INTERNATIONAL FEDERATION OF SURVEYORS INTERNATIONAL HYDROGRAPHIC ORGANIZATION INTERNATIONAL CARTOGRAPHIC ASSOCIATION







STANDARDS OF COMPETENCE FOR CATEGORY "B" NAUTICAL CARTOGRAPHERS

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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 worldwide. 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*:

B1: Mathematics, Statistics, Theory of Errors	7
B2: Information and Communication Technology	8
B3: Earth Sciences	9
E1: General Geodesy	10
E2: General Cartography	10
E3: Hydrography and Nautical Products	13
E4: Data for Nautical and Special Purpose Charting	14

E5: Photogrammetry and Remote Sensing	15
E6: Geospatial Information and Processing	16
E7: Nautical Cartography	18
E8: Legal aspects (Relating to nautical cartography)	22
E9: Special Purpose Charting	23
E10: Map/Chart Reproduction	24
CCP - COMPREHENSIVE CARTOGRAPHIC PROJECT	26

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: $\underline{www.iho.int} \rightarrow Standards \& Publications$.

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

LIST OF ACRONYMS AND INITIALISMS USED IN THIS DOCUMENT

1D	One-dimensional
2D	Two-dimensional
3D	Three-dimensional
AIS	Automatic Identification System
В	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 Regulations for International (INT) Charts and Chart
	Specifications of the IHO
S-11	IHO Publication S-11 INTernational Chart Web Catalog
S-52	IHO Publication S-52 Specifications for Chart Content and Display Aspects of ECDIS
S-57	IHO Publication S-57 IHO Transfer Standard for Digital Hydrographic Data
S-58	IHO Publication S-58 ENC Validation Checks
S-65	IHO Publication S-65 ENCs: Production, Maintenance and Distribution Guidance
S-99	IHO Publication S-99 Operational Procedures for the Organization and Management of the S-100 Geospatial Information Registry
S-100	IHO Publication S-100 <i>IHO Universal Hydrographic Data Model</i>
S-101	IHO Publication S-101 ENC Product Specification
S-102	IHO Publication S-102 Bathymetric Surface Product Specification
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

B1: Mathematics, Statistics, Theory of Errors		
Topic/Element	Content	Learning outcomes
B1.1 Co-	(i) Co-ordinate systems	Describe and use co-ordinate systems.
ordinate geometry	(ii) Linear and quadratic functions (iii) Functions in plane geometry	Describe and use equations for lines and planes.
(I)	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) Systems and units of measurement.	Describe the International System, Imperial and other systems of measurement in common use. Classify fundamental and derived units.
(I)		Classify fundamental and defived ames.
B1.3 Linear	(i) Vector and affine spaces,	Describe and apply 2D transformations
Algebra	vector and inner products,	involved in mapping.
(-)	norms	Solve linear equations using matrix
<i>(B)</i>	(ii) Linear equations, determinants	methods.
	(iii) Analytical geometry, line and	
	plane equations	
	(iv) Linear operators, matrix representation, composition,	
	inverse, transpose	
	(v) Translations, rotations,	
	coordinate transformations.	
B1.4	(i) Basic trigonometry	Apply plane and spherical trigonometry to
Trigonometry	(ii) Sphere, great circle, rhumb	cartography problems.
8	lines, sphere angles, spherical	
(B)		
. ,	triangles and spherical excess.	
B1.5 Errors and	(i) Sources of error and their	Describe and classify possible sources of
Statistics	classification	error as a result of utilization of a chart
(D)	(ii) Random variables, mean,	(i.e. measurement, digitization).
<i>(B)</i>	variance, standard deviation (iii) Covariance and correlation	Define a random variable and estimate its
	(iv) Estimation of mean, variance,	mean, variance, co-variance and standard
	co-variance	deviation.
	(v) Normal distribution.	
B1.6 Least	(i) Least squares procedure	Perform a least square calculation and
squares	(ii) Definition and use of Root	interpret results.
3 44410 3	Mean Square Error (RMSE)	The province of the province o
(B)		

B2: Information Content Content Describe the different components of a computer system and susceptible (ii) Communication board, serial links, communication between systems and peripheral devices. (iv) Communication protocols (v) Operating systems (vi) Device drivers (vii) Input/output devices (scanners, digitizers, printers, plotters) and associated technical characteristics/specifications (vii) Data storage device types, the cloud; advantages, limitations. B2.2 Office work software suites (iii) Graphics and image processing software. Use office work software suites (iii) Graphics and image processing software. Use office work software suites (iii) File types (binary, text, XML) (iii) Algorithms (loops, conditional instructions) (iv) Porgramming languages (e.g. Visual Basic, Visual C++, Python, Java) (v) Centific computation environments (e.g. Mallah) (vi) Application to data exchange, file and format conversion. Describe the order of a device driver and its relation to data transfer. List technical specifications for imput/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.	D17 C4:-1	(i) 1D = 1	Describe an effect intermediation medicals
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communications (iii) Networks integrity associated protocols used in data transfer/exchange applications.			
(iv) Communication protocols. transfer/exchange applications.		` /	_
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	(B)		

