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FEDERATION OF  
SURVEYORS**



**INTERNATIONAL  
HYDROGRAPHIC  
ORGANIZATION**



**INTERNATIONAL  
CARTOGRAPHIC  
ASSOCIATION**



**STANDARDS OF COMPETENCE  
FOR CATEGORY "B"  
NAUTICAL CARTOGRAPHERS**

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4b, quai Antoine 1er  
B.P. 445  
Monaco, MC 98011 Cedex  
MONACO  
info@iho.int  
www.iho.int

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## 1. INTRODUCTION

All components of the hydrographic surveying and nautical cartography professions face challenges as to how best to ensure the continuation of high standards and how best to ensure the continuation of best practices based on minimum standards of competence world-wide. In order to achieve these objectives, three international organizations (FIG, IHO and ICA) have developed Standards of competence that institutions, or professional bodies, may adopt for their educational/training programmes and competency schemes.

Standards indicate the minimum competences necessary for hydrographic surveyors and/or nautical cartographers. Standards recognize two levels of competence. Category "A" programmes introduce competences from the underlying principles level. Category "B" programmes introduce the competences from a practical level appropriately underpinned by the relevant theoretical content.

The intention is that a Category "A" individual with appropriate experience would be a senior professional in their chosen field (government, industry, and academia). Category "B" individuals with appropriate experience would be technical professionals leading and delivering products and services to meet specifications and outcomes.

The Standards are structured to enable the student to acquire incrementally the knowledge required in order to be a competent cartographer at the Category "B" level. More specifically, the sequence of the subjects is designed so that any new subject builds upon the content and the knowledge of the preceding subjects.

The theoretical subjects are complemented with the Comprehensive Cartographic Project (CCP) that includes all those items required to enable the student to compile and compose efficiently a modern nautical chart, ENCs and special purpose charts according to internationally adopted specifications.

Successful completion of the theoretical subjects and the CCP will enable the student to attain the appropriate Category "B" level of competence in nautical cartography.

## 2. DEFINITIONS

### 2.1 Subjects, topics and elements

The S-8B standard contains the following list of *Basic subjects and Essential subjects*:

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**Topics and Elements:**

- Each **Basic subject** or **Essential subject** comprises a list of *topics* which are denoted by Bx.y or Ex.y;
- Some of the *topics* contain *elements* which are denoted by Bx.y<c> or Ex.y<c>.

For example, the *subject* E7 “Nautical Cartography” contains the *topic* E7.1 “The Nautical Chart” that has the *element* E7.1a “Evolution of nautical charts”.

**2.2 Learning outcomes and list of content**

It is important to understand that each *topic* and/or *element* is associated with:

- One or more intended *learning outcomes* that a student should be able to achieve on completion of the programme. All *learning outcomes* should be assessed. This may be done through one of, or a combination of, the following: examination, assessed exercise or presentation, laboratory report, or final project work.
- A *content* list. This list is associated with one or more *learning outcomes* and describes the theoretical knowledge or practical/technical context which the course syllabi should address in order to meet a particular *learning outcome*.

**3. PROGRAMME PREPARATION AND SUBMISSION**

The preparation of a programme submission to the IBSC should be in accordance with the document entitled GUIDELINES FOR THE IMPLEMENTATION OF THE STANDARDS OF COMPETENCE FOR HYDROGRAPHIC SURVEYORS AND NAUTICAL CARTOGRAPHERS. This document is available from the IHO website: [www.iho.int](http://www.iho.int) → Standards & Publications.

The cross reference table is a mandatory requirement for a programme submission and **MUST** be completed. A template is specified and is available from the IHO website: [www.iho.int](http://www.iho.int)

## LIST OF ACRONYMS AND INITIALISMS USED IN THIS DOCUMENT

1D	One-dimensional
2D	Two-dimensional
3D	Three-dimensional
AIS	Automatic Identification System
B	Basic (level of knowledge)
B/W	Black and White
CATZOC	CAteGory of Zones Of Confidence
CIE	International Commission on Illumination
CCP	Comprehensive Cartographic Project
CPU	Central Processing Unit
DBMS	DataBase Management System
DEM	Digital Elevation Model
DIGEST	Digital Geographic Exchange Standard
DXF	Digital Exchange Format
ECDIS	Electronic Chart Display and Information System
ECS	Electronic Chart System
ENC	Electronic Navigation Chart
EROS	Earth Resources Observation and Science
ETRS89	European Terrestrial Reference System 1989
FIG	International Federation of Surveyors
GeoTIFF	Geographic Tag Image File Format
GIS	Geographical Information System
GML	Geographical Markup Language
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GRS80	Geodetic Reference System (1980)
GUI	Graphical User Interface
HLS	Hue, lightness/luminance, saturation
I	Intermediate (level of knowledge)
IALA	International Association of Lighthouse Authorities
IBSC	International Board on Standards of Competence for Hydrographic Surveyors and Nautical Cartographers
ICA	International Cartographic Association
IHO	International Hydrographic Organization
IMCA	International Marine Contractors Association
IMO	International Maritime Organization
INT	International
IOGP	International Oil & Gas Producers
ISO	International Standards Organization
ITRF	International Terrestrial Reference Frame
JPEG	Joint Photographic Experts Group
LAN	Local Area Network
LiDAR	Light Detection And Ranging
MatLab	Mathematics Laboratory software
OGC	Open Geospatial Consortium
P	Practicals (fieldwork and/or laboratories)
QA	Quality Assurance

QC	Quality Control
RADAR	Radio Detection And Ranging
RAM	Random Access Memory
RENC	Regional ENC Coordinating Centre
RGB	Red, Green, Blue
RHC	Regional Hydrographic Commissions
RIP	Raster Image Processing
RMSE	Root Mean Square Error
S-4	IHO Publication S-4 <i>Regulations for International (INT) Charts and Chart Specifications of the IHO</i>
S-11	IHO Publication S-11 <i>INTERNATIONAL Chart Web Catalog</i>
S-52	IHO Publication S-52 <i>Specifications for Chart Content and Display Aspects of ECDIS</i>
S-57	IHO Publication S-57 <i>IHO Transfer Standard for Digital Hydrographic Data</i>
S-58	IHO Publication S-58 <i>ENC Validation Checks</i>
S-65	IHO Publication S-65 <i>ENCs: Production, Maintenance and Distribution Guidance</i>
S-99	IHO Publication S-99 <i>Operational Procedures for the Organization and Management of the S-100 Geospatial Information Registry</i>
S-100	IHO Publication S-100 <i>IHO Universal Hydrographic Data Model</i>
S-101	IHO Publication S-101 <i>ENC Product Specification</i>
S-102	IHO Publication S-102 <i>Bathymetric Surface Product Specification</i>
SDI	Spatial Data Infrastructure
SDTS	Spatial Data Transfer Standard
SENC	System Electronic Navigation Chart
SG	Self-guided exercises (or student's personal independent work)
SOLAS	Safety of Life at Sea
SVG	Scalable Vector Graphics
T	Theoretical (theory through lectures)
TIN	Triangulated Irregular Network
UKOOA	UK Offshore Operators Association
UNCLOS	United Nations Convention on the Law of the Sea
UTM	Universal Transverse Mercator
WEND	Worldwide Electronic Navigational Chart Database
WGS84	World Geodetic System (1984)
WWW	World Wide Web
XML	Extensible Markup Language
ZOC	Zones of Confidence

