THE TOOLBOX GUIDE

Curriculum	
Learning Objectives	SkillSea Future Skills and Competence Needs (Possible Future Development) report stresses that future maritime professionals will require a solid foundation and understanding of science, technology, engineering and mathematics (STEM). This educational package aims to teach students the relevant fundamental concepts surrounding numeral, scientific and engineering skills and their application in the shipboard context. This knowledge is expected to allow maritime professionals to improve their achievement and success during their studies in nautical, electro-technical and engineering programmes, provide the underpinning knowledge required to pursue further technical careers and enable them to appreciate the changing nature of the maritime industry. The course may be delivered across three levels: - Level 1 (Basic): Fundamental STEM concepts to solve simple problems related to everyday life and maritime/shipboard context. - Level 2 (Intermediate): Application of STEM concepts in a shipboard environment and solving practical problems connected to engineering, navigation and other shipboard functions. - Level 3 (Applied): Application of STEM concepts in shipboard and broader maritime context to solve complex problems connected to engineering, navigation and other shipboard functions. This EP will focus on level 1 only. *Please see the resources file for more information on levels 2 and 3. The learning objectives focus on knowledge and skills related to physics, atmospheric physics/environment, mathematics, geography, planetary systems, and basic computer science.

Target group	Level 1 of the EP targets individuals from high school (EQF Levels 2 and 3) and existing maritime professionals wishing to upskill to pursue a seagoing career as a deck, marine engineering, marine electro-technical officer or a shore-based career.
Entry requirements	As this is an introductory EP, the entry requirements should match the requirements of the training provider.
Duration	The EP duration will be approximately 35 hours, equivalent to 1.3 ECTS. The suggested duration could be adjusted based on the outcomes of diagnostic assessments, which is strongly recommended to account for variations between national educational systems and the group profile. Lecturers might wish to select topics from the suggested scheme of work to suit their students' needs and future specialisation.
Assessment	The formative process so students can get the opportunity to assess their progression and development using self-assessment quizzes.

Course Outline	The course consists of 6 modules: **1. Physics** 1.1. Basic definitions and units used: SI units (Mass/Weight/Force/Speed/Acceleration/Velocity etc.) 1.2. Newton's Laws of Motion (Inertia, Momentum, Force) 1.3. Energy, Work, Power 1.4. Distance-Time Graphs, Velocity-Time Graphs and Calculations. 1.5. Friction and Resistance. 1.6. Archimedes principle 1.7. Atoms, nuclei, molecules, radiation, charge, current, Electric and Magnetic fields 1.8. Properties of Light: Colour, Reflection, Refraction, Scattering, Diffraction. **2. Atmospheric Physics/ Environment** 2.1. Pressure / Temperature / Volume, Definitions / Relationship. 2.2. Gas laws / Ideal gases. 2.3. Heat Transfer Mechanisms: Conduction, Convection, Radiation. 2.4. Evaporation / Condensation / Sublimation – Energy exchange 2.5. Greenhouse effect / Global Temperature rise. **3. Mathematics** 3.1. Basic calculations and rearranging equations 3.2. Basic definitions, units, and conversion. 3.3. Basic statistics: mean, mode, median, standard deviation, and other distributions. 3.4. Trigonometry: Triangles: Areas, Angles (Sine/Cosine/Tangent), Sine and Cosine Rule, Pythagoras. 3.5. Spherical Trigonometry. 3.6. Vectors/Scalars. 3.7. Matrices. 3.8. Introduction to Calculus. **4. Geography** 4.1. Map of the World. Continents / Countries / Time zones. 4.2. Oceans / Seas / Rivers / Canals. 4.3. Major shipping routes. **5. Planetary systems** 5.1. The Solar System. Planets / Stars. 5.2. Day / Night – Orbits. 5.3. Introduction to Almanac for Level 1. **6. Basic computer science** 6.1. Understanding computer terms

	6.2. Data types Operators and Codes. 6.3. Computer system architecture 6.4. Simple Computer Programming.
Learning Outcome	At the end of this course, students will be able: **Level 1 (Basic)** **1 Knowledge** 1. Identify key mathematics information and recall equations related to academic and professional skills. 2. Recall key factual information relating to physics for academic and professional skills. 3. Identify key computing and informatics knowledge related to maritime academic and professional skills. 4. Recall geography knowledge of the world relevant to the maritime industry and know major shipping routes. **2 Skills** 1. Use STEM knowledge to recognise simple problems. 2. Solve basic STEM problems using various numbers and matrices. 3. Interpret basic computer science data. 4. Differentiate between the different components of the planet's geography. **3 Responsibilities and autonomy** 1. Describe problem-solving techniques using obtained STEM knowledge and skills. 2. Reflect on the limits of their STEM knowledge and skills and communicate their advanced needs. 3. Use IT skills for everyday and basic maritime tasks. 4. Demonstrate an awareness of the links between atmospheric physics and weather forecasts.

Teaching methods	This package is expected to utilise various teaching methods to reflect the nature of the disciplines. It is strongly encouraged to seek opportunities to integrate digital skills, teamwork, leadership and problem-solving skills alongside STEM activities. It also allows students to apply STEM knowledge in real-life scenarios to consolidate their knowledge in a simulated environment. In this regard, group and pair activities could provide additional benefits and peer-to-peer feedback and evaluation.
Teaching material	The main criteria in developing teaching material should be to consider the ability of students to appreciate the importance and application of relevant STEM knowledge to daily shipboard operations. For examples, refer to the lesson plans attached to this toolbox.
Assessment	The formative process so students can get the opportunity to assess their progression and development using self-assessment quizzes.
Evaluation	
Course Review	The students will complete a survey at the end of the course. Lecturers will review the survey outcomes and provide their reflections, with possible actions for developers/deliverers to consider.

