भारत सरकार / GOVERNMENT OF INDIA
पत्तन, पोत परिवहन और जलमार्ग मंत्रालय
MINISTRY OF PORTS, SHIPPING AND WATERWAYS
समुद्रीय प्रशासन महानिदेशालय, मुंबई
DIRECTORATE GENERAL OF MARITIME ADMINISTRATION, MUMBAI

F.No. 13-11028/1/2026-ENGG-DGS **August 15, 2026**

DGMA EAC Branch Circular No.49 of 2026

Subject: Preparatory courses for MEO and ETO grade of CoC examinations, reg.

References:	a) MS Notice No.6 of 2000 b) MS Notice No.13 of 2007 c) STCW Circular No. 8 of 2012 d) STCW Circular No. 9 of 2012 e) DGS [EAC] Circular No. 02 of 2022 f) Training Circular No. 3 of 2019

Part A

I. Background

1. The Directorate General of Maritime Administration (DGMA) presently prescribes structured preparatory courses to assist candidates in preparing for the Certificate of Competency examinations for the grades of Chief Engineer Officer and Second Engineer Officer (Motor/Steam), conducted through approved Maritime Training Institutes (MTIs).

2. The existing syllabus for these preparatory courses was last comprehensively revised some years ago and has, since then, been updated only in a piecemeal manner. In the intervening period, there have been significant developments in ship technology, statutory requirements, and international training standards, that are not adequately reflected in the current course content.

II. STCW Requirements

Regulation I/6 of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978, as amended, requires that the training and assessment of seafarers be structured in accordance with the provisions of the Convention and the STCW Code.

Further, Regulation I/11 of the Convention requires certificate holders to demonstrate continued professional competence. Regulation III/1 prescribes the minimum standards of competence for Officers in Charge of an Engineering Watch, Regulation III/2 specifies the standards for Chief Engineer Officers and Second Engineer Officers, and Regulation III/6 prescribes the minimum standards of competence for Electro-Technical Officers.

Sections A-I/6, A-III/1, A-III/2 and A-III/6 of the STCW Code require candidates to acquire the prescribed knowledge, understanding and proficiency, and to demonstrate the competencies specified therein, prior to the issuance of the relevant Certificate of Competency.

III. Revision of the Syllabus for existing preparatory courses & assess the need for preparatory course for MEO Class IV and the ETO grade of examinations.

The Directorate General of Maritime Administration (DGMA), in exercise of the powers conferred under the Merchant Shipping Act, 2025 as amended, constituted a Technical Committee comprising representatives from the DGMA, domain experts from various industry organizations and professional bodies and approved Maritime Training Institutes (MTIs) to undertake the following:

(a) revisit the need for preparatory courses for different grade(s) of Engg./ETO CoC examinations;

(b) review existing training framework and course syllabi for Marine Engineer Officers and Electro-Technical Officers.

1. <u>Review of preparatory course syllabus for Chief Engineer Officers [MEO Class I] and Second Engineer Officers [MEO Class II] on ships powered by main propulsion machinery of 3000 kW and above</u>.

The Technical Committee has reviewed the feedback received from examiners, MTIs, ship owners/managers, recently qualified officers, and has identified the following factors that necessitate a revision of the preparatory course syllabus for the MEO Class I and MEO Class II grades:

- Amendments to the STCW Convention and Code, and updated IMO Model Courses, which require closer alignment of shore-based preparatory training with current competence tables.
- Widespread adoption of electronically controlled, dual-fuel, and hybrid propulsion systems, requiring updated technical content on engine management systems, automation, and control engineering.
- Growing use of alternative and low-carbon fuels (LNG, methanol, ammonia, biofuels) and the associated safety, bunkering, and operational procedures.
- Statutory and environmental developments, including MARPOL Annex VI updates, EEXI and CII requirements, and their implications for engine room operations and record-keeping.
- Increasing shipboard digitalization, cyber-security exposure, and condition-based/predictive maintenance practices.
- Observed trends in examination performance, including subject-wise pass percentages, indicating specific areas of candidate weakness that the current syllabus does not adequately address.
- The need to strengthen engine room resource management, leadership, and human element components in line with modern competency-based assessment.

The Committee proposed substantial revision to the preparatory course syllabus for the Chief Engineer Officer and Second Engineer Officer grades to include updated technical modules, revised course duration as detailed in the Revised Syllabus attached as Annexure's to this Circular.

2. <u>Review of Preparatory Course requirement for Officer on Engineering Watch (MEO Class IV) & Electro-Technical Officer (ETO) CoC Examinations</u>

The Technical Committee, after the detailed review, has submitted the following observations:

1. The candidates, especially those at the entry-level viz. MEO Class IV and ETO often struggle with initial Certificate of Competency (CoC) exams due to inadequate practical training quality, gaps in onboard vessel exposure, and lack of mentorship after completing their pre-sea courses. These candidates, after completing the minimum mandatory sea service, appear for the Certificate of Competency examinations without adequate academic revision, structured preparation, or post-sea-service technical orientation. Rote learning fails candidates during oral assessments conducted, when deep fundamental comprehension is tested
2. The Committee observed that a significant number of candidates require considerable time and multiple attempts to successfully complete the examinations, achieve the necessary level of competency, before a CoC can be awarded in accordance to the STCW Convention and Code and the Merchant Shipping (STCW) Rules, 2014, as amended.
3. The Committee recognized the need to strengthen the existing training framework to effectively bridge the gap between practical shipboard experience and the knowledge, understanding, proficiency, and competencies prescribed under the STCW Convention and the STCW Code.
4. The non-mandatory preparatory courses and the E-learning modules have not been successful in effectively stemming the failing standards of the entry level CoC examination candidate. The Committee emphasized the need for a comprehensive revision to incorporate the latest amendments to the STCW Convention and the STCW Code, the technological advancements, emerging innovations, digitalisation, automation, environmental sustainability, the human element, cyber risk management, and other developments in international maritime standards and industry best practices.

The DGMA has accepted the Committee's recommendation for introduction of mandatory preparatory courses for candidates appearing for the MEO Class-IV and Electro-Technical Officer (ETO) Certificate of Competency examinations. The revised framework is intended to strengthen candidates' technical knowledge, professional competence, and examination preparedness, thereby enhancing compliance with the STCW Convention and improving the quality of certificated marine engineering officers.

Part B

IV. Introduction of MEO Class-IV Preparatory Course

Recognizing, the need to have a structured learning programme for the candidates who after completion of the pre-sea training, have undergone the mandatory shipboard training and are eligible to appear for the Certificate of Competency as Officer in charge of an Engineering watch [MEO Class IV], the Directorate General of Maritime Administration, as recommended by the technical committee, hereby introduces a one-month Preparatory Course for the MEO Class-IV, Certificate of Competency Examination candidates**.**

The Preparatory Course shall be mandatory for the following categories of candidates:

a) all candidates applying for eligibility assessment or intending to appear for the MEO Class-IV Certificate of Competency written and/or oral examination for the first time on or after 01 January 2027; and
b) candidates who have not appeared for either written or oral examinations for any of the functions of the MEO Class-IV grade examination, in the calendar year 2026, and intend to appear written or oral examination on or after 01 January 2027.

Successful completion of the Preparatory Course shall be a pre-requisite for eligibility to appear in the MEO Class-IV Certificate of Competency examination for the above categories of candidates.

The detailed course framework and syllabus of the Preparatory Course are enclosed as **Annexure-I** to this Circular.

V. Revision of Preparatory Courses for Chief Engineer Officer [MEO Class I] and Second Engineer Officer [MEO Class II] on ships powered by main propulsion machinery of 3000 kW and above.

The Technical Committee had undertaken a comprehensive review of the existing preparatory course syllabi for the MEO Class-II and MEO Class-I Certificate of Competency examinations.

The revised syllabi have been aligned with the competency requirements prescribed under Regulation III/2 of the STCW Convention, Section A-III/2 of the STCW Code, and the associated Tables of Competence, taking into account the latest technological advancements, digitalization, automation, environmental sustainability, the human element, cyber risk management, and other developments in international maritime standards and industry best practices.

The DGMA has accepted the recommendations of the Committee and the preparatory course duration has been altered as under:

Name of the Course	Existing Duration	Revised Duration	Effective Date
MEO Class-II Preparatory Course	Four Months	Three Months	01 January 2027
MEO Class-I Preparatory Course	Two Months	No Change (Two Months)	01 January 2027

Accordingly, the following shall apply:

1. The revised MEO Class-II Preparatory Course duration of three months shall be applicable to all batches commencing on or after 01 January 2027.
2. Candidates admitted to the MEO Class-II Preparatory Course prior to 01 January 2027 shall continue under the existing four-month course duration and syllabus.
3. All Maritime Training Institutes (MTIs) approved by the Directorate General of Shipping and conducting MEO Class-I and MEO Class-II Preparatory Courses shall adopt the revised syllabi with effect from 01 January 2027.

4. MTIs shall revise their curriculum, lesson plans, teaching schedule, training material, and internal assessment methodology to ensure compliance with the revised syllabus and course duration.
5. The revised course frameworks and syllabi for the MEO Class-II and MEO Class-I Preparatory Courses are enclosed as **Annexure-II** and **Annexure-III**, respectively.

VI. Introduction of Electro-Technical Officer (ETO) Preparatory Course

The Technical Committee reviewed the existing training framework for Electro-Technical Officers prescribed under Regulation III/6 of the STCW Convention, the Merchant Shipping (Standards of Training, Certification and Watchkeeping for Seafarers) Rules, 2014 and the applicable Orders/Circulars/Notices issued by the DGMA. The Committee observed that ETO candidates generally do not undergo any structured academic revision or technical orientation after completion of the mandatory shipboard training.