B3: Earth Scien	nces	
Topic/Element	Content	Learning outcomes
B3.1 General geography of	(i) Earth as a system of interacting 'zones'	Describe the major components of the Earth as a system.
the Earth	(ii) Plate tectonics, earthquake zones	Identify general categories of land and water masses.
(B)	(iii) Earth dynamics(iv) Ecosystems.	Explain the plate tectonic theory.
B3.2 Marine geomorphology and marine	(i) Marine Geomorphologyconceptsfeatures	Describe and identify marine geographic features, such as coastline, bays, inlets, capes, oceans, seas, channels, etc.
geographic features	• processes.	Describe processes of deposition and erosion.
(B)		
B3.3 Marine	(i) Gravity	Describe the data acquired by gravity,
geophysics	(ii) Magnetics	magnetic and seismic surveys. Describe
(B)	(iii) Seismic profiles.	geophysical properties of undersea features.
B3.4 Ocean	(i) Sea water properties	List the main properties of sea water.
properties and	(ii) Ocean Dynamics	Describe ocean dynamics in terms of
dynamics	• nature	currents and tidal variations.
(B)	motiontides	
	• currents.	
B3.5 Seafloor	(i) Sediment types	Distinguish common seafloor
characteristics	(ii) Submerged aquatic vegetation	characteristics.
	(iii) Corals	
(B)	(iv) Outcropping rocks.	

3. ESSENTIAL SUBJECTS

E1: General Ge	eodesv	
Topic/Element	Content	Learning outcomes
E1.1 Introduction to geodesy (I) E1.2 Coordinate systems, frames and datums (I) E1.3 Geodetic transformations and associated computations	 (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 (iv) Local geodetic reference frames (v) Terrestrial reference systems and reference frames (vi) Datums and datum transformation techniques (vii) Vertical datums (viii) Modern geodetic reference systems and datums [GRS80, WGS84, ETRS89, ITRF]. 	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. Describe modern and traditional geodetic reference systems and associated reference frames. Describe and apply horizontal and vertical datum transformation methods using available software.
(I) E1.4 Spherical and ellipsoidal computations	(ix) Computations on the sphere (x) Computations on the ellipsoid.	Perform computations on the spherical and ellipsoidal surface using available software.
E2: General Ca	rtography	
Topic/Element	Content	Learning outcomes
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 	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
	projections (conformal, equivalent, equidistant) (iv) Methodology for the selection	emphasis on the UTM projection system.

E2.2b Study of map distortions (B)	of a cartographic projection (v) Projection formulae and planimetric coordinates (vi) Projection systems (vii) The UTM projection system. (i) Definition of Scale Factor (ii) Tissot's theorem (iii) Principal directions (iv) Tissot's indicatrix (v) Distortions in distances, areas and angles associated with specific map projections (Mercator, Transverse Mercator, Lambert conformal	Describe scale factor and its properties. Identify the prevailing properties of a projection using Tissot's indicatrix. Compute bearings and distances on projections used in nautical cartography.
E2.3 Abstract representation and generalization (1)	conic). (i) Rationale for generalization (ii) Model, semantic and cartographic generalization (iii) Elements of generalization (iv) Controls of generalization (v) Rules for semantic generalization (vi) Cartographic generalization of point, line and area features (vii) Cartographic generalization algorithms.	Explain the rationale for generalization. Distinguish between model, semantic and cartographic generalization. Classify and detail the processes of generalization. Rationalize the selection of generalization algorithms. Perform generalization of point, line and polygon features using: a) manual methods, b) appropriate generalization algorithms and associated parameters' values.
E2.4 Relief representation (I)	 (i) Rationale for terrain and sea bottom representation (ii) Methods for terrain and sea bottom representation (contouring, zoning, etc.) (iii) Relative and absolute accuracy in contouring (iv) Digital representation of the relief – Digital Elevation Models [DEM] and methods of interpolation (Inverse distance, TIN, GRID, Kriging). (v) Extraction of DEM byproducts (slope, aspect). 	Explain the reasons underpinning terrain and sea bottom representation. Describe in detail and compare common methods used for terrain and sea bottom representation. Describe common interpolation methods used for DEM creation. Create a DEM using appropriate methods and extract its by-products.
E2.5 Cartographic data, scales of measurement (B) E2.6 Symbolization	 (i) Scales of cartographic data measurement Nominal scale Ordinal scale Interval scale. (i) Rationale for symbolization (ii) Concepts of symbolization 	Categorize cartographic data according to their scale of measurement. Explain the rationale for symbolization. Describe visual variables.
(I)	(iii) Graphical elements of symbols(point, line, area)(iv) Visual variables (shape, size,	Use visual variables with respect to scale of cartographic data measurement.