# S-8B STANDARDS

## CONTENT AND INTENDED LEARNING OUTCOMES

### 1. BASIC SUBJECTS

<b>B1: Mathematics, Statistics, Theory of Errors</b>		
<b>Topic/Element</b>	<b>Content</b>	<b>Learning outcomes</b>
B1.1 Co-ordinate geometry  (I)	(i) Co-ordinate systems (ii) Linear and quadratic functions (iii) Functions in plane geometry for lines and planes.	Describe and use co-ordinate systems. Describe and use equations for lines and planes. Calculate distances between points, the intersection between lines and planes and the distance from a point to a plane.
B1.2 Systems and units of measurement  (I)	(i) Systems and units of measurement.	Describe the International System, Imperial and other systems of measurement in common use. Classify fundamental and derived units.
B1.3 Linear Algebra  (B)	(i) Vector and affine spaces, vector and inner products, norms (ii) Linear equations, determinants (iii) Analytical geometry, line and plane equations (iv) Linear operators, matrix representation, composition, inverse, transpose (v) Translations, rotations, coordinate transformations.	Describe and apply 2D transformations involved in mapping. Solve linear equations using matrix methods.
B1.4 Trigonometry  (B)	(i) Basic trigonometry (ii) Sphere, great circle, rhumb lines, sphere angles, spherical triangles and spherical excess.	Apply plane and spherical trigonometry to cartography problems.
B1.5 Errors and Statistics  (B)	(i) Sources of error and their classification (ii) Random variables, mean, variance, standard deviation (iii) Covariance and correlation (iv) Estimation of mean, variance, co-variance (v) Normal distribution.	Describe and classify possible sources of error as a result of utilization of a chart (i.e. measurement, digitization). Define a random variable and estimate its mean, variance, co-variance and standard deviation.
B1.6 Least squares  (B)	(i) Least squares procedure (ii) Definition and use of Root Mean Square Error (RMSE)	Perform a least square calculation and interpret results.

B1.7 Spatial Interpolation  (B)	(i) 1D polynomial interpolation (ii) Interpolation using splines.	Describe spatial interpolation methods.
<b>B2: Information and Communication Technology</b>		
<b>Topic/Element</b>	<b>Content</b>	<b>Learning outcomes</b>
B2.1 Computer systems  (B)	(i) Central Processing Unit (CPU) (ii) RAM, data storage (iii) Communication board, serial links, communication ports buffers, Ethernet links, data transmission rates (iv) Communication protocols (v) Operating systems (vi) Device drivers (vii) Input/output devices (scanners, digitizers, printers, plotters) and associated technical characteristics/specifications (viii) Data storage: device types, the cloud; advantages, limitations.	Describe the different components of a computer system and the alternative ways of communication between systems and peripheral devices.  Describe the role of a device driver and its relation to data transfer.  List technical specifications for input/output devices used in cartographic operations.  Describe the most commonly used data storage devices and the cloud.  Compare and contrast data storage options in the context of spatial data requirements.
B2.2 Office work software suites  (I)	(i) Word processors (ii) Spreadsheets (iii) Graphics and image processing software.	Use office work software suites.  Describe how graphics and image processing software function.
B2.3 Programming basics  (I)	(i) Basic operations of a computer program or script (ii) File types (binary, text, XML) (iii) Algorithms (loops, conditional instructions) (iv) Programming languages (e.g. Visual Basic, Visual C++, Python, Java) (v) Scientific computation environments (e.g. Matlab) (vi) Application to data exchange, file and format conversion.	Write software programs or scripts for simple data format conversion and/or basic algorithm computation.  Perform simple computations using common application environments.
B2.4 Databases and DataBase Management Systems (DBMS)  (I)	(i) DataBase Management Systems and query languages (ii) Relational databases.	Describe and design a simple database.  Create/populate a database and query its content.
B2.5 Web and network communications  (B)	(i) Networks (LANs) (ii) Internet (iii) Networks integrity (iv) Communication protocols.	Describe the different network communication configurations and associated protocols used in data transfer/exchange applications.



<b>B3: Earth Sciences</b>		
<b>Topic/Element</b>	<b>Content</b>	<b>Learning outcomes</b>
B3.1 General geography of the Earth  (B)	(i) Earth as a system of interacting 'zones' (ii) Plate tectonics, earthquake zones (iii) Earth dynamics (iv) Ecosystems.	Describe the major components of the Earth as a system. Identify general categories of land and water masses. Explain the plate tectonic theory.
B3.2 Marine geomorphology and marine geographic features  (B)	(i) Marine Geomorphology <ul style="list-style-type: none"> <li>• concepts</li> <li>• features</li> <li>• processes.</li> </ul>	Describe and identify marine geographic features, such as coastline, bays, inlets, capes, oceans, seas, channels, etc. Describe processes of deposition and erosion.
B3.3 Marine geophysics  (B)	(i) Gravity (ii) Magnetics (iii) Seismic profiles.	Describe the data acquired by gravity, magnetic and seismic surveys. Describe geophysical properties of undersea features.
B3.4 Ocean properties and dynamics  (B)	(i) Sea water properties (ii) Ocean Dynamics <ul style="list-style-type: none"> <li>• nature</li> <li>• motion</li> <li>• tides</li> <li>• currents.</li> </ul>	List the main properties of sea water. Describe ocean dynamics in terms of currents and tidal variations.
B3.5 Seafloor characteristics  (B)	(i) Sediment types (ii) Submerged aquatic vegetation (iii) Corals (iv) Outcropping rocks.	Distinguish common seafloor characteristics.