Appendix 1 – Table of Constructive Alignment – Level 1 only

Module №	**Lesson topics**	**Learning outcomes** (Numerated as per toolbox guide)	**Approx. Module Duration**	**Examples of Teaching method(s)**	**Examples of Assessment methods**
1	**Physics** 1. Basic definitions and units used: SI units (Mass/Weight/Force/Speed/Acceleration/Velocity etc.) 2. Newton's Laws of Motion (Inertia, Momentum, Force) 3. Energy, Work, Power 4. Distance-Time Graphs, velocity-Time Graphs and Calculations. 5. Friction and Resistance. 6. Archimedes principle 7. Atoms, nuclei, molecules, radiation, charge, current, Electric and Magnetic fields 8. Properties of Light: Colour, Reflection, Refraction, Scattering, Diffraction.	LO 1.1 & 1.2 LO 2.1 & 2.2 LO 3.1, 3.2 & 3.3	8h	Lecture Tutorials Supported Research Group Discussions Worked Examples Experiments Questioning Case Studies	Group Discussions Peer Assessment Self-Assessment Questioning Calculations Quizzes
2	**Atmospheric Physics/Environment** 1. Pressure / Temperature / Volume, Definitions / Relationship. 2. Gas laws / Ideal gases. 3. Heat Transfer Mechanisms: Conduction, Convection, Radiation. 4. Evaporation / Condensation / Sublimation – Energy exchange 5. Greenhouse effect / Global Temperature rise.	LO 1.1 & 1.2 LO 2.1, 2.2 & 2.3 LO 3.1, 3.2 & 3.4	5h	Lecture Tutorials Supported Research Group Discussions Worked Examples Experiments Questioning Case Studies	Group Discussions Peer Assessment Self-Assessment Questioning Calculations Quizzes

3	**Mathematics** 1. Basic calculations and rearranging equations 2. Basic definitions, units, and conversion. 3. Basic statistics: mean, mode, median, standard deviation, and other distributions. 4. Trigonometry: Triangles: Areas, Angles (Sine/Cosine/Tangent), Sine and Cosine Rule, Pythagoras. 5. Spherical Trigonometry. 6. Vectors/Scalars. 7. Matrices 8. Introduction to Calculus.	LO 1.1 LO 2.1 & 2.2 LO 3.1 & 3.2	8h	Lecture Tutorials Supported Research Group Discussions Worked Examples Questioning	Group Discussions Peer Assessment Self-Assessment Questioning Calculations Quizzes
4	**Geography** 1. Map of the World. Continents / Countries / Time zones. 2. Oceans / Seas / Rivers / Canals. 3. Major shipping routes.	LO 1.2, 1.3 & 1.4 LO 2.3 & 2.4 LO 3.3	3h	Lecture Group work Practical Exercises Case Scenarios	Self-Assessment Presentations Questioning
5	**Planetary Systems** 1. The Solar System. Planets / Stars. 2. Day / Night – Orbits. 3. Introduction to Almanac for Level 1.	LO 1.1, 1.2 & 1.3 LO 2.3 LO 3.3	3h	Lecture Group Work Case Scenarios VLE support	Self-Assessment Presentations Questioning
6	**Basic Computer Science** 1. Understanding computer terms 2. Data types, operators and codes 3. Computer system architecture 4. Simple Computer Programming.	LO 1.1, 1.2 & 1.3 LO 2.2 & 2.3 LO 3.1 & 3.3	4h	Classroom presentations Supported Research VLE Based Support Practical Exercises Group Discussions Guided Tasks	Group Discussions Self-Assessment Practical Tasks Questioning

Appendix 2 – Example Lessons

Module 1 – Lesson 1.6: Archimedes Principle

1.0 Introduction

Why do some things float and others don't? This lesson will introduce the person behind the answers and the principles seafarers still use today.

2.0 Learning Outcomes.

The participants at the end of this module will achieve the following LOs:

LO 1.1 Identify key mathematics information and recall equations related to academic and professional skills.
LO 1.2 Recall key factual information relating to physics for academic and professional skills.

LO 2.1 Use STEM knowledge to recognise simple problems.
LO 2.2 Solve basic STEM problems using various numbers and matrices.

LO 3.1 Describe problem-solving techniques using obtained STEM knowledge and skills.
LO 3.2 Reflect on the limits of their STEM knowledge and skills and communicate their advanced needs.
LO 3.3 Use IT skills for everyday and basic maritime tasks.

After the session, students will be able

1. Investigate Archimedes and some of their achievements
2. Identify Archimedes' principle
3. Discuss buoyancy, displacement, and Archimedes' principle

3.0 Teaching Methods

A PowerPoint has been provided as a prompt for the topics and discussion points. However, it relies on the tutor encouraging discussion of the statements/ideas/facts and incorporating their understanding of the topics into the session. For example, although not mentioned in the PowerPoint, the tutor may wish to use beakers, objects, and water to demonstrate the principle and some of the definitions. The PowerPoint also includes images and a brief video, which can catalyse further questioning and discussion.

4.0 Module Content
4.1 Lesson plan

Approx. Time	Contents	Learning Outcomes	Resources
0 - 5	Introduction PP S1		PowerPoint M1 1.6 Links to sources VLE Material Tutor materials
5 - 15	Archimedes PP S2 - 5	1	PowerPoint M1 1.6 Links to sources

			VLE Material Tutor materials
15 - 35	Archimedes' Principle PP S6 - 12	2, 3	PowerPoint M1 1.6 Links to sources VLE Material Tutor materials Suggestion: Beakers, objects, and water
35 - 40	2 Questions PP S13	3	PowerPoint M1 1.6
40 - 50	Group Discussion PP S14	3	PowerPoint M1 1.6 Links to sources VLE Material Tutor materials
50 - 60	Recap and Questions PP S15	1, 2, 3	PowerPoint M1 1.6

4.2 Teaching Materials

4.2.1 PowerPoints

- PowerPoint M1 1.6
- Tutor materials

4.2.2 Websites

- Links available in PowerPoint M1 1.6
- The tutor may wish to include additional links within the VLE

4.3 Socrative Questioning.

- Built into PowerPoint M1 1.6
- The tutor may wish to modify the questions and add more to the VLE through quizzes.

