

**REPUBLIC OF KENYA**

**COMPETENCY BASED CURRICULUM**

**FOR**

**MARINE ENGINEERING**

**(SHIP CONSTRUCTION)**

**LEVEL 6**



TVET CDACC

P.O. BOX 15745-00100

NAIROBI

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# FOREWORD

The provision of quality education and training is fundamental to the Government’s overall strategy for social economic development. Quality education and training will contribute to achievement of Kenya’s development blueprint and sustainable development goals.

Reforms in the education sector are necessary for the achievement of Kenya Vision 2030 and meeting the provisions of the Constitution of Kenya 2010. The education sector had to be aligned to the Constitution and this resulted to the formulation of the Policy Framework for Reforming Education and Training. A key feature of this policy is the radical change in the design and delivery of the TVET training. This policy document requires that training in TVET be competency based, curriculum development be industry led, certification be based on demonstration of competence and mode of delivery allows for multiple entry and exit in TVET programmes.

These reforms demand that Industry takes a leading role in curriculum development to ensure the curriculum addresses its competence needs. It is against this background that this curriculum has been developed.

It is my conviction that this curriculum will play a great role towards development of competent human resource for the marine sector.

**PRINCIPAL SECRETARY, VOCATIONAL AND TECHNICAL TRAINING**

**MINISTRY OF EDUCATION**

# PREFACE

Kenya Vision 2030 aims to transform the country into a newly industrializing, “middle-income country providing a high-quality life to all its citizens by the year 2030”. Kenya intends to create a globally competitive and adaptive human resource base to meet the requirements of a rapidly industrializing economy through life-long education and training. TVET has a responsibility of facilitating the process of inculcating knowledge, skills and attitudes necessary for catapulting the nation to a globally competitive country, hence the paradigm shift to embrace Competency Based Education and Training (CBET).

The Technical and Vocational Education and Training Act No. 29 of 2013 on Reforming Education and Training in Kenya, emphasized the need to reform curriculum development, assessment and certification. This called for a shift to CBET in order to address the mismatch between skills acquired through training and skills needed by industry as well as increase the global competitiveness of Kenyan labour force.

TVET Curriculum Development, Assessment and Certification Council (TVET CDACC) in conjunction with Marine Sector Skills Advisory Committee (SSAC) have developed this curriculum.

This curriculum is designed and organized with an outline of learning outcomes; suggested delivery methods, training/learning resources and methods of assessing the trainee’s achievement. The curriculum is competency-based and allows multiple entry and exit to the course.

I am grateful to the Council members, Council Secretariat, Marine SSAC, expert workers and all those who participated in the development of this curriculum.

**Prof. CHARLES M. M. ONDIEKI, PhD, FIET (K), Con. EngTech.**

**CHAIRMAN, TVET CDACC**

# ACKNOWLEDGEMENT

This curriculum has been designed for competency-based training and has independent units of learning that allow the trainee flexibility in entry and exit. In developing the curriculum, significant involvement and support was received from various organizations.

I recognize with appreciation the role of Marine Sector Skills Advisory Committee (SSAC) members for their contribution to the development of this curriculum.

I also thank all stakeholders in the marine sector for their valuable input and all those who participated in the process of developing this curriculum.

I am convinced that this curriculum will go a long way in ensuring that workers in the marine industry acquire competencies that will enable them to perform their work more efficiently.

**Dr. LAWRENCE GUANTAI M’ITONGA, PhD**

**COUNCIL SECRETARY/CEO**

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# ACRONYMS

CBET : Competency Based Education and Training

CDACC : Curriculum Development Assessment and Certification Council

CU : Curriculum

OSHA : Occupation Safety and Health Act

PPE : Personal Protective Equipment

SSAC : Sector Skills Advisory Committee

ENG : Engineering

MAR : Marine

BC : Basic Competency

CC : Common Competency

CR : Core Competency

A : Control Version

# KEY TO UNIT CODE

ENG / CU/MAR/BC/01/ 6/A

Industry or sector

Occupational Standards

Occupational area

Type of competency

Competency number

Competency level

Version Control

# COURSE OVERVIEW

Marine Engineering Level 6 (Ship Construction) qualifications consists of units of learning that an individual must achieve to equip the learner with knowledge and skills to perform Marine Engineering activities.

The units of learning to Marine Engineering level 6 (Ship Construction) qualifications include the following Competencies: Basic Units, Common Units and the Core Units of Learning.

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit of Learning Code** | **Unit of Learning Title** | **Duration in Hours** | **Credit Factor** |
| ENG/CU/MAR/BC/01/6/A | Communication Skills | 40 | 4 |
| ENG/CU/MAR/BC/02/6/A | Digital Literacy | 60 | 6 |
| ENG/CU/MAR/BC/03/6/A | Entrepreneurial Skills | 100 | 10 |
| ENG/CU/MAR/BC/04/6/A | Employability Skills | 80 | 8 |
| ENG/CU/MAR/BC/05/6/A | Environmental literacy | 40 | 4 |
| ENG/CU/MAR/BC/06/6/A | Occupational Safety and Health Practices | 40 | 4 |
| **TOTAL NUMBER OF HOURS** | | **360** | **36** |