### 3. ESSENTIAL SUBJECTS

<b>E1: General Geodesy</b>		
<b>Topic/Element</b>	<b>Content</b>	<b>Learning outcomes</b>
E1.1 Introduction to geodesy  (I)	(i) Shape and size of the Earth as a sphere, ellipsoid of revolution and geoid (ii) Definition of the authalic sphere as a model of the Earth (iii) Definition of latitude and longitude on the ellipsoid and the sphere	Describe the figure of the Earth as a geoid, an ellipsoid of revolution and a sphere.  Describe the geometry of lines on the sphere and the ellipsoid.  Identify the characteristics of loxodrome and orthodrome.
E1.2 Coordinate systems, frames and datums  (I)	(iv) Local geodetic reference frames (v) Terrestrial reference systems and reference frames (vi) Datums and datum transformation techniques	Describe modern and traditional geodetic reference systems and associated reference frames.
E1.3 Geodetic transformations and associated computations  (I)	(vii) Vertical datums (viii) Modern geodetic reference systems and datums [GRS80, WGS84, ETRS89, ITRF]. (ix) Computations on the sphere	Describe and apply horizontal and vertical datum transformation methods using available software.
E1.4 Spherical and ellipsoidal computations  (I)	(x) Computations on the ellipsoid.	Perform computations on the spherical and ellipsoidal surface using available software.
<b>E2: General Cartography</b>		
<b>Topic/Element</b>	<b>Content</b>	<b>Learning outcomes</b>
E2.1 Elements of cartography  (I)	(i) Definition of a map and a nautical chart (ii) Characteristics of maps and charts (iii) The concept of scale (iv) Categorization of maps/charts in relation to scale and purpose (v) Representing the figure of the earth on a flat surface (vi) Abstract representation and generalization (vii) Symbolization (viii) Static & dynamic maps/charts.	Describe and detail the fundamental cartographic elements and associated characteristics of maps and nautical charts.
E2.2a Map projections  (I)	(i) Map/chart projections, their properties and associated distortions (ii) Categories of map/chart projections (cylindrical, conical, azimuthal) (iii) Properties of map/chart projections (conformal, equivalent, equidistant) (iv) Methodology for the selection	Describe the properties and distortions in different categories of projections used for maps and charts.  Explain the procedure for selecting a specific projection and apply appropriate projection formulae.  Describe projection systems with emphasis on the UTM projection system.

	<p>of a cartographic projection</p> <p>(v) Projection formulae and planimetric coordinates</p> <p>(vi) Projection systems</p> <p>(vii) The UTM projection system.</p>	
E2.2b Study of map distortions  (B)	<p>(i) Definition of Scale Factor</p> <p>(ii) Tissot's theorem</p> <p>(iii) Principal directions</p> <p>(iv) Tissot's indicatrix</p> <p>(v) Distortions in distances, areas and angles associated with specific map projections (Mercator, Transverse Mercator, Lambert conformal conic).</p>	<p>Describe scale factor and its properties.</p> <p>Identify the prevailing properties of a projection using Tissot's indicatrix.</p> <p>Compute bearings and distances on projections used in nautical cartography.</p>
E2.3 Abstract representation and generalization  (I)	<p>(i) Rationale for generalization</p> <p>(ii) Model, semantic and cartographic generalization</p> <p>(iii) Elements of generalization</p> <p>(iv) Controls of generalization</p> <p>(v) Rules for semantic generalization</p> <p>(vi) Cartographic generalization of point, line and area features</p> <p>(vii) Cartographic generalization algorithms.</p>	<p>Explain the rationale for generalization.</p> <p>Distinguish between model, semantic and cartographic generalization.</p> <p>Classify and detail the processes of generalization.</p> <p>Rationalize the selection of generalization algorithms.</p> <p>Perform generalization of point, line and polygon features using:</p> <p>a) manual methods,</p> <p>b) appropriate generalization algorithms and associated parameters' values.</p>
E2.4 Relief representation  (I)	<p>(i) Rationale for terrain and sea bottom representation</p> <p>(ii) Methods for terrain and sea bottom representation (contouring, zoning, etc.)</p> <p>(iii) Relative and absolute accuracy in contouring</p> <p>(iv) Digital representation of the relief – Digital Elevation Models [DEM] and methods of interpolation (Inverse distance, TIN, GRID, Kriging).</p> <p>(v) Extraction of DEM by-products (slope, aspect.....).</p>	<p>Explain the reasons underpinning terrain and sea bottom representation.</p> <p>Describe in detail and compare common methods used for terrain and sea bottom representation.</p> <p>Describe common interpolation methods used for DEM creation.</p> <p>Create a DEM using appropriate methods and extract its by-products.</p>
E2.5 Cartographic data, scales of measurement  (B)	<p>(i) Scales of cartographic data measurement</p> <ul style="list-style-type: none"> <li>• Nominal scale</li> <li>• Ordinal scale</li> <li>• Interval scale.</li> </ul>	<p>Categorize cartographic data according to their scale of measurement.</p>
E2.6 Symbolization  (I)	<p>(i) Rationale for symbolization</p> <p>(ii) Concepts of symbolization</p> <p>(iii) Graphical elements of symbols (point, line, area)</p> <p>(iv) Visual variables (shape, size,</p>	<p>Explain the rationale for symbolization.</p> <p>Describe visual variables.</p> <p>Use visual variables with respect to scale of cartographic data measurement.</p>

	<p>orientation, color, pattern, etc.)</p> <p>(v) Basic rules of symbol design and use.</p>	<p>Distinguish types of symbols and their use</p> <p>Explain the need for and use symbol libraries.</p>
<p>E2.7 Color</p> <p>(B)</p>	<p>(i) Rationale for the use of color</p> <p>(ii) The nature of color (spectral colors vs. reflected colors)</p> <p>(iii) The dimensions of color</p> <p>(iv) Systems of color modeling/ specification (CIE, Munsell)</p> <p>(v) Electronic display color models (RGB, HLS...)</p> <p>(vi) Choosing colors for maps/charts</p> <p>(vii) Color conventions</p> <p>(viii) Patterns (B/W – color)</p> <p>(ix) Color for computer graphics (screens, plotters, printers)</p> <p>(x) Color for printing.</p>	<p>Explain the rationale, role and importance of color and its use in mapping and charting.</p> <p>Outline the principal color conventions for maps and charts and their features.</p> <p>Differentiate color for various computer graphics and printing applications.</p>
<p>E2.8 Map/chart lettering and toponymy</p> <p>(I)</p>	<p>(i) Rationale of toponymy</p> <p>(ii) Lettering and its functionality</p> <p>(iii) Lettering style, size and color</p> <p>(iv) Relationship between toponyms and the use of lettering</p> <p>(v) Naming conventions</p> <p>(vi) Positioning guidelines for toponyms of point, line and area features</p> <p>(vii) Placement of toponyms with respect to the scale/graticule.</p>	<p>Explain the rationale and the functionality of toponymic display.</p> <p>Describe and demonstrate appropriate use of lettering in relation to the inherent characteristics of cartographic features.</p> <p>Describe and apply placement rules for toponyms.</p>
<p>E2.9 Cartographic design</p> <p>(B)</p>	<p>(i) Principles of good cartographic design</p> <p>(ii) Design requirements for different map/chart categories</p> <p>(iii) Scale selection</p> <p>(iv) Graphic organization (map/chart layout)</p> <p>(v) Visual balance</p> <p>(vi) Types of data (point, linear, areal, 3D)</p> <p>(vii) Representation (of reality)</p> <p>(viii) Composition</p> <p>(ix) Visual hierarchy</p> <p>(x) Presentation</p> <p>(xi) Use of color/figure-ground/contrast.</p>	<p>Describe the principles and characteristics underpinning good cartographic design.</p> <p>Identify selected maps/charts in terms of the principles of good cartographic design (with proper justification).</p>
<p>E2.10 Map/chart compilation and composition</p> <p>(I)</p>	<p>(i) The cartographic compilation and composition process</p> <p>(ii) Compilation planning and scheduling</p> <p>(iii) Source data and map/chart scale</p> <p>(iv) Map/Chart data quality elements</p>	<p>Describe the logical process of cartographic compilation and composition identifying discrete stages.</p> <p>Differentiate between the appropriate compilation processes for maps and nautical charts of different themes and scales.</p> <p>Describe and apply cartographic data</p>

