcomes.

### **Graduate Capability**

Students graduating from an accredited program have demonstrated achievement of all general learning outcomes, including a prescribed level of math, and discipline learning outcomes selected by the program.

Having completed a program that is based on applied mathematics and scientific and engineering theory, principles and practices and having acquired the knowledge, skills and attitudes to function in the work place, graduates are;

- able to evaluate assignments, establish objectives, set parameters and determine appropriate procedures and actions.
- able to exercise due diligence in the workplace and adhere to related practices, applicable laws and health and safety practices.
- able to work in accordance with labor-management principles and practices.
- able to work independently or interdependently as part of a discipline or multi-disciplinary team.
- prepared to assume responsibility for their work.

### **Graduate Career Opportunities**

Graduates of Naval Architecture Technology - Technologist programs have career opportunities in such areas as: business, industry, construction, government, and public organizations. They may find employment in careers such as: design and construction of merchant and naval vessels, boats, and offshore structures; interpretation or preparation of specifications, technical drawings, or instructions; quality management and inspection; project management and contract management; administration; construction, operations; field and customer service; estimating; technical sales; supervision of projects; and training activities.

## Discipline Learning Outcomes (DLOs)

### **NATY01 Ship/Boat Hull Design**

- Design hulls for ships and boats.

Learning Outcome Indicators include:

- 1.1 Identify and clarify requirements of project stakeholders.
- 1.2 Discuss typical deliverables for concept, preliminary, contract, and detail design stages of design process.
- 1.3 Analyze construction documents including design and production drawings and specifications.
- 1.4 Prepare and present information as graphics using standard drafting convention.
- 1.5 Survey and document as-built modifications to produce as-built drawings.
- 1.6 Prepare and present project-related information in oral and written formats.
- 1.7 Create hand-drawn sketches.

### **NATY02 Ship /Boat Propulsion System Design**

- Design propulsion systems for ships and boats.

Learning Outcome Indicators include:

- 2.1 Discuss components of ship resistance, relationship between these components, and application of components on various operating conditions.
- 2.2 Explain and calculate ship hull frictional resistance and wave-making resistance.
- 2.3 Relate scale model testing techniques and correlation of model test results to full scale.
- 2.4 Calculate and discuss effective power using model test data or systematic series data.
- 2.5 Outline other components affecting ship resistance such as air, sea, and appendage resistance and potential benefits of fitting bow and stern bulbs.
- 2.6 Determine most efficient and effective system for vessel being designed by calculating installed power requirements based on evaluated propulsion systems and prime movers.
- 2.7 Calculate fuel consumption using empirical methods and explain factors affecting fuel consumption.
- 2.8 Design appropriate shafting arrangement based on vessel's hull form, number of screws, and prime mover and gearbox arrangement.
- 2.9 Apply classification for society and government agency rule requirements to shafting arrangements.
- 2.10 Calculate propeller slip, developed thrust, and power to be delivered to propeller and explain geometry of screw propeller.
- 2.11 Select appropriate propeller for given application based on propeller efficiency, cavitation, and tip clearance requirements, using propeller standard series.
- 2.12 Create speed versus power curve to show practical limitations on hull speed versus propulsion power requirements.

### **NATY03 Ship/Boat Electrical Mechanical Systems Design**

- Design electrical and mechanical systems for Ship and or Boat.

Learning Outcome Indicators include:

- 3.1 Prepare piping and electrical system single line diagrams.
- 3.2 Determine required capacity of given piping system including pumps.
- 3.3 Calculate HVAC duct and fan capacity based on compartment type, volume, and number of air changes required.
- 3.4 Perform electrical load analysis to determine maximum generating power required for ship service and emergency loads.
- 3.5 Validate that all systems meet or exceed all classification, governmental, and IMO regulations as designed.

### **NATY04 Ship Construction**

- Analyze and resolve technical problems related to ship construction projects applying principles of modern ship construction practices.

Learning Outcome Indicators include:

- 4.1 Create design and production drawings applying knowledge of modern ship construction build strategies.
- 4.2 Apply 'design for production' principles to anticipate and minimize technical problems in design and production stages of project.
- 4.3 Design and analyze ship and boat construction projects applying appropriate mathematical and scientific principles.
- 4.4 Resolve construction problems applying combined knowledge of shipbuilding materials, fabrication methods, cost, and environmental concerns.

### **NATY05 Bid Documents**

- Interpret, analyze and prepare bid/contract documents.

Learning Outcome Indicators include:

- 5.1 Identify various types of contracts and their legal implications on project and stakeholders involved.
- 5.2 Outline estimating procedures used for shipyard to prepare bid based on given project contract specification.
- 5.3 Discuss tendering process used by government and private sector.
- 5.4 Explain importance of coordinating specifications with drawings.
- 5.5 Create technical reports and other project documentation related to contract tendering and bidding.
- 5.6 Collaborate in preparation of preliminary and detailed cost estimates.

- 5.7 Determine actual costs and profitability of previous projects utilizing data from those projects.
- 5.8 Explain how shipyard uses past cost records to arrive at new ship price.
- 5.9 Explain process for obtaining quotes from sub-contractors for specific parts of project specification.

### **NATY06 Project Management**

- Apply principles of project management.