4.4 Self-Assessment quiz for a topic

To be built into the VLE.
It is suggested that question types include:

- True or False
- Multiple choice
- Calculations

Module 2 – Lesson 2.1: Pressure/Temperature/Volume

1.0 Introduction

Why do cold things generally shrink, and hot things generally expand? This lesson will consider the relationships between temperature, volume, and pressure.

2.0 Learning Outcomes.

Module 1:

LO 1.1 Identify key mathematics information and recall equations related to academic and professional skills.
LO 1.2 Recall key factual information relating to physics for academic and professional skills.

LO 2.1 Use STEM knowledge to recognise simple problems.
LO 2.2 Solve basic STEM problems using various numbers and matrices.
LO 2.3 Interpret basic computer science data.

LO 3.1 Describe problem-solving techniques using obtained STEM knowledge and skills.
LO 3.2 Reflect on the limits of their STEM knowledge and skills and communicate their advanced needs.
LO 3.4 Demonstrate an awareness of the links between atmospheric physics and weather forecasts.

After the session, students will be able to:

1. Define the three terms.
2. Discuss examples linked to the three terms.
3. Identify relationships between the three terms.

3.0 Teaching Methods

A PowerPoint has been provided as a prompt for the topics and discussion points. However, it relies on the tutor encouraging discussion of the statements/ideas/facts and incorporating their understanding of the topics into the session. For example, although not mentioned in the PowerPoint, the tutor may wish to use practical examples based on their available resources. The PowerPoint also includes images, which can be used as catalysts for further questioning and discussion.

4.0 Module Content

4.1 Lesson plan

Approx. Time	Contents	Learning Outcomes	Resources
0 - 5	Introduction PP S1		PowerPoint M2 2.1 Links to sources VLE Material Tutor materials
5 - 15	Definitions PP S2 - 8	1, 2	PowerPoint M2 2.1 Links to sources

			VLE Material Tutor materials
15 - 25	Question for discussion PP S9 - 10	2, 3	PowerPoint M2 2.1
25 - 40	Relationships PP S11 - 15	2, 3	PowerPoint M2 2.1 Links to sources VLE Material Tutor materials
40 - 50	Question for discussion PP S16 - 17	2, 3	PowerPoint M2 2.1 Links to sources VLE Material Tutor materials
50 - 60	Recap and Questions PP S18	1, 2, 3	PowerPoint M2 2.1

4.2 Teaching Materials

4.2.1 PowerPoints

- PowerPoint M2 2.1
- Tutor materials

4.2.2 Websites

- Links available in PowerPoint M2 2.1
- The tutor may wish to include additional links within the VLE.

4.3 Socrative Questioning

- Built into PowerPoint M2 2.1
- The tutor may wish to modify the questions and add more to the VLE through quizzes.

4.4 Self-Assessment quiz for the topic

To be built into the VLE.
It is suggested that question types include:

- True or False
- Multiple choice
- Calculations

Module 3 – Lesson 3.6: Vectors and Scalars

1.0 Introduction

Vectors are a key concept in navigation and engineering. This lesson will introduce the topic to the candidate and provide the foundation for its application.

2.0 Learning Outcomes.

LO 1.1 Identify key mathematics information and recall equations related to academic and professional skills.

LO 2.1 Use STEM knowledge to recognise simple problems.
LO 2.2 Solve basic STEM problems using various numbers and matrices.

LO 3.1 Describe problem-solving techniques using obtained STEM knowledge and skills.
LO 3.2 Reflect on the limits of their STEM knowledge and skills and communicate their advanced needs.

After the session, students will be able to:

1. Define and discuss scalars
2. Define and discuss vectors
3. Investigate basic theories and calculations

3.0 Teaching Methods

A PowerPoint has been provided as a prompt for initial topics and discussion points. However, it relies on the tutor encouraging discussion of the statements/ideas/facts and incorporating their understanding of the topics into the session. For example, the tutor may wish to use PowerPoint as an introduction so the candidates can spend most of the time exploring calculations.

4.0 Module Content
4.1 Lesson plan

Approx. Time	Contents	Learning Outcomes	Resources
0 - 5	Introduction PP S1		PowerPoint M3 3.6 Links to sources VLE Material Tutor materials
5 - 15	Scalars PP2 - 5	1	PowerPoint M3 3.6 Links to sources VLE Material Tutor materials
15 - 20	Question for discussion PP S6 - 7	1, 2	PowerPoint M3 3.6
20 - 30	Vectors PP 8 - 12	2	PowerPoint M3 3.6 Links to sources

			VLE Material Tutor materials
30 - 35	Question for discussion PP S13 - 14	2, 3	PowerPoint M3 3.6
35 - 40	Arrows PP 15 - 19	2, 3	PowerPoint M3 3.6 Links to sources VLE Material Tutor materials
40 - 55	Resultant Vectors PP 20 - 26	2, 3	PowerPoint M3 3.6 Links to sources VLE Material Tutor materials
55 - 60	Recap and Questions PP S27	1, 2, 3	PowerPoint M3 3.6

4.2 Teaching Materials

4.2.1 PowerPoints

- PowerPoint M3 3.6
- Tutor materials

4.2.2 Websites

- Links available in PowerPoint M3 3.6
- The tutor may wish to include additional links within the VLE

4.3 Socrative Questioning.

- Built into PowerPoint M3 3.6
- The tutor may wish to modify the questions and add more to the VLE through quizzes.