The Committee further observed that the absence of a structured preparatory course has adversely affected the performance of candidates in the Electro-Technical Officer (ETO) Certificate of Competency written and oral examinations.

Accordingly, the Directorate General of Maritime Administration hereby introduces a one-month Preparatory Course for the Electro-Technical Officer (ETO) Certificate of Competency Examination.

The implementation schedule of the mandatory preparatory course for the ETO candidates shall be applicable as under:

a) all candidates applying for assessment or appearing for the Electro-Technical Officer (ETO) Certificate of Competency written and/or oral examination for the first time on or after 01 January 2027; and
b) candidates who have not appeared for either written or oral examinations of the Electro-Technical Officer (ETO) Certificate of Competency examination after completion of Eligibility assessment, in the last calendar year 2026, and intend to appear for the examination on or after 01 January 2027.

Successful completion of the Preparatory Course shall be a prerequisite for eligibility to appear in the Electro-Technical Officer (ETO) Certificate of Competency examination for the above categories of candidates.

The detailed course framework and syllabus of the Preparatory Course are enclosed as **Annexure-IV** to this Circular.

VII. Approval of Preparatory courses for MEO Class-IV and ETO grade

The Training Branch of the Directorate General of Maritime Administration shall issue separate Course Approval Guidelines governing, *inter alia*:

- infrastructure requirements;
- faculty qualifications and requirements;
- course duration and training hours;
- assessment and evaluation methodology;
- attendance requirements;

- quality assurance standards; and
- other criteria for the grant and continuation of course approval.

Maritime Training Institutes (MTIs) approved by the Directorate General of Maritime Administration for conducting MEO Preparatory Courses and intending to conduct the MEO Class-IV and Electro-Technical Officer (ETO) Preparatory Courses, may make the necessary arrangements to obtain approval for the respective courses and commence training from 01 November 2026, thereby enabling eligible candidates to comply with the mandatory preparatory course requirements applicable from 01 January 2027.

VIII. The candidates are required to attend the preparatory courses as mentioned above mandatorily. The e-learning module for the MEO Class IV candidates shall not be mandatory, but all CoC exam candidates are encouraged to avail the e-learning facility offered by the DGMA for enhancing their knowledge, self-assess and track their progress. The candidates who are onboard can continue to learn, update their knowledge at their convenience through e-learning facility.

This Circular is issued with the approval of the Competent Authority.

(Praveen Nair)
Dy.Chief Surveyor cum Sr.DDG(Tech)
DGMA

To

1. The Principal Officers, Mercantile Marine Department, Mumbai/Kolkata/Chennai/Kandla/Kochi.
2. The Surveyor-in-Charge, Mercantile Marine Department, Goa/Jamnagar/Port Blair/Visakhapatnam/Tuticorin/Noida/Haldia/Paradip/Mangalore
3. Indian National Shipowner's Association (INSA), Mumbai.
4. Indian Coastal Conference Shipping Association (ICCSA), Mumbai
5. Institute of Marine Engineers (India)
6. The Chief Surveyor with the Govt.of India
7. Engineering Wing
8. Training Branch
9. Hindi cell
10. Computer cell

Annexure – I

Syllabus for MEO Class IV Preparatory Course

Duration: One month (4 weeks, 20 working days, 120 contact hours)

The Marine Engineer Officer (MEO) Class-IV Preparatory Course shall be designed to prepare candidates for the Written and Oral Examinations leading to the award of the Marine Engineer Officer Class-II Certificate of Competency (CoC) in accordance with the requirements of Regulation III/1 and the relevant provisions of the STCW Convention, 1978, as amended, including the associated sections of the STCW Code.

The course shall be conducted as a fully offline programme over a duration of twelve (4) weeks, comprising 20 working days and 120 contact hours.

The course shall comprise the following syllabus:

Marine Engineering Knowledge – General (Function 4: Marine Engineering at the Operational-Level):
Detailed study of marine boilers, covering the different types of boilers used on board ships and their applications, constructional features, boiler mountings and accessories, combustion systems and burners, safety devices, and automatic control systems. Boiler feed water arrangements, including feed pumps and deaerators, along with boiler water treatment practices aimed at preventing scale formation, corrosion, and carryover. Steam plant systems, including the principles of operation of marine steam turbines, steam distribution arrangements, and auxiliary steam services. It also covers the operation of condensers, vacuum generation and maintenance and condensate recovery processes essential for efficient steam plant operation. Basic awareness of alternative fuels: methyl/ethyl alcohol, ammonia, hydrogen etc, covering characteristics, hazards, and bunkering precautions.

Knowledge of various auxiliary machinery and systems commonly found on board ships, such as marine pumping systems and pumping arrangements, fuel oil treatment systems including heaters, filters, and service tanks, lubricating oil systems and their monitoring, and fresh water generation systems including evaporators and reverse osmosis plants. The operation and maintenance of shipboard refrigeration and air-conditioning systems. Engineering watchkeeping practices, detailing the duties and responsibilities of the engineering officer in charge of a watch. Procedures for engine room watchkeeping in both manned engine rooms and unattended machinery spaces (UMS), monitoring of machinery parameters and alarm systems, maintenance of engine room logs and reporting procedures, and adherence to safe watchkeeping practices, including proper watch handover procedures to ensure the safe and efficient operation of the ship's machinery.

Marine Engineering Knowledge – Motor (Function-4: Marine Engineering at the Operational Level):

Detailed knowledge of marine diesel engines used for ship propulsion and auxiliary power generation. The principles of operation of two-stroke and four-stroke diesel engines**,** covering the thermodynamic cycle, combustion process, and operational characteristics. The construction and

working of major engine components are studied in detail, including pistons, cylinder liners, piston rings, crankshafts, camshafts, connecting rods, and bearings, with emphasis on their functions, materials, and maintenance requirements. Fuel injection systems, including conventional fuel pumps and modern common rail injection systems, as well as the operation and role of engine governors and electronic control systems in maintaining engine speed and performance. The working principles and operation of turbochargers, scavenging arrangements, and air supply systems that support efficient combustion and engine performance. The course shall cover engine performance and operational practices, including the interpretation of indicator diagrams and methods of engine performance analysis.

Introduction of engine monitoring systems, key operating parameters, and performance indicators used to assess engine condition and efficiency. Procedures for starting, reversing, maneuvering, and stopping main engines are studied with reference to safe and efficient operation under different operating conditions. Study of engine safety devices, such as alarms, trips, and automatic shutdown systems designed to protect machinery and ensure safe operation. Maintenance and troubleshooting of marine diesel engines**,** identification and rectification of common engine faults, routine maintenance procedures, and the use of diagnostic techniques to detect abnormalities. The concept and application of engine condition monitoring and preventive maintenance practices are also covered, enabling engineering officers to maintain engine reliability, prevent failures, and ensure efficient operation of ship propulsion machinery.

Marine Engineering Knowledge (Steam) – (Function-4: Marine Engineering at the Operational Level): Principles of steam generation, thermodynamics, heat transfer and the Rankine cycle; construction, operation, maintenance and performance of marine boilers, including water-tube and fire-tube boilers, superheaters, economisers, air preheaters, boiler mountings, safety devices and automatic combustion control systems; construction, operation and maintenance of steam turbines, reduction gearing, condensers, feed-water and condensate systems, deaerators, feed pumps, circulating pumps, lubrication systems and associated auxiliary machinery; boiler water treatment, feed-water chemistry, corrosion prevention, scale control and boiler blow-down procedures; fuel oil systems, combustion equipment, burner management, boiler efficiency and energy conservation; operating procedures, watchkeeping, start-up and shut-down procedures, fault diagnosis, preventive maintenance and emergency operation of steam propulsion plants; safety precautions, statutory requirements, pressure vessels, safety valves and high-pressure steam systems; and environmental protection measures, including pollution prevention and compliance.

Marine Electro-Technology (Function-5: Electrical, Electronic and Control Engineering at the Operational Level):

Fundamentals of basic electrical engineering, including essential electrical principles such as voltage, current, resistance, power, and energy, along with the application of Ohm's law and Kirchhoff's laws in electrical circuits. Characteristics and applications of AC and DC electrical circuits, forming the foundation for understanding shipboard electrical systems.

Study of electrical machines commonly used on board ships, focusing on the construction, working principles, and operation of generators and alternators, as well as AC and DC motors used for driving various shipboard machinery and auxiliaries. Motor control systems and starting arrangements, including different starting methods and protective features. Maintenance, inspection, and fault diagnosis of electrical machines to ensure reliable and safe operation.

Shipboard electrical power low and high voltage systems, including the generation and distribution of electrical power on ships. Design and operation of main and emergency switchboards, electrical distribution networks, and essential protection systems such as circuit breakers, relays, and other electrical safety devices. The operation and maintenance of emergency generators, emergency power supply systems, battery installations, and uninterruptible power supply to ensure continuity of essential services during power failures.

Fundamentals of electronic components and circuits, such as diodes, transistors, and basic electronic assemblies. The functioning and application of sensors, transducers, and measuring instruments used for monitoring machinery parameters are also studied. Engine control and monitoring systems, as well as automation systems**,** including the use of programmable logic controllers (PLC) in shipboard machinery control and integrated automation systems, which play a vital role in improving efficiency, safety, and reliability in modern marine engineering operations. Cyber-risk awareness - basic cyber hygiene, vulnerabilities in automation and engine control systems.

Marine Engineering Practice (Function-6: Maintenance and Repair at the Operational Level):

Safe and effective use of various hand tools and precision measuring instruments such as micrometers, vernier calipers, dial gauges, and feeler gauges. Operation and applications of common machine tools, including lathes, drilling machines, milling machines, and grinding machines, along with basic fitting and machining techniques used for fabrication, repair, and maintenance of shipboard components.