	<ul style="list-style-type: none"> <li>• Accuracy (positional, thematic, temporal)</li> <li>• Resolution (spatial, temporal)</li> <li>• Consistency (logical, domain)</li> <li>• Currency</li> <li>• Completeness</li> <li>• Clarity</li> </ul> <p>(v) Data quality standards  (vi) Assessment of appropriateness of source data for map or chart compilation  (vii) Source data homogenization  (viii) Quality control process within a quality management system  (ix) Analog compilation worksheet  (x) Digital compilation worksheet.</p>	<p>quality assessment processes.</p> <p>Differentiate between analog and digital compilation processes.</p> <p>Develop a digital and an analog compilation worksheet covering a defined region and utilize it for map/chart composition and symbolization.</p>
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### **E3: Hydrography and Nautical Products**

<b>Topic/Element</b>	<b>Content</b>	<b>Learning outcomes</b>
E3.1 Hydrography, nautical cartography and navigation (B)	(i) Relationship between hydrography, nautical cartography and navigation.	Define hydrography, nautical cartography and types of navigation explaining their relationship. Identify hydrographic and other data for map/chart purposes.
E3.2 Navigational hazards and aids to navigation (B)	(i) Navigational hazards (ii) Types of buoys and beacons (iii) The IALA system (iv) Automatic Identification Systems (AISs).	Identify and describe navigational hazards. Describe the principal fixed and floating aids to navigation and their significance for nautical charting. Describe AIS.
E3.3 Navigational publications (I)	(i) Notices to mariners (ii) Sailing directions (iii) Light and radio lists (iv) Tides and current tables.	Describe and use content derived from nautical publications in a charting context.
E3.4 Hydrographic surveys (B)	(i) Types and scales of hydrographic surveys (ii) Hydrographic survey operations.	Differentiate the type and purpose of different hydrographic surveys. Describe and explain hydrographic survey operations essential to ensure nautical charting integrity.
E3.5 Positioning (B)	(i) Evolution of technology in positioning (ii) Satellite systems for positioning (iii) Relative accuracy of commonly available systems.	Describe different methods and systems used for positioning with respect to their accuracy. Describe the principles of Global Navigation Satellite Systems (GNSS).
E3.6 Depth measurement (B)	(i) Evolution of technology and methodologies for depth measurement (ii) Hydrographic vs. bathymetric data measurement.	Describe different methods and associated accuracies used in depth measurement. Describe the suitability of different depth measurement methods to achieve specific

		surveying and charting objectives.
E3.7 Hydrographic data management  (I)	(i) Management of hydrographic data at various stages in the chart compilation process  (ii) Databases for hydrographic data.	Outline hydrographic data acquisition, processing, analysis and management procedures and methodologies.  Describe the content and use of a hydrographic source database.
<b>E4: Data for Nautical and Special Purpose Charting</b>		
<b>Topic/Element</b>	<b>Content</b>	<b>Learning outcomes</b>
E4.1 Coastline and topographic data  (I)	(i) Data sources appropriate for inclusion in nautical charting for coastline and topography  (ii) Categories and corresponding definitions of coastline  (iii) Relevance of scale for selecting appropriate data sources	Describe different categories of coastline and their depiction.  Homogenize topographic data from various data sources for depiction on charts with regard to scale.
E4.2 Bathymetric data  (I)	(iv) Principles of selection and depiction of topography  (v) Principles of selection and depiction of bathymetry  (vi) Bathymetric data quality  (vii) The concept and use of CATZOC.	Evaluate bathymetric data sources for use in nautical and special purpose charts.  Explain and use CATZOC.  Homogenize hydrographic/ bathymetric data from various data sources for depiction on charts with regard to scale.
E4.3 Navigational hazards and aids to navigation  (I)	(i) Cartographic representations of hazards to navigation  (ii) Cartographic representations of aids to navigation.	Evaluate selected data sources for hazards and aids to navigation.  Describe and apply the appropriate depiction of identified navigational hazards and aids to navigation on nautical charts.
E4.4 Sailing directions and nautical publications  (I)	(i) Identification of textual and administrative data suitable for graphic presentation (boundaries, environmental areas, traffic routing etc.)  (ii) Symbiotic relationship between textual and graphic data.  (iii) E-publications.	Explain the relationship between nautical charts and textual data sources and their use (sailing directions and other nautical publications including reports, lists and tabular data).  Evaluate available administrative data for consistency in its graphical depiction and/or textual promulgation.
E4.5 Source data adjustment  (B)	(i) Chart datums: horizontal and vertical  (ii) Principles of horizontal and vertical datums  (iii) Methodologies for adjusting data against various datums  (iv) Adjusting data by use of software.	Define horizontal and vertical datums.  Identify horizontal and vertical datums commonly used in cartographic data sources.  Perform horizontal and vertical adjustments of data referred to various datums using software applications.
E4.6 Oceanographic information  (B)	(i) Identification of appropriate oceanographic data sources  (ii) Depiction of oceanographic information  (iii) Tidal and current information.	Evaluate the sources and characteristics of oceanographic data.  Assess oceanographic data for its depiction on nautical charts.  Display tidal and current information on nautical charts.