4.4 Self-Assessment quiz for the topic

To be built into the VLE.
It is suggested that question types include:

- True or False
- Multiple choice
- Calculations

Module 4: Geography

1.0 Introduction

This module introduces students to geography knowledge relevant to a maritime professional. To engage the student in this theme, it focuses on maps, geographic grid system, territorial waters, mechanisms deciding the weather and their relevance to navigation.

2.0 Learning Outcomes.

The participants at the end of this module will achieve the following LOs:

LO 1.2 Recall key factual information relating to physics for academic and professional skills.
LO 1.3 Identify key computing and informatics knowledge related to maritime academic and professional skills.
LO 1.4 Recall geography knowledge of the world relevant to the maritime industry and know significant shipping routes.

LO 2.3 Interpret basic computer science data.
LO 2.4 Differentiate between the different components of the planet's geography.

LO 3.3 Use IT skills for everyday and basic maritime tasks.

3.0 Teaching Methods

As this module focuses on basic geographical issues relevant to the maritime professional, this module will be primarily lecture-based, providing the groundwork for a more active-learning approach with group work and peer-to-peer presentations.

Module Content

- Map of the World. Continents / Countries / Time zones.
- Oceans / Seas / Rivers / Canals.
- Major shipping routes.

Lesson plan

STEP 1:
Lecture-based presentation introducing the history of sea trade

Group work.
In groups, work with the following questions:

- Summarise the history of sea trade, and discuss how it has influenced the way it is today
- Summing up on the Westline (Martin Stopford 1988), what did you find most interesting?

STEP 2:
In groups of four. Discuss the questions below:

- Recall major coastal nations and seas of the world
- Recall major currents of the oceans
- Define territorial waters

Use the knowledge from above to elaborate on the questions beneath:

- Find the largest harbours of today, and describe what characterises them
- Investigate the sea routes of today, and discuss them further

When finishing the last two questions, share your knowledge with another group.

STEP 3:
Lecture-based presentation given by the teacher based on: Mercator, UTC and GMT, geographic grid system, time zone, latitude and longitude, degrees, minutes and seconds.

A group of four will discuss the following questions:

- Explain UTC and GMT
- Describe maps and chart projections (Mercator)
- Describe the geographic grid system, latitude, longitude, degrees, minutes and seconds.

STEP 5: Repetition
Based on your answers – make app. 20 flip cards on the issue, and when finished, hand it over and exchange your flip cards with another group.

STEP 5: Case scenario
The students will work in groups of four. The study groups are on board "Maersk Margarethe" presently moored alongside in Las Palmas. The study groups are in charge of planning the voyage, as your master needs a full description of the sailing route. The groups must demonstrate their knowledge gained in previous lessons on geography.

- Port of departure: Las Palmas, Muelle de Leon y Castillo. The starboard side is alongside.
- Departure time: the 3rd of May 2021 at sunrise.
- Port of arrival: Rotterdam, Rhenus Waalhaven Terminal.

4.0 Teaching Materials

STEP 1:
Stopford M., *Maritime Economics*, Routledge, 2017

World History Encyclopedia, *History of Ancient Sea Travel: Trade, Burials and Maritime Cultures*, 2021
https://www.youtube.com/watch?v=H18oKuzln6A

STEP 3:
International Encyclopedia of Human Geography, *Mercator Projection*, 2009
https://www.sciencedirect.com/topics/earth-and-planetary-sciences/mercator-projection

PowerPoints

- PowerPoint *the history of sea trade* (not included in the material)
- PowerPoint *Mercator, UTC and GMT, geographic grid system, latitude and longitude, degrees, minutes and seconds* (not included in the material)

Websites

- Cross-Border Resource Management, Territorial Sea, 4th edition, 2021
  https://www.sciencedirect.com/topics/earth-and-planetary-sciences/territorial-sea
- International Encyclopedia of Human Geography, *Mercator Projection*, 2009
  https://www.sciencedirect.com/topics/earth-and-planetary-sciences/mercator-projection
- World History Encyclopedia, *History of Ancient Sea Travel: Trade, Burials and Maritime Cultures*, 2021
  https://www.youtube.com/watch?v=H18oKuzln6A

5.0 Socrative Questioning.

6.0 Self-Assessment quiz for topic:

Knowledge

- Explain UTC and GMT
- Describe maps and chart projections (Mercator)
- Describe the geographic grid system, latitude, longitude, degrees, minutes and seconds.
- Define territorial waters
- Recall major coastal nations and seas of the world
- Recall major currents of the oceans
- Discuss the mechanisms for deciding the weather
- Summarise the History of sea trade

- Discuss the Westline (Martin Stopford 1988)

Skills

- Sketch the major shipping routes of today on a map
- Use latitude and longitude to plot a position on a chart
- Calculate the time in various time zones from GMT/UTC time and vice versa

Competencies

- N/A

Module 5: Planetary Systems

1.0 Introduction

The purpose of this module is to introduce students to planetary systems. To engage the student in the solar system theme, it focuses on the selected and relevant area of navigation, i.e. tidal water, day and night, and understanding its relevance in navigation.

2.0 Learning Outcomes.

The participants at the end of this module will achieve the following LOs:

LO 1.1 Identify key mathematics information and recall equations related to academic and professional skills.
LO 1.2 Recall key factual information relating to physics for academic and professional skills.
LO 1.3 Identify key computing and informatics knowledge related to maritime academic and professional skills.

LO 2.3 Interpret basic computer science data.

LO 3.3 Use IT skills for everyday and basic maritime tasks.