Study of metals, alloys, and composite materials commonly used on board ships, their mechanical and chemical properties, and their suitability for different marine environments. Study of heat treatment processes, such as annealing, normalizing, hardening, and tempering, and their applications in improving the strength, durability, and performance of engineering materials.

Welding and thermal cutting techniques used in shipboard repairs and fabrication, principles and practices of gas welding and arc welding, as well as various thermal cutting methods. Welding defects, methods of inspection and quality control, and the necessary safety precautions to be observed during welding and cutting operations.

Use of Planned Maintenance Systems (PMS), techniques of condition monitoring and fault diagnosis, and systematic overhauling procedures for major marine machinery and equipment. The study of lubrication systems and basic tribology principles, enabling engineering officers to ensure proper lubrication, reduce wear and friction, and maintain the reliability and efficiency of shipboard machinery.

Ship Construction and Stability (Function-3: Controlling the Operation of the Ship and Care for Persons on Board (Operation Level)):

Ship construction, structural strength, and stability including the different types of ships and their structural arrangements, and the general layout of a vessel’s hull and internal structure. Study of hull construction methods, including various framing systems such as longitudinal and transverse framing, as well as the design and function of major structural components including decks, bulkheads, double bottom tanks, and other supporting members. Overview of the materials used

in ship construction, with emphasis on their strength, durability, and suitability for marine environments.

The concept of longitudinal strength and the ability of the hull structure to withstand various loads encountered at sea. Study of shear forces and bending moments acting along the hull girder, as well as the structural stresses that arise due to different loading conditions and sea states. The principles of ship stability, including the concepts of buoyancy, center of gravity, and center of buoyancy, and their influence on a vessel's ability to remain upright. Study of metacentric height, righting moments, and factors affecting stability such as free surface effects and shifting of weights. Damage stability, including the effects of flooding and compartmentalization on the ship's survivability in the event of hull damage.

Damage control procedures, focusing on the causes of flooding and structural damage and the measures required to control and minimize their impact. Methods of flooding control, the use of pumps and watertight closures, and procedures for emergency repairs and temporary strengthening of damaged structures to maintain the safety and seaworthiness of the vessel until permanent repairs can be carried out.

Ship Safety and Environmental Protection (SSEP) (Function-3: Controlling the Operation of the Ship and Care for Persons on Board (Operation Level)):

Study of fire prevention and firefighting causes and prevention of fires in machinery spaces, classification of fires, and the selection of appropriate fire-fighting medium. Fire detection and alarm systems, as well as the operation and maintenance of fixed fire-fighting systems, including carbon dioxide (CO_2), foam, water mist, and dry powder systems commonly installed on board ships. Study of life-saving appliances and survival equipment, including the types, construction, and operation of lifeboats, life rafts, and rescue boats, as well as personal life-saving appliances such as lifejackets and immersion suits and radio lifesaving appliances such as SART and EPIRB. The use of launching appliances, survival procedures, and the responsibilities of ship personnel during emergency abandonment situations.

Study of oil pollution prevention equipment, such as oily water separators and oil discharge monitoring systems, as well as sewage treatment plants and garbage management practices on board ships. Measures for air pollution prevention, including emission control requirements and compliance with international environmental standards. Ballast Water Management System and its equipment. Operational-level competence in BWMS including operation, maintenance, logging alarms etc.

Emergency procedures and contingency management, covering engine room emergency situations such as machinery failure, fire, flooding, and other operational emergencies. Procedures for blackout prevention and restoration of power, emergency operation of steering gear, and the conduct of emergency drills and contingency planning to ensure preparedness and effective response during critical situations.

Knowledge of international maritime conventions and regulatory frameworks governing ship safety and environmental protection. Key provisions and objectives of the International Convention for the Safety of Life at Sea (SOLAS), the International Convention for the Prevention of Pollution from Ships (MARPOL), the Standards of Training, Certification and Watchkeeping for Seafarers (STCW) Convention, the International Safety Management (ISM) Code, Maritime Labour Convention (MLC) and the International Convention on Load Lines, enabling marine engineers to understand their responsibilities in maintaining compliance with international

maritime regulations. Awareness of mental health and psychological safety: fatigue, stress and respectful workplace.

Annexure II

Syllabus for MEO Class II Preparatory Course

Duration: Three months (12 weeks, 60 working days, 360 contact hours)

The Marine Engineer Officer (MEO) Class-II Preparatory Course shall be designed to prepare candidates for the Written and Oral Examinations leading to the award of the Marine Engineer Officer Class-II Certificate of Competency (CoC) in accordance with the requirements of Regulation III/2 and the relevant provisions of the STCW Convention, 1978, as amended, including the associated sections of the STCW Code.

The course shall be conducted as a fully offline programme over a duration of twelve (12) weeks, comprising 60 working days and 360 contact hours.

The course shall comprise the following syllabus:

MARINE ENGINEERING KNOWLEDGE (GENERAL) (Function 4: Marine Engineering at the Management Level):

The engineering knowledge demonstrated by candidates shall be commensurate with that required for the safe operation, management, maintenance, and troubleshooting of the machinery, equipment, and ship structure normally under the responsibility of a Marine Engineer Officer at the Management Level.

Candidates may be required to illustrate their answers by means of clear, freehand sketches wherever appropriate.

The scope of the subject shall include, but not be limited to, the following:

1. **Technology of materials** - Metallurgy of Steel and Cast Iron, Properties and application of ferrous and non-ferrous material used in machinery on board ships, Destructive and non-destructive testing of material, Engineering processes used in construction and repair, Materials and welding.
2. **Physical & chemical properties of fuel & lubricants** - Properties and characteristics of fuels and lubricants, Shore side and shipboard sampling and testing, Interpretation of test results, Contaminants including microbiological infection, Treatments of fuels and lubricants including storage, centrifuging, blending, pretreatment and handling.

   Alternative Fuel Operations - System-level understanding, bunkering procedures, fuel properties, hazards, safety layers for methyl / ethyl alcohol, ammonia and hydrogen fuels.

3. **Construction details,** and where applicable the manner of attachment to ship, principles involved and operation Surveillance & Performance assessment of :
   (a) water gauge, thermometer, pyrometers, salinometer, ammeter, water meter, pressure gauge and other meters and gauges commonly used by engineers on board ships.

(b)All auxiliary machineries of engine room including associated systems, pumps, pumping and piping systems, air compressors, waste heat recovery systems, purifiers, oily water separators, etc.
(c) Thrust blocks, shafting, bearings, stern tubes, propellers, shipside fittings.
(d) steering gear, stabilizers.
(e) Refrigeration and air conditioning machinery, deck machinery.
(f) Auxiliary boilers and steam plant.
(g) Auxiliary compression ignition engines and associated plant.
(h) turbo-electric, diesel electric, gas turbine drives.

4. **Start Up and Shut down of Auxiliary Machinery**, including associated system: Air compressors and compressed air systems, Hydraulic power system, Types of auxiliary boilers, Auxiliary steam system, Safety valves, Boiler water levels, Use of 'Sea water in Boilers', Use of 'Fresh Water in Boilers', Boiler Water Testing, Boiler Water Treatment, Auxiliary Steam turbines, Boiler defects, Boiler and Steam turbine survey and repairs, Evaporators, Thermal fluid heating system
   a) Safe and efficient operation, Surveillance & Performance assessment of electrical machines and systems.
   b) Requirements, including operations and maintenance of pumps and pumping systems including bilge, fire main, ballast, sewage & sludge systems.
   c) Refrigeration, working principles of air conditioning, cargo and domestic refrigeration plants. Refrigerants used in marine refrigeration plants, greenhouse effects and future refrigerants. Air conditioning, including psychometric process for heating, cooling and humidification.
   d) Steering gear systems, single failure criteria of steering gear Surveillance & Performance assessment.
   e) Operation and testing of pneumatic hydraulic and electric control systems.
   f) Functions and Mechanism of Automatic Control for auxiliary machinery: Generator distribution system, Steam boiler, Oil purifier, Refrigeration system, Pumping and piping system, Steering gear system, Cargo-handling equipment and deck machinery.
   g) Operation of cargo handling equipment and deck machinery.
   h) Operation of freshwater systems, fresh water generating systems and its performance assessment.
   i) Shipboard Personnel & Resource Management & emergency preparedness.

5. **MASS – Autonomous Ships**
   Remote monitoring, fail-safe considerations.

MARINE ENGINEERING KNOWLEDGE (MOTOR) (Function 4: Marine Engineering at the Management Level):

1. **Design of Marine machinery:**

   Design features and operating mechanisms of marine diesel engines, marine gas turbines and marine steam boilers. Technical communications for design.

2. **Operations of marine machinery:**

   (a) Propulsive characteristics of diesel engines and gas turbines, including speed, output and fuel consumption. Operating limits of the propulsion plants.
   (b) Safe and efficient operation and surveillance of, main propulsion plant and its systems and services. The determination of shaft power and recognition of irregularity in the performance

of the machinery and plant. Operation, monitoring and evaluation of engine performance and capacity.

(c) Analysis and interpretation of information gained from monitoring equipment. Operation of gearing, clutches, air compressors.

(d) Planning and scheduling of engine operations.

(e) Functions and mechanism of automatic control of main engine.

(f) Safety of engine equipment, systems and services.

3. Start up and Shut down main and auxiliary machinery, including associated system – Engine components, engine lubrication, fuel injection, scavenging and supercharging, starting and reversing, cooling systems, diesel engine control and safety, diesel engine emergency operation, multi-engine propulsion arrangement.

3.1 Engine components

(a) Interpret static and dynamic loads and stresses, identifying service limitations of diesel engine components.