E4.7 Magnetic data <i>(B)</i>	(i) Magnetic variation and anomalies, computation and appropriateness for charting. (ii) Magnetic data sources utilization, computations and depiction.	Explain “magnetic variation”. Compute magnetic variation for specific positions and time. Depict magnetic anomalies.
E4.8 Metadata <i>(B)</i>	(i) Metadata for analog and digital data and chart products.	Explain the purpose and importance of creating and using metadata. Identify and utilize metadata.
E4.9 Quality Management System(s) for chart production <i>(I)</i>	(i) Nautical chart production processes and their content (ii) Quality Management System(s), Quality Control (QC) and Quality Assurance (QA) processes for the compilation and production of nautical and special purpose charts (iii) Data quality implications relevant to scales, density, accuracy, time, different datums, technologies, etc.	Describe nautical chart production processes and their content. Describe and apply QC processes to nautical chart and special purpose chart production. Identify and describe the implications on data quality arising from the variability of source data types.
E4.10 Data for special purpose charting <i>(B)</i>	(i) Requirement, use and design of special purpose charts (ii) Data types: <ul style="list-style-type: none"> <li>• Subsurface</li> <li>• Imagery</li> <li>• Geotechnical</li> <li>• Environmental</li> <li>• Engineering and asset.</li> </ul>	Describe special purpose charts and their uses. Identify and list data types for particular special purpose charts.

### **E5: Photogrammetry and Remote Sensing**

<b>Topic/Element</b>	<b>Content</b>	<b>Learning outcomes</b>
E5.1 Photogrammetry and remote sensing – application to charting <i>(B)</i>	(i) Development of photogrammetry and remote sensing: brief history and context (ii) Introduction of equipment types: sensors and formats of aerial photographs and sensed images (iii) Satellite derived bathymetry (iv) Basics of photogrammetric and remote sensing geometry in the context of adjustment and application for charting: <ul style="list-style-type: none"> <li>• Image scale, relief and radial displacement</li> <li>• Theory and implementation of spatial rectification</li> <li>• Positional control including use of aerial GPS.</li> </ul>	Describe basic geometrical principles applicable to aerial photography and imaging. Describe the use of photogrammetric and remotely sensed data sources to define topographic features for charting. List remotely sensed techniques applicable to depth measurement. Describe rectification and control methods.

E5.2 Sensor data sources  (B)	(i) Characteristics of commonly available photogrammetric and satellite sensors (such as EROS; IKONOS; SPOT; Landsat; WorldView, GeoEye-1, QuickBird panchromatic, Sentinel, ...) and associated data (ii) Pansharpener techniques (iii) RADAR altimetry.	Identify the characteristics of commonly available photogrammetric and satellite sensor data sources.  Describe the merging of high resolution panchromatic and lower resolution multispectral imagery to create a single high-resolution color image.  Compare and contrast the use of various imagery for charting.  Describe the principles of RADAR altimetry and its use.
E5.3 Geometric modelling  (B)	(i) Utilization of different imagery: panchromatic, multi-spectral bands; color, laser, altimetry (ii) Image geo-referencing (iii) Ortho-image production and utilization.	Describe the process of preparing photogrammetric and remotely sensed imagery for feature extraction.  Explain the approach to be taken for effective feature extraction suitable for charting.
E 5.4 Data management, processing and analysis  (B)		Describe geo-reference procedures for photogrammetric and remotely sensed imagery.  Identify changes to existing nautical charting content with regard to more recent imagery sources.
E5.5 Shoreline delineation, feature extraction and satellite bathymetry  (I)		Perform shoreline extraction with regard to the state of the tide at the time of imagery.  Determine intertidal areas.  Utilize remotely sensed images for bathymetry  Extract hydrographic features: reefs, rocks, hazards, sea-bed features.
E5.6 Airborne and terrestrial LiDAR systems and data products  (B)	(i) Airborne and terrestrial LiDAR systems and their capabilities (ii) Modeling land and sea-bed topography (iii) Water surface mapping (iv) Environmental mapping (v) Temporal mapping (vi) Determining change using both airborne and terrestrial data.	Describe commonly available airborne and terrestrial LiDAR systems and list their capabilities.  Describe the potential of airborne and terrestrial LiDAR systems for determining coastal features and changes over time.  Identify how such techniques are applicable to charting.
<b>E6: Geospatial Information and Processing</b>		
<b>Topic/Element</b>	<b>Content</b>	<b>Learning outcomes</b>
E6.1 Overview of Geospatial Information Science and systems  (I)	(i) Geospatial Information Science and data (ii) Geographic Information Systems [GIS] and applications (iii) Graphical User Interface (GUI).	Define Geospatial Information Science and its role in spatial data processing and utilization.  Elaborate on the characteristics and the functionality of a GIS.



<p>E6.2 Geospatial data modeling</p> <p>(I)</p>	<p>(i) Vector data models  (ii) Raster data models  (iii) Representation of point, line and area data in vector and raster models  (iv) Geospatial data structures  (v) Spatial resolution and Scale  (vi) Model suitability criteria  (vii) Topology: definition, levels and topological relationships.  (viii) Open data formats: XML, GML, SVG and their use.</p>	<p>Refer to the inherent characteristics of vector and raster data models.</p> <p>Select the appropriate data model and structure for a specific purpose and scale.</p> <p>Apply vector and raster models for the encoding of spatial data taking into account the spatial resolution required for a specific application and scale.</p> <p>Encode topological relationships in spatial data files using available software tools.</p> <p>Refer to open data formats.</p>
<p>E6.3 Geospatial data input and editing</p> <p>(I)</p>	<p>(i) Feature and attribute data encoding and standards  (ii) Data entry  (iii) Manual, semi-automatic and automatic digitization  (iv) Scanning  (v) Data editing.</p>	<p>Use a GIS environment to encode spatial data derived from manual, semi-automatic and automatic digitization.</p> <p>Apply the appropriate scanning parameters with respect to a specific application and scale and utilize the resulting file.</p>
<p>E6.4 Geospatial data transformations</p> <p>(I)</p>	<p>(i) Affine transformation  (ii) Projection transformations  (iii) Nature of problems associated with geospatial data transformations.</p>	<p>Describe and apply the most commonly used spatial data transformations using appropriate software.</p> <p>Evaluate the results of spatial data transformations.</p>
<p>E6.5 Raster to Vector Conversion</p> <p>(I)</p>	<p>(i) Raster to Vector and Vector to Raster conversion algorithms.</p>	<p>Apply raster to vector and vector to raster conversions using appropriate software.</p>
<p>E6.6 Geospatial and cartographic databases</p> <p>(B)</p>	<p>(i) Geospatial vs. cartographic databases  (ii) Geospatial/Cartographic database design  (iii) Geospatial/Cartographic database integrity  (iv) Geospatial/Cartographic database operations.</p>	<p>Describe different types of geospatial data and their representation in a DBMS environment.</p> <p>Describe a spatial database on a conceptual, logical and physical level.</p> <p>For a given design, build and populate a spatial database in a DBMS and use it to support cartographic composition.</p>
<p>E6.7 Geospatial data analysis and modeling</p> <p>(B)</p>	<p>(i) Single and multiple layer operations.</p>	<p>Describe the functionality of a GIS in geospatial data analysis and modeling.</p>
<p>E6.8 Raster data compression</p> <p>(B)</p>	<p>(i) Raster data compression methods, e.g.:</p> <ul style="list-style-type: none"> <li>• Run-length encoding</li> <li>• Freeman chain codes</li> <li>• Quad tree encoding</li> <li>• JPEG compression.</li> </ul>	<p>Describe the various raster data compression methods in terms of space saving and resolution.</p>