	orientation, color, pattern, etc.)	Distinguish types of symbols and their use
	(v) Basic rules of symbol design	
	and use.	Explain the need for and use symbol libraries.
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E2.7 Color	(i) Rationale for the use of color	Explain the rationale, role and importance
(D)	(ii) The nature of color (spectral	of color and its use in mapping and
(B)	colors vs. reflected colors)	charting.
	(iii) The dimensions of color	Outline the principal color conventions
	(iv) Systems of color modeling/ specification (CIE, Munsell)	for maps and charts and their features.
	(v) Electronic display color	Differentiate color for various computer
	models (RGB, HLS)	graphics and printing applications.
	(vi) Choosing colors for	
	maps/charts	
	(vii) Color conventions	
	(viii) Patterns (B/W – color)	
	(ix) Color for computer graphics	
	(screens, plotters, printers)	
	(x) Color for printing.	
E2.8 Map/chart	(i) Rationale of toponymy	Explain the rationale and the functionality
lettering and	(ii) Lettering and its functionality	of toponymic display.
toponymy	(iii) Lettering style, size and color	Describe and demonstrate appropriate use
	(iv) Relationship between	of lettering in relation to the inherent
(I)	toponyms and the use of	characteristics of cartographic features.
	lettering	Describe and apply placement rules for
	(v) Naming conventions	toponyms.
	(vi) Positioning guidelines for	
	toponyms of point, line and area features	
	(vii) Placement of toponyms with	
	respect to the scale/graticule.	
E2.9	(i) Principles of good	Describe the principles and characteristics
Cartographic	cartographic design	underpinning good cartographic design.
design	(ii) Design requirements for	Identify selected maps/charts in terms of
	different map/chart categories	the principles of good cartographic design
(B)	(iii) Scale selection	(with proper justification).
	(iv) Graphic organization	(F. of a Jasana
	(map/chart layout)	
	(v) Visual balance	
	(vi) Types of data (point, linear,	
	areal, 3D)	
	(vii) Representation (of reality)	
	(viii) Composition	
	(ix) Visual hierarchy (x) Presentation	
	(xi) Use of color/figure-	
	ground/contrast.	
E2.10 Map/chart	(i) The cartographic compilation	Describe the logical process of
compilation and	and composition process	cartographic compilation and composition
composition	(ii) Compilation planning and	identifying discrete stages.
•	scheduling	Differentiate between the appropriate
(I)	(iii) Source data and map/chart	compilation processes for maps and
	scale	nautical charts of different themes and
	(iv) Map/Chart data quality	scales.
	elements	Describe and apply cartographic data
L	<u>l</u>	= 1.21100 min appi) cartograpine data

	 Accuracy (positional, thematic, temporal) Resolution (spatial, temporal) Consistency (logical, domain) Currency Completeness Clarity 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. 	quality assessment processes. Differentiate between analog and digital compilation processes. Develop a digital and an analog compilation worksheet covering a defined region and utilize it for map/chart composition and symbolization.
E3: Hydrograp	hy and Nautical Products	
Topic/Element E3.1 Hydrography, nautical cartography and navigation	Content (i) Relationship between hydrography, nautical cartography and navigation.	Learning outcomes 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) 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	(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

E3.7 Hydrographic data at various stages in the chart compilation process management (ii) Databases for hydrographic data. (iii) Databases for hydrographic data. (iii) Databases for hydrographic data. (iv) Databases for hydrographic data. (iv) Databases for hydrographic data. (iv) Data sources appropriate for Coastline and topographic data (iv) Data sources appropriate for inclusion in nautical charting for coastline and topography (iv) Categories and corresponding definitions of coastline (ivi) Relevance of scale for the data sources for depiction on charts with regard to scale. (iv) Management of hydrographic data acquisition processing, analysis and management procedures and methodologies. Describe the content and use of a hydrographic source database. (iv) Describe different categories of coast and their depiction. Homogenize topographic data from various data sources for depiction on charts with regard to scale. Evaluate bathymetric data sources for depiction data sources for depiction on charts with regard to scale.	
Hydrographic data at various stages in the chart compilation process management (ii) Databases for hydrographic data. (I) E4: Data for Nautical and Special Purpose Charting Topic/Element Content E4.1 (i) Data sources appropriate for Coastline and topographic data (I) Data sources appropriate for inclusion in nautical charting for coastline and topography (ii) Categories and corresponding definitions of coastline (I) Relevance of scale for	
data chart compilation process management (ii) Databases for hydrographic data. (I) Databases for hydrographic data. (Iii) Databases for hydrographic data. (Iii) Databases for hydrographic data. (Iii) Data Special Purpose Charting Topic/Element Content E4.1 (i) Data sources appropriate for inclusion in nautical charting for coastline and topographic data (Iii) Categories and corresponding definitions of coastline (Iiii) Relevance of scale for	
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E4: Data for Nautical and Special Purpose Charting Topic/Element Content Learning outcomes E4.1 (i) Data sources appropriate for Coastline and topographic data for coastline and topography (ii) Categories and corresponding definitions of coastline (iii) Pelevance of scale for topic industry of the coastline in the coastline i	line
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Topic/Element Content Learning outcomes E4.1 Coastline and topographic data for coastline and topography (ii) Categories and corresponding definitions of coastline (I) Learning outcomes Describe different categories of coast and their depiction. Homogenize topographic data from various data sources for depiction on charts with regard to scale.	line
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(ii) Categories and corresponding definitions of coastline charts with regard to scale.	
(I) definitions of coastline charts with regard to scale.	
(iii) Relevance of scale for	
Evoluate hethymatic data coverse for	
l selecting appropriate data	
Bathymetric in nautical and special purpose charts	
data (iv) Principles of selection and Explain and use CATZOC.	
depiction of topography Homogenize hydrographic/ bathymet	ric
(I) (v) Principles of selection and data from various data sources for	
depiction of bathymetry depiction on charts with regard to sea	le.
(vi) Bathymetric data quality	
(vii) The concept and use of	ļ
CATZOC.	
E4.3 (i) Cartographic representations Evaluate selected data sources for har	zards
Navigational of hazards to navigation and aids to navigation.	
hazards and aids (ii) Cartographic representations Describe and apply the appropriate	
to navigation	
of aids to navigation. depiction of identified navigational hazards and aids to navigation on nau	tical
(I) hazards and aids to havigation on had charts.	ticui
E4.4 Sailing (i) Identification of textual and Explain the relationship between nau	tion1
directions and administrative data suitable for charts and textual data sources and the	
publications (boundaries, environmental publications including reports, lists at	IU
areas, traffic routing etc.) tabular data).	C
(ii) Symbiotic relationship Evaluate available administrative date consistency in its graphical depiction	
tonsistency in its grapinear depiction	ļ
data. and/or textual promulgation.	
E4.5 Source (i) Chart datums: horizontal and Define horizontal and vertical datums	
City Division of the state of t	iS
(D) continuity used in entrographic data	
(iii) Methodologies for adjusting	
data against various datums Perform nonzontal and vertical	
(iv) Adjusting data by use of adjustments of data referred to various	.S
software. datums using software applications.	
E4.6 (i) Identification of appropriate Evaluate the sources and characteristic	cs of
Oceanographic oceanographic data sources oceanographic data.	J.5 O1
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Assess occanographic data for its	
(R) (iii) Tidal and current information	
Display tidal and current information	on
nautical charts.	