(b) Evaluate different fabrication methods of diesel engine components, including: Welding, forging, utilizing composite materials, plasma-spraying, laser hardening and use of ceramics and other special materials.

(c) Identify two and four stroke operating cycle forces, couples, and moments, relating these to design principles of: Crankshafts, bedplates, foundations, cross heads.

(d) Explain out of balance gas and inertia forces, couples, and moments, and relate these to flywheels, balance weights, first/second order balancing, and hull vibration.

(e) Explain factors contributing to torsional vibration and identify methods of minimizing or eliminating harmful effects of critical speeds.

(f) Evaluate the calibration of: Pistons, cylinder liners, piston rings, bearings, crankshafts, to identify wear patterns, limits, and means of correction

(g) Specify alignment and adjustment criteria of: Crankshafts, chain drives, gear drives, integral thrust bearings, crossheads

(h) Compile specified working clearances and limits of all bearings, sliding surfaces, and interference fits of a typical diesel engine, using engine builders' manuals.

3.2 Engine Lubrication

(a) Identify diesel engine lubricant types, properties, and applications. Outline principles of diesel engine lubrication. Contamination and deterioration of diesel engine lubricants - Discuss the sources/ causes types, and effects of contamination.

(b) Describe typical testing and treatment methods, and Interpret typical results of testing, giving appropriate actions which should be undertaken.

(c) Describe, using diagrams, the distribution of lubricating oil to diesel engines, in particular the: Guides and crosshead bearings of slow speed diesel engines, Top end bearings of medium speed engines, Bottom end bearing, Main bearings, Camshaft drives, showing direction of flow, typical clearances, and stating normal operating parameters.

3.3 Fuel Injection

(a) Explain why atomization and penetration of fuel and the turbulence of air are essential to optimum combustion in a diesel engine.

(b) State typical injection pressures and viscosities for different grades of fuel.

(c) Describe how and why fuel pumps, camshafts, and injectors are altered for varying fuel types.

(d) Describe, with the aid of simple sketches, the difference between constant and variable injection timing of fuel, showing materials, principal parts, methods of operation and adjustments of common types of fuel pump.

(e) Electronic fuel injection control and monitoring systems; common rail fuel injection systems; fuel injection rate shaping; and operation of engines in economy and emission control modes; and principles of dual-fuel engines.
(f) Compare injection requirements for slow speed, medium speed, and high-speed diesel engines, including pilot injection and pre-combustion chambers.
(g) Identify common service faults, symptoms, and causes of combustion problems, specifying appropriate adjustments, including methods of fuel pump timing.
(h) Summarize Occupational Health & Safety aspects of handling and testing fuel injection systems.
(i) Explain, using relevant diagrams and stating normal operating parameters: Fuel valve cooling arrangement and Uni-fuel and dual-fuel systems (for high/medium viscosity fuel types)
(j) Discuss the atmospheric pollution aspects of diesel engine combustion and give methods which reduce this pollution (especially SOx and NOx reduction).

3.4 Scavenging and Supercharging

Evaluate the need for scavenging diesel engines, Compare methods of scavenging diesel engines, Specify methods of providing pressurized air for combustion in diesel engines, Assess pressure charging methods for diesel engines, Assess pressure charging methods for diesel engines, Examine the working principles of turbochargers, Assess lubrication and cooling requirements of turbochargers, Analyze typical faults and identify appropriate actions to be undertaken with defective or damaged turbochargers.

3.5 Starting and Reversing

(a) Describe starting procedures of diesel engines for power generation, propulsion, and emergency use.
(b) Explain starting and maneuvering requirements/sequences for direct coupled reversible and geared propulsion diesel engines, for fixed and controllable pitch propeller applications
(c) Describe, with labeled diagrams to indicate major components, typical maneuvering and reversing systems for propulsion diesel engines
(d) Compare different methods of reversing direct coupled propulsion diesel engines
(e) Identify common faults and identify appropriate actions to be undertaken with typical diesel engine starting and maneuvering systems
(f) Compare the different methods of utilizing diesel engines for ship propulsion, including - Direct coupled, reversible slow and medium speed engines and Clutched and geared reversible and unidirectional medium speed engines with a fixed pitch propeller, Clutched and geared reversible and unidirectional medium speed engines with a controllable pitch propeller, and Diesel electric drive.

3.6 Cooling systems

(a) Analyze the problems that may arise in cooling water spaces of diesel engines.
(b) Evaluate common methods of diesel engine cooling water treatment.
(c) State the importance of maintaining diesel engine thermal efficiency and evaluate thermal loads on engine components.
(d) Justify cooling media selection and state the advantages and disadvantages of various diesel cooling methods.
(e) Evaluate the tests used in the control of diesel engine cooling water treatment.
(f) Enumerate the normal operating limits for diesel engine cooling water treatment.
(g) Interpret the implications of out of limit readings from water treatment tests and state the corrective procedures which should be undertaken.

(h) Itemize the sources and types of contamination of diesel engine cooling water and explain the effects of these contaminations on the reserves of treatment chemicals.
(i) Compare the procedures which may be used to counter contamination of diesel engine cooling water.
(j) Explain, using relevant diagrams and stating normal operating parameters, typical methods of cooling:
(k) Medium and slow speed diesel engine pistons, Exhaust valves, Cylinders, Turbochargers, Cylinder heads.

3.7 Diesel Engine Control and Safety
3.8 Diesel Engine Emergency operation
3.9 Multi-engine Propulsion Arrangement

MARINE ENGINEERING KNOWLEDGE (STEAM) (Function 4: Marine Engineering at the Management Level):

1. **Design features and operative mechanism of a Marine Steam Turbines and associated auxiliaries**

a) Describes with the aid of sketches/computer aided drawing, material selection and design features of steam turbines - Convergent and convergent/divergent nozzles and Nozzle boxes, Impulse and reaction turbines, Pressure and velocity compounding, Pressure/velocity diagrams, Optimum blade speeds, Hybrid blades, Materials of blades and other components, Turbine construction, Erosion shields, Bearings, thrust bearings, Turbine glands and gland steam systems, Astern turbines, Turbine casings, Diaphragms, Reheat turbines, Support and expansion of turbines.
b) Describes with the aid of sketches the operative mechanism of steam turbines - Alarms and trips, warming through, Normal and emergency operation, Shut down procedures, Turbine performance, Sequential nozzle operation, Resonance, Critical speed, Vibration, Emergency control systems, Rotor straightening.
c) Describes with the aid of sketches/computer aided drawing, material selection and design features of steam turbine gear box - Single and double reduction, Double helical involute gear teeth, Single and double locked gear trains, Epicyclic gearing, Flexible couplings, Nodal drive, Method of manufacturing of spur gears.

2. **Design features and operative mechanism of Marine Steam Boiler and associated auxiliaries**

a) Describes with the aid of sketches/computer aided drawing, material selection and design features of marine steam boilers - Types of main steam boilers, Methods of construction, Boiler fittings and drum internals, Water circulation, Gas circulation, Operating parameters, Support and expansion, Super heaters and their temperature control, Soot blowers, Economizers, Air heaters, Steam to steam generation, Chemistry of combustion, Burners and burner registers, Local and remote water level indicators, Safety valves.
b) Describes with the aid of sketches/computer aided drawing, material selection and design features of marine steam boiler feed water
c) systems - Main feed systems, Condenser types, level control, construction, materials, support, expansion, operating parameters, loss of vacuum and leak testing, Air ejectors, Vacuum pumps, Extraction pumps, Gland condensers, Low pressure heaters, Drain coolers, High-pressure heaters, Turbo feed pumps, hydraulic balance, De-aerators.

3. **Propulsive characteristics of Steam Turbine -** Propeller curve, Propeller design point, Fouled hull, sea margin and heavy propeller, Continuous service rating, Limits for continuous operation, Limits for overload operation, Evaluate plant performance and analysis.

4. **The efficient operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery**

(a) Performance data of individual turbines and cycle components during sea trial
(b) Periodic acquisition of above-mentioned data and comparison for location of deterioration,
(c) Enthalpy drop test in superheated section of steam turbine
(d) Quantification of stage efficiency losses – Leakage, Friction, Aerodynamic and Changes in flow passage areas.

5. **Theoretical knowledge:**

(a) Ancillary feed water/ steam plant and combustion equipment.
(b) Safe and efficient operation of steam plant. The determination of shaft power and the recognition of irregularity in the performance of machinery and plant. Analysis and interpretation of information gained from monitoring equipment.
(c) Boiler and feed water testing and interpretation of results. Chemical treatment of feed water and boiler water. Effect of high chloride content, high phosphate reserve and high hydrazine reserve.
(d) Methods of superheated temperature control, importance of steam purity and steam separation.
(e) Boiler, steam pipeline, condenser and turbine support arrangement and expansion.
(f) Procedure for warming up and cooling down of main turbines. Emergency lighting up procedure for main boilers.
(g) Repair and maintenance procedure for refractory, insulation, water wall tubes (membrane type) water tubes, safety valve, retractable soot blowers, burners, steam traps and water level indicators.
(h) Understanding of automatic combustion control system, burner management system, safety cut-outs and alarm system. Gas burning and monitoring system.
(i) Types of auxiliary boilers, Auxiliary steam system, Safety valves, Boiler water level indicators, Use of Sea water in Boilers, Use of Fresh Water in Boilers, Boiler Water Testing, Boiler Water Treatment, Auxiliary Steam turbines, Boiler defects, Boiler survey and repairs, Evaporators, Thermal fluid heating system.

MARINE ELECTROTECHNOLOGY (Function-5: Electrical, Electronic and Control Engineering at the Management Level):

In addition to the basic Electro Technology knowledge acquired at the operational level as regards to Electromagnetism, Electromagnetic induction, simple magnetic circuits, simple magnetic theory, alternating current theory, A.C. circuits and distribution systems involving A. C. & D. C. Shipboard installations & associated protective devices; the following additional syllabus to be adhered for the function "Electrical, Electronic and Control Engineering at the Management Level".