3.0 Teaching Methods

As this learning outcome is about familiarisation with the planetary system, this will be primarily lecture-based, providing the groundwork for a more active-learning approach with group work and peer-to-peer presentations.

Level 1: Basic understanding of the planetary systems (list of definitions)
Activity: blended learning, group work

Module Content

1. **The Solar System. Planets / Stars.**
   - The stars and the sun
   - The planets and their orbits
   - Astronomical navigation, on a principal level.
2. **Day / Night – Orbits.**
   - The orbit and rotation of the earth
   - The inclination of the earth
   - Summer/Winter, day/night
3. **Introduction to Almanac for Level 1.**

- The Moon
- Tidal water
- Dusk, dawn, and twilight (civil, nautical and astronomical)
- The Almanac

Lesson plan

Assignment 1 – Research Question (RQ): How does the Solar System affect navigation?

Q1 – Recall the most famous planets and stars.
Q2 - Name the most important stars and planets used for navigation and how you can recognise them
Q3 - Choose 3 of the findings in Q2, and find more data on the 3 findings.
Use https://solarsystem.nasa.gov/planets/overview/
Q4 - Draw the location of the planets in the solar system, and discuss their relevance to navigation
Q5 - List the planets of the solar system and their position from the sun
Q6 - Explain why the orbits of the planets are aligned in the same plane
Q7 - Discuss the importance of a chronometer in relation to deciding one's position

Hand-in: Make a video that answers the RQ and presents your findings from Q1-Q7

Assignment 2 – RQ: The importance of orbits and almanac and their impact on navigation

Q1 - Define orbits and almanac
Q2 – Assess the importance of orbits, the rotation of the earth, as well as the inclination of the earth, and they affect navigation
Q3 – Study how the earth moves and the phases of the moon. How does it affect time, night and day, summer and winter
Get inspired by this video: https://www.youtube.com/watch?v=IJhgZBn-LHg.

Lecture-based presentation: PowerPoint on tides
Q4 – What is an almanac, and how can it be used when planning a voyage?
Q5 - Demonstrate how to measure the azimuth to the sun and the altitude
Q6 - Demonstrate the usage of a tide table (what is tidewater)

Hand-in: Make a PowerPoint presentation showing the importance of orbits and almanac when planning a voyage.

Case scenario: Planning a voyage
The students will work in groups of four. The study groups are on board "Maersk Margarethe" presently moored alongside in Las Palmas. The study groups are in charge of planning the voyage, as your master needs a full description of the sailing route. The groups must demonstrate their knowledge gained in previous RQs on the solar system.

- Port of departure: Las Palmas, Muelle de Leon y Castillo. The starboard side is alongside.

- Departure time: the 3rd of May 2021 at sunrise.
- Port of arrival: Rotterdam, Rhenus Waalhaven Terminal.

4.0 Teaching Materials

PowerPoints

- PowerPoint on tides (not enclosed in the material)

Websites

- NASA solar system
  https://solarsystem.nasa.gov/planets/overview/

- **Sciencing**
  https://sciencing.com/moon-phases-seasons-change-6453642.html

5.0 Socrative Questioning.

6.0 Self-Assessment quiz for topic:

Which stars and plants are mostly used in navigation?
What factors from the solar system will you consider in planning the voyage?

Module 6 – Lesson 6.1: Understanding Computer Terms

1.0 Introduction

The lesson introduces the basic concept of the computer or processor and sets their use into the wider context of shipboard operation. Introduces some common and essential terminology.

2.0 Learning Outcomes.

Understanding computer terminology and basic architecture. Introduction to Bit, Byte, RAM ROM etc.

The lesson provides the basis for contributing to the learning outcomes 1.1, 1.2, 1.3, and 2.3 from the toolbox guide.

LO 1.1 Identify key mathematics information and recall equations related to academic and professional skills.
LO 1.2 Recall key factual information relating to physics for academic and professional skills.
LO 1.3 Identify key computing and informatics knowledge related to maritime academic and professional skills.

LO 2.3 Interpret basic computer science data.

After the session, students will be able to

1. Explain the key concepts, principles and techniques associated with computing and information technology systems.
2. Recognise major computer and processor development trends and use in a shipboard setting.
3. Explain or define key terms used in computer science.

3.0 Teaching Methods

Online recordings could provide a lesson for self-study. However, a PowerPoint™ presentation is provided as a guide for a tutor-led lesson and indicates initial topics and discussion points. Timings are indicative but will vary depending upon the tutor encouraging discussion of the statements/ideas/facts and students incorporating their understanding of the topics into the session. For example, the tutor may wish to use PowerPoint™ as an introduction so that the candidates can spend most of the time exploring the meaning of terms and their interrelationships.

4.0 Module Content

4.1 Lesson plan

Approximate timing (minutes)	**Content**	**Learning outcome**	**Resource**

5	Introduction to the topic. Description of a computer system. Explanation of why computers and processors are used in various uses in shipboard operation. Emphasis is placed on basic architecture and function.	1 & 3	
10	Explain the Major Functions of Computer System Introduce the Main Features of computer identifying, terms command, input, data, instruction, store, and output. Describe the Main features of a computer system, explaining the terms Automation, Speed, Storage, Accuracy, Versatility, Diligence, Reliability, Memory (RAM, ROM)	1 & 3	Suggested Powerpoint™ and face-face. Ref Introduction 6.1 Alternatively online resources e.g. YouTube. See a)
15	Introduce and then describe in basic detail the main components, Hardware, Software, Humanware, Firmware, Bridgeware, Introduce terms Monitor, CPU, Motherboard, RAM, HDD/SSD, and other Storage media. Completion of an example table	1,2 &3	Students are prompted to complete a table indicating marine examples
10	Summarise the terms and use of Software, operating system, application software, and E-accessibility software. Provide examples.	2 & 3	Students are prompted to suggest examples in common use.
15	Explain the term 'bit'. Describe the binary nature of a computer system. 1/0; On/off, True/false. Introduce the terms Byte, Kilobyte, megabyte, and Gigabyte. Introduce the numberings bases 2,8,10,16 Introduce the concept of coding with reference to ASCII.	3	Students are to undertake a self-assessment questionnaire.
5	Summary and Introduction to Lesson 6.2		

4.0 Teaching Materials

- Powerpoint to support face-face classroom presentations or use of prerecorded materials.
- Embedded tasks.