Learning Outcome Indicators include:

- 6.1 Assess, monitor, document, and present progress reports for construction projects.
- 6.2 Schedule projects utilizing critical path planning techniques.
- 6.3 Verify inspection of construction projects.
- 6.4 Modify project schedules by interpreting and applying results of quality assurance testing.
- 6.5 Explain role of shipyard planning office.
- 6.6 Monitor projects by comparing activities and results to data from a variety of sources, including reports, minutes, field data and field notes, site inspections, established criteria, site and weather demands, schedule, projected cost estimates, and actual costs.
- 6.7 Collaborate in resolution of construction problems related to materials, scheduling, resources, and budgetary concerns in order to implement and complete construction projects.
- 6.8 Create deficiency lists and take appropriate actions to resolve deficiencies.

### **NATY07 Stability Calculations**

- Create complete set of hydrostatic data defining stability characteristics of given vessel by performing static stability calculations.

Learning Outcome Indicators include:

- 7.1 Explain relationship between ship hull form and static stability characteristics.
- 7.2 Calculate static stability data using various methods including software commonly used in industry to produce hydrostatic curves.
- 7.3 Interpret information required from hydrostatic curves and their uses and applications.
- 7.4 Calculate location of a vessel's centre of gravity for any condition of loading.
- 7.5 Calculate new location of vessel's centre of gravity when mass is lifted, shifted, loaded, or unloaded from vessel.
- 7.6 Calculate effect of fluid-free surface on stability of a vessel.
- 7.7 Calculate transverse and longitudinal GM and determine change in list or trim due to added mass or shift of mass aboard the vessel.

## **NATY08 Documentation Requirements**

- Prepare complete trim and stability book to government agency requirements, including damaged stability and icing conditions for given vessel.

Learning Outcome Indicators include:

- 8.1 Explain effects of varying height of centre of gravity, dimensions of beam, freeboard, length and draft, and displacement on large angle stability.
- 8.2 Create drawing of cross curves of stability from righting-arm versus displacement data obtained using software commonly used in industry.
- 8.3 Explain principles of righting-arms, moments, and significance of metacentric height when assessing vessel's stability characteristics.
- 8.4 Create drawing curves of statical stability and determine areas under curve, maximum righting arm, and vanishing point.
- 8.5 Explain government agency criteria for stability assessment and the associated stability standards for each ship type.
- 8.6 Explain theoretical basis for inclining test and describe how inclining test is carried out aboard vessel.
- 8.7 Explain how location of centre of gravity is determined for vessel in given condition using inclining test data.
- 8.8 Calculate volumes of full, partially-full, regular, and irregular shaped tanks, making allowance for structure within tank.
- 8.9 Explain all elements required in complete stability book prepared for submission to government agency for approval.
- 8.10 Determine required operating conditions to be included in trim and stability book based on vessel type, including worst foreseeable condition and icing condition (if applicable).

## **NATY09 Ship Inspection**

- Survey and inspect existing vessels and prepare general condition, refit, and damage reports, and refit and repair specifications.

Learning Outcome Indicators include:

- 9.1 Implement field surveys and measurements of existing vessels as required.
- 9.2 Create complete scale drawings of existing vessels as required.
- 9.3 Prepare reports, cost estimates, and other documentation.

## **NATY10 Structural Design**

- Design efficient structural arrangement for given ship type based on vessel size, hull form, service area, internal volume requirements, and openings in decks and hull.

Learning Outcome Indicators include:

- 10.1 Determine framing system most suited to hull form and length of vessel.
- 10.2 Explain role of various components of ship's structure in overall strength of hull.

- 10.3 Explain magnitude of longitudinal stresses on ship's hull and importance of adequate longitudinal strength.
- 10.4 Explain various modes of failure of ship's structure and importance of continuity in structural arrangement.
- 10.5 Discuss impact structural arrangement has on general arrangement of ship.
- 10.6 Calculate all ship structural components (primary and secondary) using first principles and classification society rules.
- 10.7 Create drawings of complete profile and decks including construction and amidships sections using CAD software commonly used in industry.
- 10.8 Assess impact that configuration of structure will have on initial cost of construction of vessel.
- 10.9 Assess impact of structural weight on carrying capacity of vessel and overall vessel performance.
- 10.10 Explain impact on hull strength and stresses caused by large hatch openings or openings in side shell.
- 10.11 Determine scantlings of additional structure required for various ice classes using classification society rules.

#### **NATY11 Outfit Materials and Equipment**

- Select appropriate outfit materials and equipment for given vessel for accommodation, mooring, access, lifesaving, and cargo handling purposes.

Learning Outcome Indicators include:

- 11.1 Specify appropriate joiner bulkheads, linings, ceilings, deck coverings, and furnishings for working and accommodation spaces in accordance with government agency and IMO requirements.
- 11.2 Specify appropriate insulations for various applications in accordance with regulatory requirements.
- 11.3 Design internal and external stairways and ladders for efficient and safe access to all areas of vessel.
- 11.4 Specify and arrange appropriate anchoring and mooring equipment to satisfy classification society and government agency rules.
- 11.5 Determine capacity and type of various lifesaving appliances and appropriate locations for these items as per regulatory requirements.
- 11.6 Specify and arrange cargo handling systems such as cranes, masts and derricks, elevators, ramps, or cargo handling piping systems in accordance with rule requirements.
- 11.7 Explain appropriate use and location of various types of watertight doors, hatches, and manholes.
- 11.8 Create various firefighting, life- saving, fire zone, and escape route key plans for posting aboard ship as per government agency requirements.
- 11.9 Recommend appropriate active or passive cathodic protection system for given vessel based on principles of galvanic corrosion.

- 11.10 Specify appropriate paint systems for all external ship surfaces including underwater hull, topsides, superstructure, and decks.
- 11.11 Specify appropriate paint systems for all internal surfaces such as accommodation areas, machinery spaces, dry cargo holds, and inside cargo, ballast, fresh water, and fuel tanks.

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