(;)	Magnetic registion and	Evaluia "manadia vanistian"
(1)		Explain "magnetic variation".
	appropriateness for charting.	Compute magnetic variation for specific positions and time.
(11)		Depict magnetic anomalies.
(')	*	
(1)		Explain the purpose and importance of
	digital data and chart products.	creating and using metadata.
		Identify and utilize metadata.
(i)	Nautical chart production	Describe nautical chart production
(1)	-	processes and their content.
(ii)		Describe and apply QC processes to
(11)		nautical chart and special purpose chart
		production.
	(QA) processes for the	Identify and describe the implications on
	compilation and production of	data quality arising from the variability of
	nautical and special purpose	source data types.
	charts	source data types.
(iii)		
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(:)		D 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
(1)		Describe special purpose charts and their
(ii)		uses.
(11)	• •	Identify and list data types for particular
		special purpose charts.
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motr		
		Learning outcomes
		Describe basic geometrical principles
(1)	1	applicable to aerial photography and
		imaging.
	context	Describe the use of photogrammetric and
(ii)	Introduction of equipment	remotely sensed data sources to define
	types: sensors and formats of	topographic features for charting.
	aerial photographs and sensed	List remotely sensed techniques
1		List ichiotely sensed techniques
	images	
	Satellite derived bathymetry	applicable to depth measurement.
	Satellite derived bathymetry Basics of photogrammetric and	applicable to depth measurement. Describe rectification and control
	Satellite derived bathymetry Basics of photogrammetric and remote sensing geometry in	applicable to depth measurement.
	Satellite derived bathymetry Basics of photogrammetric and remote sensing geometry in the context of adjustment and	applicable to depth measurement. Describe rectification and control
	Satellite derived bathymetry Basics of photogrammetric and remote sensing geometry in the context of adjustment and application for charting:	applicable to depth measurement. Describe rectification and control
	Satellite derived bathymetry Basics of photogrammetric and remote sensing geometry in the context of adjustment and application for charting: Image scale, relief and	applicable to depth measurement. Describe rectification and control
	Satellite derived bathymetry Basics of photogrammetric and remote sensing geometry in the context of adjustment and application for charting: Image scale, relief and radial displacement	applicable to depth measurement. Describe rectification and control
	Satellite derived bathymetry Basics of photogrammetric and remote sensing geometry in the context of adjustment and application for charting: Image scale, relief and radial displacement Theory and	applicable to depth measurement. Describe rectification and control
	Satellite derived bathymetry Basics of photogrammetric and remote sensing geometry in the context of adjustment and application for charting: Image scale, relief and radial displacement Theory and implementation of spatial	applicable to depth measurement. Describe rectification and control
	Satellite derived bathymetry Basics of photogrammetric and remote sensing geometry in the context of adjustment and application for charting: Image scale, relief and radial displacement Theory and implementation of spatial rectification	applicable to depth measurement. Describe rectification and control
	Satellite derived bathymetry Basics of photogrammetric and remote sensing geometry in the context of adjustment and application for charting: Image scale, relief and radial displacement Theory and implementation of spatial	applicable to depth measurement. Describe rectification and control
	(i) (ii) metr Cor (i)	anomalies, computation and appropriateness for charting. (ii) Magnetic data sources utilization, computations and depiction. (i) Metadata for analog and digital data and chart products. (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. (i) Requirement, use and design of special purpose charts (ii) Data types: • Subsurface • Imagery • Geotechnical • Environmental • Engineering and asset. metry and Remote Sensing Content (i) Development of photogrammetry and remote sensing: brief history and context (ii) Introduction of equipment types: sensors and formats of aerial photographs and sensed