E6.9 Geospatial data transfer standards (B)	(i) Geospatial data transfer standards (S-57, S100, SDTS, DXF, DIGEST, ISO....) (ii) Geospatial data transfer process.	Explain the rationale underpinning geospatial data transfer. Describe a typical process for transferring geospatial data between different hardware and software environments.
E6.10 Spatial Data Infrastructures (B)	(i) Spatial Data Infrastructures [SDI] for the marine environment.	Identify and explain the content and the role of a SDI for the marine environment as a means of: facilitating and coordinating the exchange of spatial data among providers and users compilation and production of nautical charts. marine spatial planning.
E6.11 Web services (B)	(i) Web services for geospatial data (ii) Map and chart compilation, composition and publication on the web.	Compare web services with traditional processes for delivery, storage and portrayal of spatial data.

## **E7: Nautical Cartography**

### **E7.1 The Nautical Chart**

<b>Element</b>	<b>Content</b>	<b>Learning outcomes</b>
E7.1a Evolution of nautical charts (I)	(i) Paper (national and INT) (ii) ENC (ECDIS) (iii) ECS.	Outline the evolution of nautical charts and chart systems.
E7.1b Nautical charts (I)	(i) Planning (ii) Navigation (iii) Types of charts (iv) Chart reading.	Classify various types of nautical charts according to their primary purpose. Analyze various types of charts and their uses.
E7.1c Nautical chart design (I)	(i) Characteristics (ii) Content (iii) Terminology (iv) Symbolization.	Describe present day characteristics and design principles of nautical charts. Describe the impact of technology on nautical chart design and production.
E7.1d Nautical chart reference framework (I)	(i) Chart graticule (ii) Chart grid.	Compute and prepare chart graticule and chart grid using appropriate software according to specifications.

### **E7.2 International Organizations and the Nautical Chart**

<b>Topic/Element</b>	<b>Content</b>	<b>Learning outcomes</b>
E7.2a Role and structure of the IHO (B)	(i) IHO roles and structure (ii) General Assembly (iii) Regional Hydrographic Commissions	Describe the roles of IHO, IMO and IALA with respect to the development and use of nautical charts for safe navigation.
E7.2b Role of the IMO (B)	(iv) Committees and Working Groups (v) IMO and the SOLAS convention	

E7.2c Role of the IALA  (B)	(vi) IALA guidelines and recommendations.	
<b>E7.3 Nautical chart compilation and production</b>		
<b>Topic/Element</b>	<b>Content</b>	<b>Learning outcomes</b>
E7.3a Planning and scheming  (B)	(i) Geographical area and scale (ii) Chart scheming (iii) Overlapping and nesting principles.	Refer to the planning processes adopted internationally for the scheming and production of (official) nautical charts.
E7.3b Data sources  (I)	(i) Metadata considerations (ii) Source data selection (iii) Source data homogenization (iv) Source data registration.	Analyze methods applied for the appropriate selection and homogenization of source data.
E7.3c Content and Symbology  (I)	(i) Coastlines <ul style="list-style-type: none"> <li>• Natural</li> <li>• Constructed</li> <li>• Approximate</li> </ul> (ii) Bathymetry <ul style="list-style-type: none"> <li>• Soundings</li> <li>• Italicized</li> <li>• Upright</li> <li>• Special (e.g. Swept)</li> <li>• Sounding pattern selection</li> <li>• Principles</li> <li>• Automated techniques</li> <li>• Channel depiction</li> </ul> (iii) Bathymetric contours (iv) Dangers to navigation <ul style="list-style-type: none"> <li>• Rocks</li> <li>• Wrecks</li> <li>• Reefs</li> <li>• Shoals</li> <li>• Offshore constructions</li> <li>• Submarine pipelines and cables</li> <li>• Obstructions</li> <li>• Sea floor descriptions</li> </ul> (v) Topography <ul style="list-style-type: none"> <li>• Depiction using seaward view principle</li> <li>• Natural features</li> <li>• Landmarks</li> <li>• Constructed features</li> <li>• Conspicuous objects</li> </ul> (vi) Boundaries and limits <ul style="list-style-type: none"> <li>• Dredged areas</li> <li>• Controlled areas</li> <li>• Controlled routes</li> <li>• Baselines</li> <li>• International boundaries</li> </ul>	Identify the various categories of features portrayed in nautical charts and use them in nautical chart production.  Explain the rationale underpinning the symbology for each feature and/or data category and apply them in nautical chart production.

	<p>and maritime zones</p> <p>(vii) Navigation aids</p> <ul style="list-style-type: none"> <li>• Lights, beacons, buoys, marks</li> <li>• Light sectors</li> <li>• Leads</li> <li>• Radio beacons</li> <li>• Radar reflectors</li> <li>• Recommended tracks</li> <li>• Recommended routes</li> </ul> <p>(viii) Source data diagrams – depiction</p> <p>(ix) ZOC</p> <p>(x) Titles and chart notes</p> <p>(xi) Graphic scales.</p>	
E7.3d Chart compilation and composition  (I)	(i) The chart compilation and composition processes. <ul style="list-style-type: none"> <li>• Element selection</li> <li>• Database extraction</li> <li>• Synthesis and homogenization</li> <li>• Conflict resolution</li> <li>• Validation.</li> </ul>	Describe and perform the processes required for chart compilation and composition from a geospatial data base using standalone software systems or integrated cartographic production systems.
E7.3e IHO Standards and Chart Specifications (I)	(i) IHO standards and chart specifications (ii) INT chart specifications <ol style="list-style-type: none"> <li>a. INT 1</li> <li>b. INT 2</li> <li>c. INT 3</li> </ol> <p>(iii) IHO S-4 (iv) IHO S-11 (v) Feature attribution (vi) Text (Styles as symbols) (vii) Notes, legends.</p>	Describe the processes of the IHO Member States for the development of international chart and ENC standards. Identify, describe and use the international standards and specifications for nautical charts.
E7.3f Updating  (I)	(i) Notices to mariners (ii) Editions.	Perform a complete chart updating task including editing, updating and publishing.
E7.3g Mapping on demand  (B)	(i) Customized mapping from existing databases.	Explain the concept of mapping on demand.
<b>E7.4 Map/chart production systems</b>		
<b>Topic/Element</b>	<b>Content</b>	<b>Learning outcomes</b>
E7.4a Commercial Systems  (B)	(i) Commercial systems for map/chart production (ii) Graphics and image processing software in cartographic applications (iii) Open standards and open source systems	Identify common commercial systems used for map/chart production. Identify commercial graphic and image processing systems. Use a commercial system for map/chart composition and production.
E7.4b Open Source Systems  (B)	(iv) Open Geospatial Consortium (OGC).	Describe the concept of open source systems as applied to map/chart production. Identify some open source geospatial