1. **Automatic Control Engineering and safety devices.**
    a) Introduction - Open and closed control loops, Process control. Essential components in process control loops.
    b) Sensors and transmitters - Resistance temperature devices. Thermocouples. Flow and

pressure measurement. Level measurement. Ambient temperature compensation. Viscosity measurement. Torque measurement. Force balance transmitters. Oil/water interface and oil in water monitoring. The pneumatic flapper/nozzle system. Pneumatic 20 – 100 kPa, analogue 4 to 20 mA signals, Pneumatic pilot relays, Control air supply. Operational amplifiers. Electrical supply.

c) Controllers and Basic Control Theory - Disturbances and time delays and means to reduce them. Two step, proportional, integral, and derivative control actions.

d) Final Control Elements - Diaphragm operated control valves. Flow/lift characteristics of control valves. Control valve actuators and positioners. "Fail - safe", "fail - set" strategies. Wax element valves. Electrically operated valves.

e) Control Loop Analysis - Temperature control systems. Level control systems. Pressure control systems. Split range and cascade control. Single, two and three element control.

f) Governors - Need for governors. Governor terms, concepts and operation. Hydraulic governors. Digital governors, Power sharing. Governing systems.

2. Design features and system configuration of automatic control equipment and safety devices:

2.1 General Requirements

(a) Electrical equipment designed for land use is often not suitable for use in ships.

(b) As far as possible, all materials should be non-flammable explains where flame retardant materials may be used.

(c) Meaning of the term flame retardant

(d) Angles of heel and trim at which machinery should be capable of operating.

(e) Effect of temperature changes on - Electromagnetic devices, Generator voltage.

(f) Common maximum temperatures of air and sea water used for design purposes.

(g) Axis of a rotating machine should not be placed athwart ships unless so designed.

(h) Need to periodically check the security of all electrical connections.

(i) Requirements regarding the provision of electrical power and lighting for normal operation and for an emergency.

2.2 Main Engine

(a) Control Theory - Changing set points. Basic control system design. First order and second order systems. Transfer Functions. Control system stability. Natural frequency and control systems. Time lag and time constant. System response.

(b) Tuning - System response. Control loop tuning. Ziegler-Nichols, Cohen-Coon tuning methods.

(c) Signal Transmission Systems - Digital communication bus and fibre optic signal transmission systems

(d) Final Control Elements - Control valve trim. Selecting control valves and their actuators. Valve sizing.

(e) Electronic PID Controllers - Single loop digital controllers. Manual and automatic tuning of electronic controllers.

(f) Monitoring & Control Systems - Boiler water level control. Advanced boiler combustion control. Diesel engine cooling control, Main engine control for FP and CP propellers. Alarm and monitoring systems. Programmable logic control and SCADA (supervisory control and data acquisition); Data logging and data transfer.

(g) General requirements of automatic control equipment and safety devices - Monitoring system, Safety system, System independence, Local control, Failure mode and effect analysis, Power supply.

(h) Remote control – Diesel propulsion, Control - electronic, electro-pneumatic, electro-hydraulic or pneumatic, Malfunctions – alarm, engine slow down, engine stop.

(i) UMS Systems - Concept of Unattended Machinery Spaces (UMS). Requirements of UMS. Bridge control. Testing regime for UMS.

(j) Software version control, construction and use of computer network on ships for bridge-based, engine room-based and commercial applications.

2.3 Generator and distribution system - Instrumentation and Safety in Generator and Distribution system, Auxiliary Diesel Generator Alarm and Shut Down, Automatic Starting of Propulsion Auxiliaries.

2.4 Steam boiler

(a) Following failures will have alarms and display – feedwater high salinity, high water level, boiler pressure high and low, super heater outlet
temperature high, fuel pump low outlet pressure, heavy fuel temperature high and low (or high and low viscosity), uptake high temperature, control system power failure, atomization steam / air pressure low

(b) Following failures will have alarms, display and automatic shutdown of boiler – low water level, supply air pressure failure, ignition or flame failure.

3. Design features and system configuration of operational control equipment for electrical motors:

3.1 Three Phase A.C. Motors - Construction, principle of operation of 3-phase induction motors, Design features of star and delta motors, Starting, speed controlling and braking methods of 3-phase induction motors, Load-torque characteristics and protection.

3.2 Three Phase Synchronous Motors - Construction. Principle of operation. Load characteristics, Power factor improvement with synchronous motors.

3.3 Effect of varying frequency and voltage of A.C. Motors – Speed, Temperature, Torque, Power output and Starting time, current.

3.4 Motor control and protection - D. C. motors, A. C. motors.

3.5 Insulated Gate Bipolar Transistor (IGBT) motor speed control - Gate driving characteristics with high current, High frequency, high current switch, Advantages of IGBT in varying motor speed control.

3.6 Motor speed control - Application of thyristors and Variable Frequency Drive (VFD) in motor speed control.

3.7 Three Phase Generators - Construction. Salient and cylindrical rotor types, Shaft generators, Excitation methods, Automatic voltage regulation, Synchronization, Parallel operation, Generator trouble shooting.

3.8 Three Phase Transformers - Construction Polarity, Configurations in Star and Delta combinations, Open delta configuration.

3.9 Distribution - Main switchboard construction and configuration. Short circuit protection - fuses, main circuit breakers, the generator air circuit breaker, Protection co-ordination, Distribution configuration, Electrical equipment for tankers and hazardous areas and safety systems.

3.10 Emergency Power - Automatic starting arrangements for the emergency generator, Emergency power requirements, Essential and non-essential circuits, Batteries.

4. Electronics, Power Electronics

(a) Semiconductor Devices - Uni-junction transistor, The Bipolar transistor, operation and characteristics, bias circuits, AC and DC current gain, data sheets. Field Effect Transistors, operation. Thyristors, SCRs, GTOs, DIACs and TRIACs operation and characteristics. Insulated gate bipolar transistor (IGBT), Snubber circuits, commutation, data sheets. Device applications in electronic control, surveillance and recording systems, power supplies, rectification, smoothing circuits, stabilization, switching, amplification, pulse shaping, clipping and clamping. PMOSFET (Power metal oxide semiconductor field-effect transistor). Design features of cycloconverter, variable frequency drives and their applications onboard ships.

(b) Integrated Circuits - Ideal operational amplifier, characteristics, types, mounting methods and markings, advantages of ICs. Practical operational amplifier, circuit configurations, CMRR, instrumentation amplifier, 4-20mA circuit. Voltage regulators, multivibrators. IC applications and common circuits. Data sheets.

(c) Electronic Fault Diagnosis - Interpretation and use of electronic systems and subsystem circuit diagrams, operation and maintenance manuals. Electronic test equipment, method of DMM display. Use of CRO as a testing and display instrument. Analysis of measurement and test result on components and circuits. Methods of fault detection.

5. High voltage systems:

Design features, operational and safety requirements for marine HV system. Mandatory rules for HV system in safe and flammable areas and with/ without earthling. Carrying out switching and isolation procedure.

6. Management of Troubleshooting & Restoration of electrical & electronic equipment to operating conditions.

6.1 Control System & Troubleshooting:

(a) Troubleshooting of electrical and electronic control equipment - Electrical safety, Test equipment, Interpretation of circuit symbols, Logical six step trouble shooting procedure, Generation, Prime mover electrical control, Main air circuit breaker, Protection of generators, Electrical distribution systems, Motors, Electrical survey requirements, Calibrate and adjust transmitters and controllers, Control system fault finding.

(b) Function test of electrical. Electronic control equipment and safety devices.

(c) Troubleshooting of monitoring systems - Test and calibration of sensors and transducers of monitoring system.

(d) Software version control - Programmable logic controllers (PLC), Microcontrollers, Digital techniques.

6.2 Maintenance & repair of the following:

Electrical and electronic systems operating in flammable areas, Carrying out safe maintenance and repair procedures, Detection of machinery malfunction, location of faults and action to prevent damage.

7. Cybersecurity – Management of Shipboard Cyber Risks

Cyber risk assessments, control system vulnerabilities, incident response, role of engineering officers.

MARINE ENGINEERING PRACTICE (Function-6: Maintenance and Repair at the Management Level):

1. Theory of maintenance:

Theoretical knowledge of Marine engineering practice and maintenance of machinery.

Methods of dealing with wear and tear of machinery, both electrical and mechanical. Alignment of machinery components. Correction of defects.

Detection of machinery malfunction, location of faults and action to prevent damage - Unplanned maintenance.

Temporary or permanent repairs in the event of breakdown:

(a) Failure of cross-head bearing/ main bearing/ bottom end bearings of main engine
(b) Breakage of chain drives of main engine
(c) Breakdown on turbo chargers
(d) Breakdown of main air conditioning and fridge system
(e) Collapse/ failure of multiple boiler water tubes

2. Practice of maintenance:

Management and conduct of ship maintenance by planned maintenance and preventive maintenance as per ISM Code. Theory of condition monitoring and its application onboard ships. Principles of tribology and its practices.

Planning and execution of dry docking and other major repairs. Manageable breakdowns and emergency repairs.

Planning and execution of safe maintenance activity and repair procedures taking into account technical, legislative, safety procedurals specification, appropriate plan, specification of materials and equipment available for maintenance and repairs.

Risk assessment and evaluation before commencement of maintenance activity.

Destructive and non destructive testing.

Major contamination of main L.O. sump – Action/ handling/ rectification.

Severe flooding of engine room bilges – Action/ handling/ rectification.

Trials and restoration of the plant after repairs. Safe working practices.