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

E6.2 Goognatical	(i) Vector data models	Refer to the inherent characteristics of
E6.2 Geospatial data modeling	(i) Vector data models(ii) Raster data models	vector and raster data models.
data modering	(iii) Representation of point, line	
(I)	and area data in vector and	Select the appropriate data model and structure for a specific purpose and scale.
	raster models	
	(iv) Geospatial data structures	Apply vector and raster models for the
	(v) Spatial resolution and Scale	encoding of spatial data taking into account the spatial resolution required for
	(vi) Model suitability criteria	a specific application and scale.
	(vii) Topology: definition, levels	
	and topological relationships.	Encode topological relationships in spatial data files using available software tools.
	(viii) Open data formats: XML,	
	GML, SVG and their use.	Refer to open data formats.
E6.3 Geospatial	(i) Feature and attribute data	Use a GIS environment to encode spatial
data input and	encoding and standards	data derived from manual, semi-automatic
editing	(ii) Data entry (iii) Manual, semi-automatic and	and automatic digitization.
(I)	automatic digitization	Apply the appropriate scanning
(1)	(iv) Scanning	parameters with respect to a specific application and scale and utilize the
	(v) Data editing.	resulting file.
E6 / Cocception	(i) Affine transformation	9
E6.4 Geospatial data	(ii) Projection transformations	Describe and apply the most commonly used spatial data transformations using
transformations	(iii) Nature of problems associated	appropriate software.
transformations	with geospatial data	Evaluate the results of spatial data
(I)	transformations.	transformations.
		trunsformations.
E6.5 Raster to	(i) Raster to Vector and Vector to	Apply raster to vector and vector to raster
Vector	Raster conversion algorithms.	conversions using appropriate software.
Conversion		
(I)		
E6.6 Geospatial	(i) Geospatial vs. cartographic	Describe different types of geospatial data
and cartographic	databases	and their representation in a DBMS
databases	(ii) Geospatial/Cartographic	environment.
	database design	Describe a spatial database on a
(B)	(iii) Geospatial/Cartographic	conceptual, logical and physical level.
	database integrity	For a given design, build and populate a
	(iv) Geospatial/Cartographic	spatial database in a DBMS and use it to
	database operations.	support cartographic composition.
E6.7 Geospatial	(i) Single and multiple layer	Describe the functionality of a GIS in
data analysis	operations.	geospatial data analysis and modeling.
and modeling	r	
(B)		
E6.8 Raster data	(i) Raster data compression	Describe the various raster data
compression	methods, e.g.:	compression methods in terms of space
(P)	Run-length encoding	saving and resolution.
(B)	Freeman chain codes	
	• Quad tree encoding	
	 JPEG compression. 	1

E6.9 Geospatial	(i) Geospatial data transfer	Explain the rationale underpinning
data transfer	standards (S-57, S100, SDTS,	geospatial data transfer.
standards	DXF, DIGEST, ISO)	Describe a typical process for transferring
(D)	(ii) Geospatial data transfer	geospatial data between different
(B)	process.	hardware and software environments.
E6.10 Spatial	(i) Spatial Data Infrastructures	Identify and explain the content and the
Data	[SDI] for the marine	role of a SDI for the marine environment
Infrastructures	environment.	as a means of:
(D)		facilitating and coordinating the
(B)		exchange of spatial data among providers
		and users
		compilation and production of nautical
		charts.
EC 11 W/ 1	CWI	marine spatial planning.
E6.11 Web	(i) Web services for geospatial data	Compare web services with traditional
services	(ii) Map and chart compilation, composition and publication on	processes for delivery, storage and portrayal of spatial data.
(B)	the web.	portrayar or spatiar data.
E7: Nautical Ca		
E7.1 The Nautica		
Element	Content	Learning outcomes
E7.1a Evolution	(i) Paper (national and INT)	Outline the evolution of nautical charts
of nautical	(ii) ENC (ECDIS)	and chart systems.
charts	(iii) ECS.	
(I)		
E7.1b Nautical	(i) Planning	Classify various types of nautical charts
charts	(ii) Navigation	according to their primary purpose.
	(iii) Types of charts	Analyze various types of charts and their
(I)	(iv) Chart reading.	uses.
E7.1c Nautical	(i) Characteristics	Describe present day characteristics and
chart design	(ii) Content	design principles of nautical charts.
	(:::) TD : 1	
	(iii) Terminology	Describe the impact of technology on
(I)	(iv) Symbolization.	Describe the impact of technology on nautical chart design and production.
	(iv) Symbolization.	nautical chart design and production.
E7.1d Nautical	(iv) Symbolization.(i) Chart graticule	nautical chart design and production. Compute and prepare chart graticule and
E7.1d Nautical chart reference	(iv) Symbolization.	nautical chart design and production. Compute and prepare chart graticule and chart grid using appropriate software
E7.1d Nautical	(iv) Symbolization.(i) Chart graticule	nautical chart design and production. Compute and prepare chart graticule and
E7.1d Nautical chart reference	(iv) Symbolization.(i) Chart graticule	nautical chart design and production. Compute and prepare chart graticule and chart grid using appropriate software
E7.1d Nautical chart reference framework (I)	(iv) Symbolization.(i) Chart graticule	nautical chart design and production. Compute and prepare chart graticule and chart grid using appropriate software according to specifications.
E7.1d Nautical chart reference framework (I) E7.2 Internation Topic/Element	(iv) Symbolization. (i) Chart graticule (ii) Chart grid. nal Organizations and the Nautical Content	nautical chart design and production. Compute and prepare chart graticule and chart grid using appropriate software according to specifications. Chart Learning outcomes
E7.1d Nautical chart reference framework (I) E7.2 Internation Topic/Element E7.2a Role and	(iv) Symbolization. (i) Chart graticule (ii) Chart grid. al Organizations and the Nautical Content (i) IHO roles and structure	nautical chart design and production. Compute and prepare chart graticule and chart grid using appropriate software according to specifications. Chart Learning outcomes Describe the roles of IHO, IMO and
E7.1d Nautical chart reference framework (I) E7.2 Internation Topic/Element E7.2a Role and structure of the	(iv) Symbolization. (i) Chart graticule (ii) Chart grid. al Organizations and the Nautical Content (i) IHO roles and structure (ii) General Assembly	nautical chart design and production. Compute and prepare chart graticule and chart grid using appropriate software according to specifications. hart Learning outcomes Describe the roles of IHO, IMO and IALA with respect to the development
E7.1d Nautical chart reference framework (I) E7.2 Internation Topic/Element E7.2a Role and structure of the IHO	(iv) Symbolization. (i) Chart graticule (ii) Chart grid. (ii) Chart grid. (ii) Chart grid. (i) Chart graticule (ii) Chart grid. (i) In Chart graticule (ii) General Assembly (iii) Regional Hydrographic	nautical chart design and production. Compute and prepare chart graticule and chart grid using appropriate software according to specifications. Chart Learning outcomes Describe the roles of IHO, IMO and IALA with respect to the development and use of nautical charts for safe
E7.1d Nautical chart reference framework (I) E7.2 Internation Topic/Element E7.2a Role and structure of the IHO (B)	(iv) Symbolization. (i) Chart graticule (ii) Chart grid. nal Organizations and the Nautical Content (i) IHO roles and structure (ii) General Assembly (iii) Regional Hydrographic Commissions	nautical chart design and production. Compute and prepare chart graticule and chart grid using appropriate software according to specifications. hart Learning outcomes Describe the roles of IHO, IMO and IALA with respect to the development
E7.1d Nautical chart reference framework (I) E7.2 Internation Topic/Element E7.2a Role and structure of the IHO (B) E7.2b Role of	(iv) Symbolization. (i) Chart graticule (ii) Chart grid. (ii) Chart grid. (i) In Chart grid. (i) In Chart grid. (i) In Content (i) In Coles and structure (ii) General Assembly (iii) Regional Hydrographic Commissions (iv) Committees and Working	nautical chart design and production. Compute and prepare chart graticule and chart grid using appropriate software according to specifications. Chart Learning outcomes Describe the roles of IHO, IMO and IALA with respect to the development and use of nautical charts for safe
E7.1d Nautical chart reference framework (I) E7.2 Internation Topic/Element E7.2a Role and structure of the IHO (B)	(iv) Symbolization. (i) Chart graticule (ii) Chart grid. (ii) Chart grid. (ii) Chart grid. (i) IAO roles and structure (ii) General Assembly (iii) Regional Hydrographic Commissions (iv) Committees and Working Groups	nautical chart design and production. Compute and prepare chart graticule and chart grid using appropriate software according to specifications. Chart Learning outcomes Describe the roles of IHO, IMO and IALA with respect to the development and use of nautical charts for safe
E7.1d Nautical chart reference framework (I) E7.2 Internation Topic/Element E7.2a Role and structure of the IHO (B) E7.2b Role of	(iv) Symbolization. (i) Chart graticule (ii) Chart grid. (ii) Chart grid. (i) In Chart grid. (i) In Chart grid. (i) In Content (i) In Coles and structure (ii) General Assembly (iii) Regional Hydrographic Commissions (iv) Committees and Working	nautical chart design and production. Compute and prepare chart graticule and chart grid using appropriate software according to specifications. Chart Learning outcomes Describe the roles of IHO, IMO and IALA with respect to the development and use of nautical charts for safe