		standards, their content and the organizations developing them.
E7.4c Map/chart production systems evaluation  (I)		Identify the benefits and/or limitations of the use of commercial and/or open source systems.
<b>E7.5 Electronic chart production</b>		
<b>Topic/Element</b>	<b>Content</b>	<b>Learning outcomes</b>
E7.5a Introduction to electronic charts  (I)	(i) Definition of ENC, SENC and ECDIS (ii) IMO carriage requirements (iii) ENC as product (iv) Production conventions <ul style="list-style-type: none"> <li>• Issuance</li> <li>• Numbering</li> <li>• Cell structure</li> <li>• Updating</li> <li>• Official status</li> <li>• Security protection</li> <li>• SENC</li> </ul>	Describe ENC, SENC and ECDIS Explain the product characteristics of ENCs.
E7.5b IHO standards for ENC production  (B)	(i) IHO S-57 <ul style="list-style-type: none"> <li>• Contents including appendices</li> <li>• Data model</li> <li>• Topology</li> </ul> (ii) Object Catalogue <ul style="list-style-type: none"> <li>• Object, attribute and master/slave classes</li> <li>• Spatial objects</li> <li>• Feature objects</li> <li>• Relationships</li> <li>• Special cases</li> </ul>	Identify the international standards and specifications relating to ENCs. Describe the ENC standards and explain the relationships between them. Describe the S-57 data model. Describe the content of Presentation Library. Describe the rationale underpinning the development of S-100. Describe the S-100 universal hydrographic data model.
E7.5c ENC production and distribution  (I)	(iii) IHO S-52 <ul style="list-style-type: none"> <li>• Presentation Library</li> </ul> (iv) IHO S-65 <ul style="list-style-type: none"> <li>• ENC production</li> <li>• Quality control</li> <li>• Quality assurance</li> <li>• Quality management systems</li> </ul> (v) IHO S-58 <ul style="list-style-type: none"> <li>• Validation process</li> <li>• Spatial accuracy</li> <li>• Feature completeness</li> <li>• Logical consistency</li> <li>• ECDIS display consistency</li> <li>• Software validation tools</li> <li>• False warnings</li> <li>• Errors and warnings</li> </ul>	Explain Object Based Data Bases. Explain the general principles underpinning electronic chart data visualization. Describe recommended production procedures for ENCs. Identify best practices for the QC/QA of an ENC including gaps and overlaps of adjacent cells. Use software applications to produce an ENC. Describe the ENC distribution system.

	<ul style="list-style-type: none"> <li>(vi) ENC distribution system <ul style="list-style-type: none"> <li>• IHO S-63</li> <li>• IHO WEND principles and RENCs</li> </ul> </li> <li>(vii) IHO S-100</li> <li>(viii) IHO S-99 <ul style="list-style-type: none"> <li>• S-100 Registry and Registers</li> <li>• S-101 ENC product specification</li> <li>• S-102 Bathymetry surface product specification.</li> </ul> </li> </ul>	
<b>E7.6 Rasterized products</b>		
<b>Topic/Element</b>	<b>Content</b>	<b>Learning outcomes</b>
E7.6 Raster charts  (B)	<ul style="list-style-type: none"> <li>(i) The rasterization process</li> <li>(ii) Scanning processes</li> <li>(iii) Advantages and limitations of rasterized chart products</li> <li>(iv) Raster data structures</li> <li>(v) Raster chart formats</li> <li>(vi) Raster chart products</li> <li>(vii) Raster chart images and tiles</li> <li>(viii) Raster chart images – use within GIS and other environments.</li> </ul>	<p>Describe the characteristics, advantages and limitations of rasterized chart products.</p> <p>Describe rasterizing processes.</p> <p>Describe the use of rasterized chart images within navigation systems.</p>
<b>E8: Legal aspects (Relating to nautical cartography)</b>		
<b>Topic/Element</b>	<b>Content</b>	<b>Learning outcomes</b>
E8.1 Liability and responsibility  (B)	<ul style="list-style-type: none"> <li>(i) The IMO SOLAS convention</li> <li>(ii) The status of an official nautical chart <ul style="list-style-type: none"> <li>• General status under IMO carriage requirements</li> <li>• Legal document</li> <li>• Status post maritime incident</li> </ul> </li> <li>(iii) The role of national hydrographic agencies</li> <li>(iv) Potential legal issues: <ul style="list-style-type: none"> <li>• Duty of care</li> <li>• Product liability</li> <li>• Defectiveness</li> <li>• Fitness for purpose.</li> </ul> </li> </ul>	<p>Describe the role and responsibilities of national hydrographic agencies as required under the Safety of Life at Sea convention</p> <p>Describe the status of the nautical chart as both an operational and legal entity.</p> <p>Outline the role and responsibilities of the nautical cartographer.</p> <p>Describe potential issues of legal liability relating to nautical charts.</p>
E8.2 Intellectual property and copyright  (B)	<ul style="list-style-type: none"> <li>(i) Definition</li> <li>(ii) Protection</li> <li>(iii) Permission/License and fees</li> <li>(iv) Disclaimers</li> <li>(v) Penalties.</li> </ul>	<p>Define intellectual property and copyright in the framework of nautical charting.</p> <p>Compare how copyright issues are managed within different map and chart production agencies.</p>
E8.3 Law of the Sea  (B)	<ul style="list-style-type: none"> <li>(i) Historical development of the Law of the Sea</li> <li>(ii) The United Nations Convention on the Law of the Sea (UNCLOS): <ul style="list-style-type: none"> <li>• General provisions</li> </ul> </li> </ul>	<p>Describe the historical evolution of the Law of the Sea</p> <p>Describe the types of lines and areas defined under UNCLOS and their delimitation</p>