Inspection and Adjustment of Equipment relevant to Marine Engineering.

3. Marine Engineering practice – Theoretical & Practical Knowledge

Classification society and class certificates, statutory certification of ships, Surveys for maintenance and renewal of class and statutory certificates.

Digitalisation / Data Driven Maintenance - Predictive analytics, digital twins, e-logbooks.

NAVAL ARCHITECTURE (Function-3: Controlling the Operation of the Ship and Care for Persons on Board (Management Level):

General. Wetted surface formulae. Simpson's rules applied to second moments of areas, volumes, centroids and centres of pressure. Hydrostatic curves.

1. Structural strength: Total Pressure on Vertical Bulkhead of various shapes, Center of Pressure, Diagrams of Shear force and bending moment, Longitudinal Bending Moment in Still Water and wave induced.

2. Transverse stability:

Effect of free liquid surface and sub-division of tanks. Dangers due to water accumulation during fire-fighting Practical requirements to ensure stability at sea. Management of water and fuel tanks. Filling and emptying tanks at sea. Movement of centre of gravity. Angle of Loll and Stability beyond Angle of Loll, Correcting an angle of loll. Stability during Dry docking and Grounding, Damaged Stability,

3. Longitudinal stability:

Longitudinal BM_L and GM_L, Centre of flotation and its calculation. Moment to change trim by one centimeter.

Trim: Changes due to adding or removing fuel, ballast or cargo. Changes due to alteration in density of sea water. Changes due to bilging of compartments, Using the Lost Buoyancy and Added Mass methods. Dynamical Stability, SOLAS, ILLC Convention requirement,

Forces on rudder and stress in rudder stock. Heel when turning, including effect of centrifugal force and of force on rudder.

4.Resistance and propulsion:

Resistance and Fuel Consumption, Propeller and Power, Rudders & Damage Control. Various Types of resistance, Geometry of Propeller, The law of corresponding speeds. Froude's law of comparison. Simple problems on the prediction of full scale resistance from model experiments. Elementary treatment of propeller and simple problems on pitch, pitch ratio, apparent slip, wake velocity, Thrust and Power. Bulbous Bow, Sea trials and interpretation of data recorded. Effects of fouling.

Drag and Lift of Propeller, Problems on propellers involving the use of wake factor, Effective Power, Delivered Power, Propulsive & Quasi Propulsive coefficient, Propeller efficiency, Bollard Pull, Computation of thrust and Power, Cavitation No, Cavitation Tunnel test of Model propeller, Co relation between Model and Full Propeller, Vibration in ships.

Ducted Propeller, Voith Schneider Propeller, Water Jet Propulsion.

Factors affecting trim and stability and measures necessary to preserve trim and stability. Effect on trim and stability of a ship in the event of damage to, and consequent flooding of, a compartment and countermeasures to be taken. IMO recommendations concerning ship stability

5. **Ship construction:**

Fundamental principles of ship construction and the theories and factors affecting trim and stability and measures necessary to preserve trim and stability Ship Types and Terms, Stresses in Ship Structures, Ship Dynamics, Hydrostatics, Displacement, TPC, Coefficients of Form, Areas and Volumes of ship shapes, 1st and 2^{nd} Moments, Center of Gravity, Transverse Stability, Trim, Stability during dry docking and stability during grounding, Forces on ship under various

conditions, including the effect of panting and pounding. Construction of all parts of steel ships. Use of high tensile steel and aluminum.
Structural fire protection arrangements. Dry docking. Design features of ships for general and specialized trades.

Life saving equipment Operation and handling gear for lifeboats and life rafts. Ship measurement and classification. Meaning of 'classed' and 'unclassed' ships. Common terms used in measurement of modern steel ships. Common terms used in tonnage measurement e.g. gross tonnage, net tonnage.

SHIP'S SAFETY, ENVIRONMENTAL PROTECTION AND PERSONNEL CARE (Function-3: Controlling the Operation of the Ship and Care for Persons on Board (Management Level)):

1. Legislative requirements and measures to ensure safety of life at sea and protection of the marine environment

a) Knowledge of Merchant Shipping Act, relevant International Maritime Law embodied in international agreements and conventions - United Nations Convention on the Law of Sea (UNCLOS), International Maritime Organization (IMO), World Health Organization (WHO), Introduction to International Labour Organization (ILO), Treaties, conventions, protocols, rules and regulations, List of IMO Conventions & Authorities & Regulations.
b) Certificates and other documents to be carried on board ships by international conventions (as per SOLAS Annex 1) and how they may be obtained and period of their legal validity.
c) Responsibilities under the relevant requirements of the international convention on load lines.
d) Responsibilities under the relevant requirements of the International Convention for the Safety of Life at Sea - Brief description of International Convention for the Safety of Life at Sea, Obligation - to carry out surveys and maintain validity of certificates, to maintain records and rights of master.
e) Responsibilities under the relevant requirements of the International Convention for the Prevention of Pollution from Ships - Annex I, Annex II, Annex III, Annex IV, Annex V, Annex VI.
f) Maritime declarations of Health and the requirements of the International Health Regulations - WHO‟s International Health Regulations 2005 (IHR), WHO‟s Guidelines for drinking water quality, International Medical Guide for ships (IMGS) and IMO‟s Medical First Aid Guide (MFAG)
g) Responsibilities under International Instruments Affecting the Safety of the Ships, Passengers, Crew or Cargo:

- ILO’s Maritime Labour Convention 2006 (MLC 2006)
- Convention on the International Regulation for Preventing Collisions at Sea (COLREG) 1972
- International Convention on Salvage 1989; Lloyd’s Standard Form of Salvage Agreement (LOF 2000)
- Convention on Limitation of Liability of Maritime Claims 1976
- International Convention for the unification of certain rules of law relating to Bills of Lading (Hague-Visby Rules)
- Charter parties
- Marine Insurance, General Average and P & I Club

h) Methods and aids to prevent pollution of the environment by ships
(i) List of Conventions, Sources of Marine Pollution, Effects of Marine oil spills and Noise
(ii) International Convention for the Control and Management of Ship's Ballast Water and Sediments
(iii) International Convention for the Control of Harmful Anti-Fouling Systems on Ships (AFS) 2001
(iv) Regulations for prevention of oil pollution as per Annex I of MARPOL 73/78
(v) Regulations for control of pollution from noxious liquid substances carried in bulk as per Annex II of MARPOL 73/78
(vi) Regulations for the Prevention of Pollution by harmful substances carried by sea in packaged form as per Annex III of MARPOL 73/78
(vii) Requirements covering the carriage of dangerous goods by sea as per Chapter VII of the SOLAS Convention
(viii) Regulations for the Prevention of Pollution by Sewage from Ships as per Annex IV of MARPOL 73/78
(ix) Regulations for the Prevention of Pollution by Garbage from Ships as per Annex V of MARPOL 73/78
(x) Regulations for the Prevention of Air Pollution as per Annex VI of MARPOL 73/78

i) National Legislation for implementing international agreements and Conventions.

2. Safety and security of the vessel, crew and passengers

(a) Life Saving Appliances Regulations (SOLAS) - Life-Saving appliances and arrangements (Chapter III of SOLAS) and Life-Saving Appliance Code.
(b) Organization of fire and abandon ship drill.
(c) Maintenance, functions and use of Life Saving Appliances, Fire-Fighting and other safety systems.
(d) Actions to protect and safeguard all persons on board in emergencies; rescue of persons from a vessel in distress or from a wreck; and Man-overboard procedures.
(e) Action and means to limit damage and salve the ship following fire, explosion, collision or grounding – Contingency plans for response to emergencies and Procedures for abandoning ship.

3. Develop Emergency and Damage Control Plans and Handle Emergency Situation

(a) Methods and Aids for Fire Prevention, detection and extinction - Fire -fighting equipment.

4. Use Leadership and Managerial Skills

(a) Knowledge of shipboard Personnel Management and Training - Engineer and Manager, Human Resource Management, Training and Development, Maintenance Management.
(b) Knowledge of International Maritime Conventions and recommendations and related National Legislations - The ISM Code, STCW Convention, ILO's MLC 2006.
(c) Ability to apply task and workload management – Communication, Team building, Planning and co-ordination, Personal assignments, Time and resource constraints, Prioritization.
(d) Knowledge and ability to apply effective resource management - Allocation, assignment and prioritization of resources, Effective communication on board and ashore, Decisions reflect consideration of team experience.
(e) Knowledge and ability to apply decision-making techniques - Management processes and functions, Negotiating skills, Situation and risk assessment, Identify and generate options, Select course of action, Evaluation of outcome effectiveness.
(f) Development, implementation, and oversight of standard operating procedures - Project planning and controlling.
(g) Mental Health, Psychological Safety & Sexual Assault and Sexual Harassment and bullying prevention.

Annexure III

Syllabus for MEO Class I Preparatory Course

Duration: Two months (8 weeks, 40 working days, 240 contact hours)

The Marine Engineer Officer (MEO) Class-I Preparatory Course shall be designed to prepare candidates for the Written and Oral Examinations leading to the award of the Marine Engineer Officer Class-I Certificate of Competency (CoC) in accordance with the requirements of Regulation III/2 and the relevant provisions of the STCW Convention, 1978, as amended, including the associated sections of the STCW Code.

The course shall be conducted as a fully offline programme over a duration of eight (8) weeks, comprising 40 working days and 240 contact hours.