E7.0 - D-1f	(-:\ TAT A:\1-1:	T			
E7.2c Role of	(vi) IALA guidelines and				
the IALA	recommendations.				
(D)					
	(B) E7.3 Nautical chart compilation and production				
		Y			
Topic/Element	Content	Learning outcomes			
E7.3a Planning	(i) Geographical area and scale	Refer to the planning processes adopted			
and scheming	(ii) Chart scheming	internationally for the scheming and			
(D)	(iii) Overlapping and nesting	production of (official) nautical charts.			
E7.3b Data	principles. (i) Metadata considerations	Analyse mathed and and a for the			
		Analyze methods applied for the			
sources	(ii) Source data selection	appropriate selection and homogenization of source data.			
(1)	(iii) Source data homogenization	of source data.			
E7.3c Content	(iv) Source data registration.(i) Coastlines	Identify the various categories of features			
and Symbology	Natural	portrayed in nautical charts and use them			
and Symbology	Constructed	in nautical chart production.			
(<i>I</i>)		Ī			
	Approximate Dethymatory	Explain the rationale underpinning the			
	(ii) Bathymetry	symbology for each feature and/or data			
	• Soundings	category and apply them in nautical chart production.			
	• Italicized	production.			
	• Upright				
	• Special (e.g. Swept)				
	Sounding pattern				
	selection				
	• Principles				
	Automated techniques				
	• Channel depiction				
	(iii) Bathymetric contours				
	(iv) Dangers to navigation				
	• Rocks				
	• Wrecks				
	• Reefs				
	• Shoals				
	Offshore constructions				
	 Submarine pipelines and 				
	cables				
	 Obstructions 				
	• Sea floor descriptions				
	(v) Topography				
	 Depiction using seaward 				
	view principle				
	 Natural features 				
	• Landmarks				
	Constructed features				
	Conspicuous objects				
	(vi) Boundaries and limits				
	Dredged areas				
	 Controlled areas 				
	 Controlled routes 				
	 Baselines 				
	International boundaries				