	<ul style="list-style-type: none"> <li>• Base points</li> <li>• Baselines - normal (including bay closing lines); straight and archipelagic</li> <li>• Internal waters</li> <li>• Territorial sea</li> <li>• Contiguous zones</li> <li>• Exclusive Economic Zone</li> <li>• Continental Shelf and Extended Continental Shelf.</li> </ul> <p>(iii) Status of the nautical chart for portrayal of boundaries and maritime zones</p> <p>(iv) Delimitation of boundaries and maritime zones.</p>	Explain the status of the official nautical chart as a reference in relation to the depiction of boundaries and maritime zones.
<b>E9: Special Purpose Charting</b>		
<b>E9.1 Industrial and Engineering Survey Chart Production</b>		
<b>Element</b>	<b>Content</b>	<b>Learning outcomes</b>
E9.1a Introduction to industrial and engineering surveys charting  (B)	<p>(i) Types of Industrial and Engineering Surveys.</p> <p>(ii) Data from remotely operated and autonomous vehicles</p> <p>(iii) Requirement for cartographic presentation.</p> <p>(iv) Applicable standards (e.g. IOGP; UKOOA; IMCA; ...).</p>	Describe specific requirements, equipment and standards for engineering survey charts.
E9.1b Route surveys charting  (B)	<p>(i) Rationale of charts and graphics for route surveys</p> <p>(ii) Forms of presentation for route survey data</p> <p>(iii) Use of vertical exaggeration in DEMs and profiles.</p>	Describe specific requirements and guidelines for route survey charts.
E9.1c Dredging surveys charting  (B)	<p>(i) Rationale of charts and graphics for dredging surveys</p> <p>(ii) Forms of presentation for dredging survey data</p> <p>(iii) Presentation techniques for volumetrics.</p>	Describe specific requirements for dredging survey charts.
E9.1d Shallow geophysical site surveys charting  (B)	<p>(i) Rationale of charts and graphics for Geophysical Site surveys.</p> <p>(ii) Forms of presentation for Geophysical Site survey data.</p> <p>(iii) Presentation techniques for Geophysical Site survey data including the depiction of multiple layers.</p>	Describe specific requirements and guidelines for shallow geophysical survey charts.

E9.1e Still photograph and video surveys charting  (B)	(i) Rationale for the use of still photograph and video surveys (ii) Photographic and video formats (iii) Video eventing (iv) Relating video survey to other relevant charts and graphics (v) Positional considerations.	Describe specific requirements and standards for photographic and/or video survey charts.
E9.1f Geo-technical surveys charting  (B)	(i) Rationale of charts and graphics for geotechnical data (ii) Forms of presentation for geotechnical data including written reporting.	Describe specific requirements and guidelines for engineering survey charts.
E9.1g Environmental surveys charting  (B)	(i) Rationale of charts and graphics for environmental data (ii) Forms of presentation for environmental data.	Describe specific requirements and guidelines for environmental survey charts.
E9.1h Industrial and engineering survey data representation  (B)	(i) Forms of presentation for industrial and engineering survey data.	Differentiate the representation of industrial and engineering survey data from nautical charting data.
<b>E10: Map/Chart Reproduction</b>		
<b>Topic/Element</b>	<b>Content</b>	<b>Learning outcomes</b>
E10.1 Forms of map/chart artwork  (B)	(i) Positive artwork (ii) Negative artwork.	Describe the forms of map/chart artwork and their characteristics.
E10.2 Output options  (B)	(i) Soft copies (ii) Hard copies.	Explain the differences and use of available output options.
E10.3 Raster processing techniques  (B)	(i) Page description language (Adobe Postscript) (ii) Raster Image Processing (RIP).	Explain raster processing techniques.
E10.4 Output devices  (B)	(i) Electrostatic printers/plotters (ii) Ink-jet printers/plotters (iii) Laser printers/plotters (iv) Thermal printers (v) Image setters.	Describe the technical characteristics of the various output devices used in cartographic production.
E10.5 Color management  (B)	(i) Standards for Color Matching (ii) Color profiles (iii) Gamut mapping.	Explain the need for the use of color standards and the creation of color profiles. Describe the gamut mapping process.
E10.6 Color separation  (B)	(i) Color separation (ii) Image Setters (iii) Compositing separations (iv) Composite to film (v) Composite to plate.	Explain the need for color separation. Describe the color separation process in analogue and digital environments.
E10.7 Proofing  (B)	(i) Pre-press proofing (ii) Photo-mechanical proofs	Explain the need for proofing. Distinguish between photo-mechanical



	(iii) Digital proofs.	and digital color proofs.
E10.8 Lithography  (B)	(i) Single color lithography (ii) Multiple color lithography.	Explain the processes involved in single and multi-color lithography.
E10.9 Plate making  (B)	(i) Plate making process.	Describe the plate making process.
E10.10 Press work  (B)	(i) Offset lithography (ii) Printing units (iii) Printed output quality check.	Describe the offset lithographic process. Describe map/chart quality checks in offset printing
E10.11 Printing papers  (B)	(i) Printing paper specifications.	Refer to printing paper specifications.

## CCP - COMPREHENSIVE CARTOGRAPHIC PROJECT

Programmes must include a supervised and evaluated Comprehensive Cartographic Project (CCP) with a minimum aggregate period of **at least four weeks**; see “GUIDELINES FOR THE IMPLEMENTATION OF THE STANDARDS OF COMPETENCE FOR HYDROGRAPHIC SURVEYORS AND NAUTICAL CARTOGRAPHERS”.

Notes:

- a. The Comprehensive Cartographic Project does not include practical exercises, which form a part of the course modules syllabi and are designed to complement the theory component see “GUIDELINES FOR THE IMPLEMENTATION OF THE STANDARDS OF COMPETENCE FOR HYDROGRAPHIC SURVEYORS AND NAUTICAL CARTOGRAPHERS”.
- b. The Comprehensive Cartographic Project must contain all those items that will enable the student to compile and compose a modern nautical chart, ENC's and special purpose charts according to international specifications.
- c. The Comprehensive Cartographic Project must be divided in phases, representing the distinct processes involved in cartographic composition and production i.e. planning, preparation, acquisition & processing, composition, deliverables (paper charts, ENC's, special purpose charts) and reports.
- d. Each phase will be further divided in tasks that will:
  - result in specific outcome(s)
  - require specific equipment, software, data sources, etc.
  - be carried out in specific number of hours and
  - be related to specific S-B elements.

THE TABLE -AS SPECIFIED IN THE GUIDELINES- MUST BE COMPLETED AND SUBMITTED IN ADDITION TO A DETAILED AND COMPREHENSIVE NARRATIVE DESCRIPTION OF THE COMPREHENSIVE CARTOGRAPHIC PROJECT MODULE IN ACCORDANCE WITH THE GUIDELINES.