- **PowerPoints**
  Module 6 Introduction Understanding Computer Terms 6.1.pptx

- **Websites**
  https://www.youtube.com/watch?v=qfUZBKDh9BY

5.0 Socrative Questioning.

Suggested tasks and questions are included in the associated Powerpoint™.

6.0 Self-Assessment quiz for topic:

To be built into the VLE.
It is suggested that question types include:

- True or False
- Multiple choice
- Calculations

Module 6 – Lesson 6.2: Data Types, Operators and Binary Codes

1.0 Introduction

The lesson develops students understanding from the introduction in Lesson 6.1. Students consolidate an understanding of how binary operators can be used and combined to develop complex computer systems.
The lesson provides a basic understanding of how the system of binary numbers can be operated upon. Introduces the logic operators AND, OR, NOT, and XOR.
Students develop a broader understanding of how bits can be formed into more complex codes. ASCII is developed. The need for expanded codes such as UNICODE is required.

2.0 Learning Outcomes.

Understanding binary computer operations and introducing terms Machine Code, Assembly Language. Identifies the relationship between and use of common character sets.

The lesson provides the basis for contributing to learning outcomes: 1.1, 1.2, 1.3, 2.2 & 2.3 from the toolbox guide.

LO 1.1 Identify key mathematics information and recall equations related to academic and professional skills.
LO 1.2 Recall key factual information relating to physics for academic and professional skills.
LO 1.3 Identify key computing and informatics knowledge related to maritime academic and professional skills.

LO 2.2 Solve basic STEM problems using various numbers and matrices.
LO 2.3 Interpret basic computer science data.

After the session, students will be able to

1. Describe the representation of a Bit in various forms
2. Identify basic Boolean (logical) operators AND, OR, NOT, XOR
3. Explain the use of binary codes to represent characters
4. Explain the term' character set.'
5. Describe with examples (for example, ASCII and Unicode) the relationship between the number of bits per character in the character set and the number of characters which can be represented.

3.0 Teaching Methods

The lesson serves to revise or introduce basic terms and place a maritime context on the general topic of Logical operators and coding.
The session can be delivered in a classroom setting or as a recorded self-access resource.
A PowerPoint™ presentation can be used, and a suggestive set of slides is appended to cover the main discussion points.
It would be anticipated that most students will have heard many of the terms previously.
They may be less familiar with the LOGIC function. Time should be given for students to practice.
The session is used to place context on subsequent lessons at level 2.

The PowerPoint™ includes areas for discussion and student activity.

4.0 Module Content
Lesson Plan

Approximate timing (minutes)	**Content**	**Learning outcome**	**Resource**
5	Introduction to the topic. Recap on Lesson 6.1	LO 2.3	Powerpoint™ or developed self-reading materials/recording
15	Reemphasise the need for computers to communicate at some point with humans. Confirm that students understand that computers communicate internally by binary digits. (0 and 1) which are electrical signals. They can be thought of as straightforward switches. Encode these into a form that we can easily read and understand – letters and numbers. Explain that humans have been using digital codes to communicate information at a distance for hundreds of years. Explain the term "Character Set."	1 & 4	Suggested Powerpoint™ and face-face. Ref Introduction 6.2 Alternatively online resources e.g. YouTube, see a) below.
	Further, explain the ASCII character set from Lesson 6.1. Discussion that traditionally used 7 bits but now uses 8 bits. Identify that 8 bits doubles the number of available codes.	1, 2,3,4 & 5	Students are tasked with identifying how many states can be represented with 7 bits and 8 bits.

	Students calculate the maximum number of characters that can be represented using 7 bits, and then they will be introduced to the ASCII table. Example ASCII using the deanery Codes. Introduce the concept of Boolean operators AND, OR, NOT XOR. Explain that codes are required for control. Provide maritime examples. Introduce the concept of Error Checking and introduce the term "parity" bit. Students will then practice coding words using decimal and binary numbers		
10	Explain that additional characters and codes are required. Reference to a Mobile Phone Introduce the extended ASCII Code. Explain that easier for Humans to program a computer at a machine level in HEX (or OCTAL). Introduce the Terms "Machine Code", "Assembly Language"	1,4, & 5	Students prompted to suggest why additional codes are necessary. Scientific calculator with Decimal, Binary, Hex and Octal functions.
5	Explain that with additional commands and catering for different human languages, additional character sets are required. Introduce UNICODE—use of 16 bits. If time permits, students can explore UNICODE using the website.	3 & 5	Students are tasked to calculate the codes available using 16-bit
5	Summary and Introduction to Lesson 6.3		Students are to undertake a self-assessment questionnaire.
NOTE	Depending on students' prior knowledge, additional time may need to be allocated for practice and supervision.		

4.1Teaching Materials

- PowerPoint™ to support face-face classroom presentations or the use of prerecorded materials.
- Embedded tasks. Handout of the ASCII Code
- Suggested UNICODE website

PowerPoints

- Module 6 Introduction 6.2.pptx

Websites

- https://unicode-table.com/en/#0089

5.0 Socrative Questioning

Used as interactive/discussion sessions. Example on slides 7,17,18, and 19.