	and manitime	
	and maritime zones	
	(vii) Navigation aids	
	 Lights, beacons, buoys, marks 	
	Light sectors	
	• Leads	
	Radio beacons	
	Radio beacons Radar reflectors	
	Recommended tracks	
	Recommended routes	
	(viii) Source data diagrams –	
	depiction	
	(ix) ZOC	
	(x) Titles and chart notes	
	(xi) Graphic scales.	
E7.3d	(i) The chart compilation and	Describe and perform the processes
Chart	composition processes.	required for chart compilation and
compilation and	Element selection	composition from a geospatial data base
composition	Database extraction	using standalone software systems or
(-)	Synthesis and	integrated cartographic production
(I)	homogenization	systems.
	Conflict resolution	
E7.2. IIIO	Validation.	Describe the accessor of the IIIO
E7.3e IHO Standards and	(i) IHO standards and chart specifications	Describe the processes of the IHO Member States for the development of
Chart	(ii) INT chart specifications	international chart and ENC standards.
Specifications	a. INT 1	
(I)	b. INT 2	Identify, describe and use the international
(2)	c. INT 3	standards and specifications for nautical charts.
	(iii) IHO S-4	charts.
	(iv) IHO S-11	
	(v) Feature attribution	
	(vi) Text (Styles as symbols)	
	(vii) Notes, legends.	
E7.3f Updating	(i) Notices to mariners	Perform a complete chart updating task
(1)	(ii) Editions.	including editing, updating and
(I)		publishing.
E7.3g Mapping	(i) Customized mapping from	Explain the concept of mapping on
on demand	existing databases.	demand.
(B)		
	production systems	<u> </u>
Topic/Element	Content	Learning outcomes
E7.4a	(i) Commercial systems for	Identify common commercial systems
Commercial	map/chart production	used for map/chart production.
Systems	(ii) Graphics and image processing	Identify commercial graphic and image
	software in cartographic	processing systems.
(B)	applications	Use a commercial system for map/chart
	(iii) Open standards and open	composition and production.
E7 4h Oracii	source systems	
E7.4b Open	(iv) Open Geospatial Consortium	Describe the concept of open source
Source Systems	(OGC).	systems as applied to map/chart production.
(R)		<u> </u>
(B)		Identify some open source geospatial

		standards, their content and the organizations developing them.
E7.4c Map/chart production systems evaluation		Identify the benefits and/or limitations of the use of commercial and/or open source systems.
(I)		
E7.5 Electronic c		
Topic/Element	Content	Learning outcomes
E7.5a	(i) Definition of ENC, SENC and	Describe ENC, SENC and ECDIS
Introduction to electronic charts	ECDIS (ii) IMO carriage requirements (iii) ENC as product	Explain the product characteristics of ENCs.
(I)	(iv) Production conventions	
	 Issuance 	
	• Numbering	
	Cell structure	
	UpdatingOfficial status	
	Security protection	
	• SENC	
E7.5b IHO	(i) IHO S-57	Identify the international standards and
standards for	Contents including	specifications relating to ENCs.
ENC production	appendices	Describe the ENC standards and explain
(D)	 Data model 	the relationships between them.
(B)	• Topology	Describe the S-57 data model.
	(ii) Object Catalogue	Describe the content of Presentation
	 Object, attribute and master/slave classes 	Library.
	Spatial objects	Describe the rationale underpinning the
	• Feature objects	development of S-100.
	 Relationships 	Describe the S-100 universal
	 Special cases 	hydrographic data model.
E7.5c ENC	(iii) IHO S-52	Explain Object Based Data Bases.
production and	Presentation Library Nuclear Section 1. 1	Explain the general principles
distribution	(iv) IHO S-65	underpinning electronic chart data visualization.
(I)	ENC productionQuality control	
	Quality controlQuality assurance	Describe recommended production procedures for ENCs.
	Quality management	1 ^
	systems	Identify best practices for the QC/QA of an ENC including gaps and overlaps of
	(v) IHO S-58	adjacent cells.
	Validation process	Use software applications to produce an
	Spatial accuracy Factors complete research	ENC.
	Feature completenessLogical consistency	Describe the ENC distribution system.
	Logical consistencyECDIS display	
	consistency	
	 Software validation tools 	
	• False warnings	
	 Errors and warnings 	

		_
	(vi) ENC distribution system	
	• IHO S-63	
	 IHO WEND principles 	
	and RENCS	
	(vii) IHO S-100	
	(viii) IHO S-99	
	S-100 Registry and	
	Registers	
	• S-101 ENC product	
	specification	
	• S-102 Bathymetry surface	
	product specification.	
E7 6 Destarised		
E7.6 Rasterized		T .
Topic/Element	Content	Learning outcomes
E7.6 Raster	(i) The rasterization process	Describe the characteristics, advantages
charts	(ii) Scanning processes	and limitations of rasterized chart
	(iii) Advantages and limitations of	products.
(B)	rasterized chart products	Describe rasterizing processes.
	(iv) Raster data structures	Describe the use of rasterized chart
	(v) Raster chart formats	images within navigation systems.
	(vi) Raster chart products	
	(vii) Raster chart images and tiles	
	(viii) Raster chart images – use	
	within GIS and other	
	environments.	
E8: Legal aspec	cts (Relating to nautical cartograp	
Topic/Element	Content	Learning outcomes
E8.1 Liability	(i) The IMO SOLAS convention	Describe the role and responsibilities of
and	(ii) The status of an official	national hydrographic agencies as
responsibility	nautical chart	required under the Safety of Life at Sea
	 General status under IMO 	convention
(B)	carriage requirements	Describe the status of the nautical chart as
	Legal document	both an operational and legal entity.
	Status post maritime	Outline the role and responsibilities of the
	incident	nautical cartographer.
	(iii) The role of national	
	hydrographic agencies	Describe potential issues of legal liability
	(iv) Potential legal issues:	relating to nautical charts.
	Duty of care	
	Product liability	
	Defectiveness	
	• Fitness for purpose.	
E8.2 Intellectual	(i) Definition	Define intellectual property and copyright
property and	(ii) Protection	in the framework of nautical charting.
copyright	(iii) Permission/License and fees	_
Copyright	(iv) Disclaimers	Compare how copyright issues are
(R)	(v) Penalties.	managed within different map and chart
(B)	(v) Tellatties.	production agencies.
E8.3 Law of the	(i) Historical development of the	Describe the historical evolution of the
Sea	Law of the Sea	Law of the Sea
	(ii) The United Nations	Describe the types of lines and areas
(B)	Convention on the Law of the	defined under UNCLOS and their
	Sea (UNCLOS):	delimitation
	General provisions	
<u> </u>	Concrat provisions	1