The course shall comprise the following syllabus:

1. Knowledge of national maritime legislation, including the Indian Merchant Shipping Act, 2025, Rules framed thereunder; and, understanding of international maritime instruments such as treaties, conventions, protocols and codes, including their processes of formulation and adoption, with particular reference to the United Nations Convention on the Law of the Sea, 1982 (UNCLOS). Understanding of the role and functions of the International Maritime Organization (IMO), including knowledge of major IMO Conventions and instruments relating to maritime safety, prevention of marine pollution, liability and compensation regimes, and other associated maritime regulatory subjects.
2. Overview of Quality, Safety and Energy Management Systems in maritime organizations with reference to the International Safety Management Code (ISM Code) and ISO 9001:2008, including their interrelationship and application on board ships. Introduction to IMO guidelines on the ISM Code issued by the International Maritime Organization, and their linkage with ISO 14001, OH&S systems and ISO 50001**.** Principles of shipboard internal auditing, including types of audits, auditing techniques, audit reporting, identification of non-conformances and corrective/preventive actions. Overview of certification requirements for quality management and ISM systems including DOC and SMC, and introduction to the concepts of Total Quality Management (TQM) and continuous improvement in maritime organizations.

3. Overview of Classification Societies and their functions in ensuring the safety, structural integrity and seaworthiness of ships, including statutory certificates and documents under international conventions. Study of the role and duties of classification societies, principles of ship classification, and classification surveys including continuous surveys of machinery and hull, other survey methods, and enhanced special survey programmes. Procedures for assignment, maintenance, suspension and withdrawal of class. Role of Classification Societies as Recognized Organizations to flag administrations for statutory survey and certification of ships. Duty of care and responsibilities owed by Classification societies. RO Code and RO monitoring by maritime administrations. Ship inspections for first entry into the Indian flag with reference to the Merchant Shipping Act, 2025 and the Merchant Shipping (Registration of Indian Ships) Rules, 2026 relating to registration and compliance requirements. Introduction to open registry and its implications in international shipping.

4. Principles of ship stability including stability during dry docking, damage stability in cases of flooding or grounding, and countermeasures to maintain adequate stability. Overview of relevant requirements under the SOLAS Convention Chapter II-1 relating to subdivision, stability, trim and structural stress, and relevant provisions of the MARPOL Convention. Introduction to the International Code on Intact Stability 2008 (2008 IS Code) covering mandatory and recommended stability criteria for safe ship operation. Basic understanding of probabilistic damage stability assessment, including ship collision damage analysis and the treatment of variables such as ship speed, collision angle, type and displacement in stability evaluation.

5. Overview of Official Log Books, including their purpose, statutory significance and maintenance in accordance with the Merchant Shipping Act, 2025 and relevant rules. The Official Log Book serves as the formal record of a ship's voyages and significant events on board, acts as a communication link between the Master and the Administration, and is a legally admissible document in court proceedings. Emphasis is placed on legislative requirements for proper upkeep and accurate entries in compliance with statutory provisions.

6. Monitoring and control of compliance with legislative requirements relating to safety of life at sea and protection of the marine environment, including knowledge of conventions adopted by the International Maritime Organization. Statutory shipboard certificates and documents, their issuance and validity, and responsibilities under the International Convention on Load Lines, International Convention for the Safety of Life at Sea (SOLAS), and International Convention for the Prevention of Pollution from Ships (MARPOL), along with relevant national legislation such as the Merchant Shipping Act, 2025. Chief Engineer's role in tanker vetting and inspection programmes such as the Ship Inspection Report Programme (SIRE), Tanker Management and Self-Assessment (TMSA), and the RightShip Inspection Programme, together with marine environmental awareness and industry best practices recommended by International Chamber of Shipping, INTERTANKO, BIMCO, and Oil Companies International Marine Forum. Managerial oversight of BWMS commissioning testing and malfunction reporting.

7. Knowledge of ship security systems in accordance with the International Ship and Port Facility Security (ISPS) Code, including mandatory requirements and guidance contained in Part A and Part B under SOLAS Chapter XI-2, and coverage of piracy threats and anti-piracy measures, including existing and proposed counter-piracy practices and industry guidance.

8. Knowledge of the role of the World Health Organization in global public health, including monitoring disease outbreaks and health systems, and the provisions of the International Health Regulations (2005) relating to shipboard health documentation such as the Ship Sanitation Control Exemption Certificate and Ship Sanitation Control Certificate, which replaced the earlier Deratting / Deratting Exemption Certificates. The requirement for the Master to complete the Maritime Declaration of Health using the standard international form, reporting particulars such as the validity of Ship Sanitation Certificates and the number of passengers and crew, as well as awareness of WHO Guidelines for Drinking Water Quality. Role of the International Labour Organization with an overview of the MLC, 2006 requirements relating to the Maritime Labour Certificate, Declaration of Maritime Labour Compliance and defending the ill-treatment of seafarers in foreign ports with clear knowledge of Universal Declaration of Human Rights and International Covenant on Civil and Political Rights.

9. Knowledge of Port State Control as the inspection of foreign ships in national ports to verify compliance with international regulations relating to ship condition, equipment, manning, and operation. Updates on Port State Control directives, the concept, role, and duties of the Flag State in exercising regulatory control over ships registered under its flag, and responsibilities as outlined by the International Chamber of Shipping and the International Shipping Federation. Coverage shall also include participation in the IMO Member State Audit Scheme, commitments under regional Memoranda of Understanding (MoU), relevant instruments used by MoU authorities, inspection procedures, rectification and detention, appeal procedures and the importance of Detention review panels, provision of information by authorities, operational violations, and procedures for proposing and enforcing amendments to MoU provisions.

10. Knowledge of ship survey and certification requirements, including the principles of the Harmonized System of Survey and Certification (HSSC). Types of statutory surveys such as initial, annual, intermediate, periodical, renewal, non-periodical surveys, in-water surveys and additional surveys, their purpose and scope, general survey requirements, and the statutory certificates required to be carried on board ships under the harmonized system.

11. Knowledge of marine insurance including Hull and Machinery Insurance and the role and operation of Protection and Indemnity Clubs, covering principles of indemnity, mutuality, and third-party liabilities, and types of P&I covers such as cargo damage, collision, personal injury or death, pollution, wreck removal, crew repatriation, and stowaways. Charter party concepts

(time, voyage, and bareboat charter) and the Chief Engineer's role in compliance with charter party requirements, including fuel management, sampling, and machinery maintenance. Principles of marine insurance under the Marine Insurance Act 1906, general and particular average, and basic concepts of marine salvage under the International Convention on Salvage 1989 and the Lloyd's Standard Form of Salvage Agreement (LOF).

12. Knowledge of emergency preparedness and response for shipboard emergencies such as oil spill, fire, flooding, collision, grounding, and personnel accidents. Must cover emergency and damage control plans, vital damage control systems including communications, emergency power, pumping, fire main and drainage systems, and measures for effective response and drills. It shall include damage control strategies, emergency repairs, restoration of services, and coordination with authorities and owners. Accident case studies, root cause analysis, reporting procedures, and principles of risk assessment and risk management including ALARP in accordance with the International Safety Management (ISM) Code and industry best practices such as Tanker Management and Self-Assessment (TMSA). Also address detection, handling and restoration procedures for major machinery failures such as main engine bearing failure, turbocharger breakdown, boiler tube failure, lubricating oil contamination, and severe flooding of engine room bilges.

13. Study of human relations and modern management principles, including organizational behaviour and the influence of individual and group behaviour within organizations. The syllabus shall cover communication and information flow within organizations, conflict management, and the influence of human factors in shipboard systems. It shall include cross-cultural aspects of shipboard management, workload management, planning, coordination, delegation, prioritization, and effective resource management. Emphasis shall be placed on effective communication on board and ashore, leadership, motivation, assertiveness, decision-making techniques, situational awareness, and risk assessment. Coverage shall also include prevention of human error, corrective actions, development and implementation of standard operating procedures, and crisis management on board ships, including human behaviour during emergencies and the importance of drills. Psychological safety leadership, anti-harassment procedures and fatigue-risk management shall also be covered.

14. Study of training and instructional responsibilities of the Chief Engineer as a trainer for engine room personnel. The syllabus shall cover the skills required for effective training, including comprehension, conceptualization, creativity, and conduct, along with personal qualities such as confidence, communication ability, adaptability, and leadership. It shall include the training process comprising training needs analysis, design and development, and deployment of training. Emphasis shall also be placed on discipline on board, counselling, housekeeping, safety and

hygiene, mentoring and motivation through role modelling, and encouraging group participation and discussion for effective learning and team development.

15. Study of inventory management on board ships, including management of spares and stores, safety stock levels, and re-order planning using the Re-Order Point (ROP) concept, including lead time considerations. The syllabus shall also cover calculation and management of bunker fuel requirements, inventory control of fuel and lubricating oils, including the use of low BN cylinder oil for low sulphur fuels, and quality management of stored materials. Relevant case studies, including those from the Marine Accident Investigation Branch, shall also be discussed.

16. Study of Management Information Systems (MIS) in ship management, including computer system resources and computer-based information systems. The syllabus shall cover Decision Support Systems and Expert Systems, their role in problem solving and decision making, and the benefits of such systems in supporting operational and managerial functions. It shall also include types of Decision Support Systems such as knowledge-based systems, communication-driven DSS, data-driven DSS, document-driven DSS, and model-driven DSS. Oversight of MASS trials, remote operations, fundamentals of sensor technology, digital documentation & e-certification compliance.

17. Study of record management in the engine room, including preparation, maintenance, and interpretation of records relating to machinery operation and maintenance. The syllabus shall also cover the Chief Engineer's standing orders, night order book, updating of circulars, and maintenance of statutory records such as the Oil Record Book and other documentation required under the International Convention for the Prevention of Pollution from Ships (MARPOL).

18. Study of economising fuel consumption on board ships, including effective power balancing and propulsive characteristics of diesel engines in relation to speed, output and fuel consumption. Bunker management, use of low sulphur fuels and fuel change-over procedures, fuel quality requirements in accordance with the ISO 8217 marine fuel standard, and factors affecting vessel performance, including interpretation of engine load diagrams.