6.0 Self-Assessment quiz for topic:

Can be presented either as a multiple-choice quiz within a classroom setting or as an interactive quiz set up in the VLE.

An example is provided on slides 20-23

Module 6 – Lesson 6.3: Computer system architecture

1.0 Introduction

The lesson develops students understanding from the introduction in Lessons 6.1 and 6.2. Students are introduced to the basic functional blocks of a processor and a computer system.
The lesson requires students to identify the main components of a computer system and the Processor unit. Students can relate their knowledge of data types, operators and low-level programming to the hardware. The session further consolidates the representation of data and instructions inside a computer.

2.0 Learning Outcomes.

The lesson consolidates Lessons 6.1 and 6.2 and contributes to learning outcomes: 1.1, 1.2, 1.3, 2.2, 2.3 & 3.3 from the toolbox guide.

LO 1.1 Identify key mathematics information and recall equations related to academic and professional skills.
LO 1.2 Recall key factual information relating to physics for academic and professional skills.
LO 1.3 Identify key computing and informatics knowledge related to maritime academic and professional skills.

LO 2.2 Solve basic STEM problems using various numbers and matrices.
LO 2.3 Interpret basic computer science data.

LO 3.3 Use IT skills for everyday and basic maritime tasks.

After the session, students will be able to

1. Recognise the fundamental hardware components that make up a computer's hardware and the role of each of these components.
2. Draw a simple block diagram of a CPU and explain each function
3. Explain the use of multicore processors

3.0 Teaching Methods

The lesson recaps the content of lessons 6.1 and 6.2 and requires students to apply their knowledge of computer functions and requirements to the architecture of a Computer system and the CPU.
Reinforces the students' basic terminology and places a maritime context on computer architecture.
The session can be delivered in a classroom setting or as a recorded self-access resource.
A PowerPoint™ presentation can be used, and a suggestive set of slides is appended to cover the main discussion points.
Time should be given for students to undertake the questions and practice.
The session is used to place context on subsequent lessons at level 2.

The PowerPoint™ includes areas for discussion and student activity.

4.0 Module Content
4.1 Lesson Plan

Approximate timing (minutes)	Content	Learning outcome	Resource
5	Introduction to the topic. Students are prompted to explain the functions and requirements of a computer system	1	Powerpoint™ or developed self-reading materials/recording
10	Students are prompted to recall the main parts of a computer system introduced in lesson 6.1. Input devices (Keyboard, mouse etc.) Output devices (Monitor, printer etc.), CPU (Processor), Motherboard containing main memory RAM and ROM. Storage (Hard Disk Drive (HDD) or Solid State Drive (SSD). Floppy Disk Drive Optical The role of the CPU and Memory is emphasised.	1&2	Introduced to a computer block diagram. Students prompted to identify the main components.
15	Describe and explain the terms and functionality of the Micro(processor) Use a block diagram to explain the terms ALU, Register Array, Accumulator, Students are tasked with sketching a simple block diagram	1 & 2	Suggested Powerpoint™ and face-face delivery. Ref Introduction 6.3 Students are tasked with sketching the simple block diagram of the processor and labelling the relevant parts.
20	Discuss the basic features of how a Microprocessor works, introducing and explaining that it follows a sequence: Introduce the terms Fetch, Decode, and then Execute. Reemphasise that the information is in a binary form. Initially, the instructions are stored in the memory in sequential order. Describe and explain the purpose of additional Terms Used in a processor Instruction Set, Bandwidth, Clock Speed. Students should express a speed in megahertz (MHz) or gigahertz (GHz). Identify that it is also known as Clock Rate.	1 & 2	Students are prompted to answer questions related to how the instructions are handled processor (binary). Explain the term byte. Students should be prompted to express clock speed in kHz, MHz, and GHz.

	Word Length Describe an 8-bit microprocessor that can process 8-bit data at a time. Engage student discussion on the word length ranges from 4 bits to 64 bits depending upon the type of the microcomputer. Recap on Data Types and the use in the processor− The microprocessor has multiple data type formats like binary, ASCII, Introduce BCD and signed and unsigned numbers.		Students tasked with a BCD example.
5	Introduce the multicore processor and related terms. Provide a marine example, e.g. Datalogger and/or ECDIS. Briefly introduce the concept of A-D and D-A conversion.	1 & 3	
5	Summary and introduction to Lesson 6.4		Students are to undertake a self-assessment questionnaire.
NOTE	Depending on students' prior knowledge, additional time may need to be allocated for practice and supervision.		

4.1Teaching Materials

- PowerPoint™ to support face-face classroom presentations or the use of prerecorded materials.
- Embedded tasks.

PowerPoints

- Module 6 Computer Architecture 6.3.pptx

5.0 Socrative Questioning.

Used as interactive/discussion sessions. Example on slides 6, 12, 18, 19,21

6.0 Self-Assessment quiz for topic:

Can be presented either as a multiple-choice quiz within a classroom setting or as an interactive quiz set up in the VLE.
An example is provided on slide 28

Module 6 – Lesson 6.4: Simple Computer Programming

1.0 Introduction

The lesson consolidates students understanding from the introduction in Lessons 6.1 and 6.2. and 6.3. Students expand their knowledge from 6.1 on the term 'Software' and how a program is constructed to instruct the processor to perform a defined function.

Students consider a flow chart in describing an algorithm. They distinguish between two broad classes of Software: operating systems and applications. Students are then introduced to one technique to organise the instructions for a computer to understand. The lesson introduces the concepts and terminology of high-level programming. Focus is placed on differentiating between the application software and the operating system.

2.0 Learning Outcomes.

The lesson consolidates Lessons 6.1, 6.2 and 6.3 and contributes to learning outcomes: 1.1, 1.2, 1.3, 3.1 & 3.3 from the toolbox guide.