	D : .	E1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1
	 Base points 	Explain the status of the official nautical
	 Baselines - normal 	chart as a reference in relation to the
	(including bay closing	depiction of boundaries and maritime
	lines); straight and	zones.
	archipelagic	
	 Internal waters 	
	 Territorial sea 	
	 Contiguous zones 	
	• Exclusive Economic Zone	
	 Continental Shelf and 	
	Extended Continental	
	Shelf.	
(iii)) Status of the nautical chart for	
	portrayal of boundaries and	
	maritime zones	
(iv)) Delimitation of boundaries and	
	maritime zones.	

E9: Special Purpose Charting

FO 1 Industrial and	d Engineering Survey	Chart Production
E9.1 Industrial an	u Engmeering Survey	' Chart Production

Element	Content	Learning outcomes
E9.1a	(i) Types of Industrial and	Describe specific requirements,
Introduction to	Engineering Surveys.	equipment and standards for engineering
industrial and	(ii) Data from remotely operated	survey charts.
engineering	and autonomous vehicles	
surveys charting	(iii) Requirement for cartographic	
	presentation.	
(B)	(iv) Applicable standards (e.g.	
	IOGP; UKOOA; IMCA;).	
E9.1b	(i) Rationale of charts and	Describe specific requirements and
Route surveys	graphics for route surveys	guidelines for route survey charts.
charting	(ii) Forms of presentation for route	
	survey data	
(B)	(iii) Use of vertical exaggeration in	
	DEMs and profiles.	
E9.1c	(i) Rationale of charts and	Describe specific requirements for
Dredging	graphics for dredging surveys	dredging survey charts.
surveys	(ii) Forms of presentation for	
charting	dredging survey data	
	(iii) Presentation techniques for	
(B)	volumetrics.	
E9.1d	(i) Rationale of charts and	Describe specific requirements and
Shallow	graphics for Geophysical Site	guidelines for shallow geophysical survey
geophysical site	surveys.	charts.
surveys	(ii) Forms of presentation for	
charting	Geophysical Site survey data.	
	(iii) Presentation techniques for	
(B)	Geophysical Site survey data	
	including the depiction of	
	multiple layers.	

E9.16 (ii) Forms of presentation for environmental surveys charting (B) (ii) Forms of presentation for environmental survey data representation (B) (iii) Forms of presentation for environmental survey data representation (B) (iv) Positive artwork (iv) Page description language (Adobe Postscript) (chainques (iv) E10.5 Color management (iv) Color separation (iv) Composite to plate. E10.16 Color separation (iv) Composite to plate. E10.17 Proofing (B) (iv) Rationale of charts and graphics for environmental survey charts and graphics for environmental survey charts and graphics for environmental survey charts. Describe specific requirements and guidelines for engineering survey charts. Describe specific requirements and guidelines for engineering survey charts. Describe specific requirements and guidelines for engineering survey charts. Describe specific requirements and guidelines for engineering survey charts. Describe specific requirements and guidelines for engineering survey charts. Describe specific requirements and guidelines for engineering survey charts. Describe specific requirements and guidelines for engineering survey charts. Describe specific requirements and guidelines for engineering survey charts. Describe specific requirements and guidelines for engineering survey charts. Describe the creation of industrial and engineering survey data representation of industrial and engineering survey data from nautical charting data. E10.1 Forms of industrial and engineering survey data representation of industrial and engineering survey data representation of industrial and engineering survey data representation of industrial and engineering survey data	FO 1	(') D (' 1 C (1 C (11	D '1 'C' ' 1
and video surveys charting (B) (B) (B) (B) (B) (B) (B) (B	E9.1e	(i) Rationale for the use of still	Describe specific requirements and
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(iii) Compositing separations (iv) Composite to film (v) Composite to plate. E10.7 Proofing (i) Pre-press proofing (i) Pre-press proofing (iii) Compositing separations analogue and digital environments. Explain the need for proofing.		-	
(B) (iv) Composite to film (v) Composite to plate. E10.7 Proofing (i) Pre-press proofing Explain the need for proofing.	separation		Describe the color separation process in
(v) Composite to plate. E10.7 Proofing (i) Pre-press proofing Explain the need for proofing.	(7)		analogue and digital environments.
E10.7 Proofing (i) Pre-press proofing Explain the need for proofing.	(<i>B</i>)		
	710.5		
(B) (ii) Photo-mechanical proofs Distinguish between photo-mechanical		(1) Pre-press proofing	Explain the need for proofing.
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	(iii) Digital proofs.	and digital color proofs.
E10.8 Lithography	(i) Single color lithography(ii) Multiple color lithography.	Explain the processes involved in single and multi-color lithography.
(B)		
E10.9 Plate making	(i) Plate making process.	Describe the plate making process.
(B)		
E10.10 Press	(i) Offset lithography	Describe the offset lithographic process.
work	(ii) Printing units (iii) Printed output quality check.	Describe map/chart quality checks in offset printing
(B)		
E10.11 Printing papers	(i) Printing paper specifications.	Refer to printing paper specifications.
(B)		

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, ENCs 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, ENCs, 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.