19. Study of budgeting and cost control in ship operations, including principles of cost value analysis for cost reduction and the classification of fixed and consumable costs. The syllabus shall cover voyage expenses such as bunker fuel, port charges, cargo handling costs, canal tolls, agency fees and commissions, as well as analysis of dry-docking and repair costs. It shall also include evaluation and contemporary methods in reduction of downtime; and, its impact on operational efficiency and expenditure.

20. Study of practical electricity and electronics including power electronics on board ships, including high voltage (HV) systems, their definition, applications, advantages, safety

requirements, busbar arrangements, insulation, short circuit effects and protection, generator and motor protection, and testing protocols such as insulation resistance measurement. Concepts of electrical propulsion including synchronous motor drives and Azipod propulsion systems, their construction, operation, advantages, limitations, maintenance requirements, and speed control using variable frequency methods such as Pulse Width Modulation. In addition, it shall include the use and application of circuit breakers in HV systems, particularly SF_6 and vacuum circuit breakers and their advantages in marine high voltage installations.

21. Study of recent developments in marine diesel engines and propulsion systems including dual fuel engines and contemporary technologies as may be adopted from time to time by eminent engine builders. Camshaft-less engines, electronic governors, common rail fuel injection systems, and control systems for electronically controlled engines. Recent developments in tribology such as advanced bearing lubrication techniques, alpha cylinder lubricator systems, fuel dilution in lubricating oils and methods of prevention, friction–speed characteristics in lubrication, and hydrodynamic lubrication of seals. In addition, developments in propulsion systems such as contra-rotating propellers, wake equalizing ducts, water jet propulsion, electrical propulsion, and PTO/PTI arrangements in modern propulsion systems. New innovations in supercharging systems, turbo chargers, turbo alternators and hybrid systems for improving overall plant efficiency. Additional management-level competence shall include supervisory responsibilities for alternative-fuel systems, including:

    - integration of alternative-fuel risk assessments into the Safety Management System (SMS);
    - oversight of bunkering operations for low-flashpoint and emerging fuels in accordance with applicable safety guidelines;
    - evaluation of operational limits, safeguards, and fuel-system boundaries for safe machinery operation;
    - incorporation of fuel-specific maintenance and inspection requirements into the Planned Maintenance System (PMS).

22. Study of greenhouse gas (GHG) emissions from ships, including statutory restrictions on EU waters; methods for monitoring, controlling, and reducing emissions in compliance with the latest IMO conventions. Understanding of carbon capture and carbon neutralization technologies, design and development of hull forms and optimization techniques to minimize wake and frictional resistance, propeller & rudder interaction; and, the application of new-generation low-friction, fouling-resistant, and environmentally compliant paints and coatings. Use of carbon-free and carbon-neutral fuels, along with emerging technologies for emission reduction, all in accordance with IMO regulations such as MARPOL Annex VI, the Energy Efficiency Existing Ship Index (EEXI), Carbon Intensity Indicator (CII), and the IMO Strategy for the reduction of GHG emissions from ships.

23. General understanding of Artificial Intelligence (AI) and its emerging applications in the maritime industry. The use of AI in ship navigation support systems, predictive maintenance of machinery, fuel efficiency optimization, voyage planning, autonomous shipping concepts, and data-driven decision-making in vessel operations and fleet management. Digitalization of maritime transport including the use of digital platforms, smart ships, integrated bridge systems, remote monitoring of machinery, electronic documentation, and the role of Internet of Things (IoT) in shipboard and port operations. Basic knowledge of blockchain technology and its application in shipping, including secure digital record-keeping, electronic bills of lading, cargo tracking, supply chain transparency, and improved coordination among shipowners, charterers, ports, and logistics stakeholders. Additional management-level competence in cyber-risk management under the ISM Code, including oversight of engineering-related cyber-risk controls, ensuring cyber-risk considerations are incorporated into the SMS, supporting internal audits on cyber-related systems and contributing to preparedness for cyber-incident response.
24. The study of Classic maritime casualties; Practices related to Casualty Investigations, related IMO guidelines and procedures.
25. Underwater noise; ship designs and operations to reduce such noise and allied areas.

Annexure IV

Syllabus for Electro-Technical Officer (ETO) Preparatory Course

(Duration: One Month – 4 Weeks, 20 Working Days, 120 Contact Hours)

The syllabus of the Electro-Technical Officer (ETO) Preparatory Course shall be designed to prepare candidates for the Written and Oral Examinations leading to the issue of the Electro-Technical Officer Certificate of Competency (CoC) in accordance with the requirements of Regulation III/6 and Section A-III/6 of the STCW Convention, 1978, as amended.

The course shall be conducted as a four-week, fully offline programme, with emphasis on classroom instruction and practical troubleshooting. A minimum of two hours of supervised practical training shall be conducted each working day, directly linked to the theoretical subjects covered on that day.

The course shall comprise the following subjects:

1. **Marine Electrical Engineering** (28 Hours)

Fundamentals of electrical engineering; DC and AC circuits; three-phase systems and electrical measurements; electrical machines, including generators, alternators, transformers and motors; marine electrical power generation and distribution systems; main and emergency switchboards; synchronizing, load sharing and power management systems; protective devices and electrical safety; battery systems, charging arrangements and uninterruptible power supply (UPS) systems; electrical systems of deck machinery, including mooring winches, windlasses and cranes; GMDSS power supply arrangements; internal communication systems; public address (PA) systems; sound-powered telephones; intrinsically safe (Ex-i) and explosion-proof (Ex-d) equipment; and hazardous area electrical installations.

2. Marine Electronics (16 Hours)

Semiconductor devices and electronic components; analogue and digital electronics; power electronic devices and their applications; electronic control circuits; microprocessors and microcontrollers; communication and navigation equipment interfaces; electronic fault diagnosis and testing techniques; digital ship sensors; electronic data loggers; smart ship technologies; Voyage Data Recorder (VDR) interfaces; and networked electronic equipment.

3. Automation and Control Engineering (18 Hours)

Principles of automatic control systems; sensors, transmitters and actuators; Programmable Logic Controllers (PLCs); automation of main engines and auxiliary machinery; boiler automation systems; alarm, monitoring and control systems; Integrated Automation Systems (IAS); Power Management Systems (PMS); Operational Technology (OT) architecture; cyber security of OT systems; advanced PLC diagnostics; Modbus and

Profibus troubleshooting; Variable Frequency Drives (VFDs); harmonic analysis; physical network isolation; and stand-alone OT recovery procedures.

4. High Voltage Technology (12 Hours)

High-voltage generation and distribution systems on board ships; construction and operation of high-voltage equipment; high-voltage protection systems; safety precautions and the use of personal protective equipment (PPE); isolation procedures; Permit-to-Work (PTW) systems; testing and maintenance of high-voltage installations; electrical safety for methanol fuel systems, ammonia fuel systems and hydrogen fuel cells; and Battery Energy Storage Systems (BESS) and hybrid propulsion electrical systems.

5. Instrumentation and Control Systems (10 Hours)

Principles of marine instrumentation; measurement of pressure, temperature, level and flow; speed and position sensing devices; calibration and testing of instruments; signal transmission and conditioning; instrument fault diagnosis; Continuous Emission Monitoring Systems (CEMS); cryogenic instrumentation; cryogenic sensor calibration; cargo automation; and decarbonization automation systems.

6. **Electrical Maintenance and Troubleshooting** (18 Hours)

Planned maintenance of electrical and electronic equipment; interpretation of electrical drawings and circuit diagrams; testing using electrical measuring instruments; insulation resistance and continuity testing; maintenance and troubleshooting of motors, generators, transformers and switchgear; fault diagnosis in automation and electronic control systems; practical troubleshooting techniques for shipboard electrical equipment; advanced PLC troubleshooting; VFD commissioning; harmonic measurement; OT network fault diagnosis; VDR communication testing; sensor loop calibration; electrical fault simulation; and integrated automation system troubleshooting.

7. **Shipboard Safety, Environmental Protection and Maritime Regulations** (10 Hours)

Safe working practices on board ships; electrical safety procedures; Lock-Out/Tag-Out (LOTO) procedures; fire prevention and firefighting related to electrical installations; the requirements of SOLAS, MARPOL, the STCW Convention, the ISM Code and the ISPS Code; pollution prevention and environmental protection measures; occupational health and safety requirements; workplace culture on board; prevention of violence and harassment; the human element; cyber risk management; alternative fuel safety; and emerging IMO environmental regulations.

8. **Written and Oral Examination Preparation** (8 Hours)

Numerical problem-solving; practice of previous examination papers; case studies on shipboard electrical and electronic systems; mock written examinations; mock oral examinations and viva voce; and discussion on practical shipboard fault-finding and troubleshooting scenarios.

Practical Training

Practical training shall be integrated throughout the course and shall include electrical measurements; interpretation of electrical drawings; insulation resistance and continuity testing; testing and maintenance of motors, generators, transformers and switchgear; VFD parameter setting; switchboard operations; protection systems; PLC familiarization and programming; GMDSS power supply testing; VDR testing; automation and instrumentation exercises; high-voltage safety demonstrations; fault diagnosis of deck machinery; reefer electrical troubleshooting; electronic circuit testing; soldering techniques; smart sensor diagnostics; CEMS calibration; and practical fault diagnosis using laboratory equipment or simulators.

The Maritime Training Institute (MTI) shall ensure that all practical sessions are conducted using appropriate instruments, equipment and training aids. Wherever it is not practicable to demonstrate practical exercises using actual equipment, AI-enabled visual demonstrations, virtual simulations and instructional videos may be used to familiarize candidates with the relevant equipment, procedures and practical applications.