LO 1.1 Identify key mathematics information and recall equations related to academic and professional skills.
LO 1.2 Recall key factual information relating to physics for academic and professional skills.
LO 1.3 Identify key computing and informatics knowledge related to maritime academic and professional skills.

LO3.1 Describe problem-solving techniques using obtained STEM knowledge and skills.
LO 3.3 Use IT skills for everyday and basic maritime tasks.

After the session, students will be able to

1. Distinguish between Machine Code, Assembly Language and High-Level Programming languages.
2. Describe the difference between an operating system and an application program,
3. Explain the need for and benefits of high-level programming languages.
4. Identify key features in designing an application program using a flow chart as an example.

3.0 Teaching Methods

The lesson develops the themes of lessons 6.1, 6.2 and 6.3 and requires students to apply their knowledge of Hardware and Software to the need for operating systems and programming languages. Students can explain the role and benefits of high-level programming.
The session can be delivered in a classroom setting or as a recorded self-access resource.

A PowerPoint™ presentation can be used. A Powerpoint™ presentation has not been included in this lesson.
Time should be given for students to undertake the questions and practice on the topics covered.
The session is used to place context on subsequent lessons at level 2.

In line with Lessons 6.1 – 6.3, a PowerPoint™ can be developed to include discussion and student activity areas.

Further study on programming can be gained by using the Microsoft Microbit web resources
https://makecode.microbit.org/#

4.0 Module Content
4.1 Lesson Plan

Approximate timing (minutes)	**Content**	**Learning outcome**	**Resource**
5	Introduction to the topic. Students are prompted to distinguish between machine code and assembly language and explain the limitations for humans. The use of high-level languages and the development of complex programs are introduced.	1	Powerpoint™ or can be developed with self-reading materials/recording.
10	Recap on Lesson 6.1 and recap the purpose of firmware and Software. Describe What is meant by high-level programming language. Recap that Software is a collection of instructions that tell the computer how to work, in contrast to the physical hardware, which requires instructions to produce output. Students are prompted to recall the main terms. Explain that Software can be split into two categories, application software and operating systems. Describe that Application software is the name given to programs which enable a computer to perform specific tasks. Contrast that an operating system provides general-purpose Software that controls the sharing of resources amongst	1 & 2	Powerpoint™ or can be developed with self-reading materials/recording. Web source, e.g. Furuno FMD See link below.

	the various programs, ensuring that they are not competing for the same resource. Provide general and marine-specific examples of the OS (e.g. WINDOWS®, Windows Embedded Standard 2009 macOS, iOS, Android, UNIX etc. Provide a general and marine example, e.g. The program that processes the image in the Radar or ECDIS is one example; a word processor running on a PC is another.		
10	Explain that the process of developing any software starts with an analysis of the task or tasks to be performed by the computer, an analysis designed to tease out how the computer is to behave under every possible circumstance, which leads to developing an algorithm. Describe that the next step will be to write the computer program. This will take the various elements of the task and convert them into a program by using a high-level programming language, a structured language with a limited set of words and symbols which can be used to tell a computer how to perform a task. Briefly mention the iterative process and the need for the program to be 'debugged' (made free of errors) through extensive testing and documented to facilitate future work. After this, there may be more forms of testing, from user evaluation of the 'user experience' of using the Software. Explain that this is an essential and time-consuming task in Ship Critical systems. Highlight longer-term requirements before your program can be used, such as user training in complicated applications.	3	Students are prompted to answer questions related to .

	Computer hardware and its programs are the first steps to delivering an effective system.		
15	Further, develop the idea of identifying the requirements of an application program. Identify a common starting point by breaking down the overall task or objective of the program into smaller tasks. Introduce the technique of using a flowchart, showing each of these smaller steps on the way to delivering the task. Cover the Start/Stop Input/Output, Process, and Decision Connector symbols. Provide graphical examples Provide a simple task for students to create a flow chart using the appropriate example as time permits	2,3 & 4	Powerpoint™ or can be developed with self-reading materials/recording For web-source, see the link below.
10	Describe and explain the functions of an OS in general terms. Highlight the functions of sharing of resources and ensuring the efficient running of a computer by: Loading application programs from secondary memory into main memory and managing their execution. Supporting application programs by managing their use of the computer's resources. managing the storage of programs and data in secondary memory accepting inputs from and supplying outputs to the user. Describe and explain the functions of an application in general terms. These can be explored in more detail if time permits.	1 & 2	Suggested Powerpoint™ and face-face. Ref Introduction 6.4
5	Give examples of high-level languages and reiterate their use and benefits. e.g. Python. Java. C++ C# Visual Basic. JavaScript.	3	Suggested Powerpoint™ and face-face.
5	Summary and conclusion. Reiterate the terms		Students are to undertake a self-

	Operating system Application software Embedded computer Flowchart Provide guidance on further study. Students guide to Microsoft micro bit website.		assessment questionnaire. Further study development using Microsoft micro bit resources and MakeCode simulator
NOTE	Depending on students' prior knowledge, additional time may need to be allocated for practice and supervision.		

4.1Teaching Materials

PowerPoint™ to support face-face classroom presentations or the use of prerecorded materials. This has not been provided.
As with examples of 6.1, 6.2 and 6.3 inclusion of Embedded tasks is of value.

PowerPoints

None included

Websites
https://lemp.io/which-operating-system-is-used-in-the-furuno-fmd-ecdis/

https://www.smartdraw.com/flowchart/flowchart-symbols.htm

https://makecode.microbit.org/

5.0 Socrative Questioning.
Used as interactive/discussion sessions.

6.0 Self-Assessment quiz for topic:

Can be presented either as a multiple-choice quiz within a classroom setting or as an interactive quiz set up in the VLE.