**Common units of Learning:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit of Learning Code** | **Unit of Learning Title** | **Duration in Hours** | **Credit Factor** |
| ENG/CU/MAR/CC/01/6/A | Mechanical science principles | 75 | 7.5 |
| ENG/CU/MAR/CC/02/6/A | Fluid mechanics principles | 75 | 7.5 |
| ENG/CU/MAR/CC/03/6/A | Thermodynamics principles | 75 | 7.5 |
| ENG/CU/MAR/CC/04/6/A | Electrical principles | 150 | 15 |
| ENG/CU/MAR/CC/05/6/A | Ship construction principles | 120 | 12 |
| ENG/CU/MAR/CC/06/6/A | Ship stability | 120 | 12 |
| ENG/CU/MAR/CC/07/6/A | Engineering mathematics | 150 | 15 |
| ENG/CU/MAR/CC/08/6/A | Basic sea survival skills | 100 | 10 |
| **Total** | | **865** | **86.5** |

**Core Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit of Learning Code** | **Unit of Learning Title** | **Duration in Hours** | **Credit Factor** |
| ENG/CU/MAR/CR/01/6/A | Vessel hull and superstructure survey | 120 | 12 |
| ENG/CU/MAR/CR/02/6/A | Vessel operational system survey | 120 | 12 |
| ENG/CU/MAR/CR/03/6/A | Engineering drawings | 100 | 10 |
| ENG/CU/MAR/CR/04/6/A | Marine pump installation and maintenance | 200 | 20 |
| ENG/CU/MAR/CR/05/6/A | Air compressor installation and maintenance | 200 | 20 |
| ENG/CU/MAR/CR/06/6/A | Marine engineering works | 180 | 18 |
| ENG/CU/MAR/CR/07/6/A | Marine electrical and electronic system operation | 220 | 22 |
| ENG/CU/MAR/CR/08/6/A | Operation and maintenance of ship control and automation systems | 220 | 22 |
| ENG/CU/MAR/CR/09/6/A | Marine transmission, shaft and propulsion system maintenance | 220 | 22 |
| ENG/CU/MAR/CR/10/6/A | Operation and maintenance of navigation and communication systems | 200 | 20 |
| ENG/CU/MAR/CR/11/6/A | Marine auxiliary systems assessment and monitoring | 150 | 15 |
| ENG/CU/MAR/CR/12/6/A | Marine organization management | 100 | 10 |
|  | Industrial Attachment | 480 | 48 |
| **Total** | | **2510** | **251** |
| **Grand Total** | | **3735** | **373.5** |

The total duration of the course for an average trainee is **3750** hours which is equivalent to 124 weeks at 30 hours of learning per week including 480 hours (12 weeks) of field attachment.

**Entry Requirements**

An individual entering this course should have any of the following minimum requirements:

1. Kenya Certificate of Secondary Education (KCSE) mean grade C (Minus)

**Or**

1. Certificate Level 5 in a related course

**Or**

1. Equivalent qualifications as determined by Kenya National Qualifications Authority (KNQA)

**Field attachment**

An individual enrolled in this course will undergo a field attachment for a duration of 480 hours which is equivalent to 12 weeks at 40 hours per week in a Marine Engineering firm/organization.

**Assessment**

The course will be assessed at two levels:

**Internal assessment**: conducted continuously by the trainer (internal assessor) who is monitored by an accredited internal verifier.

**External assessment:** conducted by an accredited external assessor who is monitored by an accredited external verifier.

The assessors and verifiers are accredited by TVET CDACC which also coordinates external assessment.

**Certification**

An individual will be awarded a Certificate of Competency on demonstration of competence in a unit of competency. To be awarded a Certificate in Marine Engineering (Ship Construction) Level 6, an individual must demonstrate competence in all the units of competency.

These certificates will be awarded by TVET CDACC in conjunction with the training provider.

# BASIC UNITS OF LEARNING

# COMMUNICATION SKILLS

**UNIT CODE:** ENG/CU/MAR/BC/01/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Communication Skills

**Duration of Unit:** 40 hours

**Unit Description**

This unit covers the competencies required to demonstrate communication skills. It involves, meeting communication needs of clients and colleagues; developing communication strategies, establishing and maintaining communication pathways, conducting interviews, facilitating group discussion and representing the organization.

**Summary of Learning Outcomes**

1. Meet communication needs of clients and colleagues
2. Develop communication strategies
3. Establish and maintain communication pathways
4. Promote use of communication strategies
5. Conduct interview
6. Facilitate group discussion
7. Represent the organization

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Meet communication needs of clients and colleagues | * Communication process * Modes of communication * Medium of communication * Effective communication * Barriers to communication * Flow of communication * Sources of information * Organizational policies * Organization requirements for written and electronic communication methods * Report writing * Effective questioning techniques (clarifying and probing) * Workplace etiquette * Ethical work practices in handling communication * Active listening * Feedback * Interpretation * Flexibility in communication * Types of communication strategies * Elements of communication strategy | * Interview * Written texts |
| 1. Develop communication strategies | * Dynamics of groups * Styles of group leadership * Openness and flexibility in communication * Communication skills relevant to client groups | * Interview * Written texts |
| 1. Establish and maintain communication pathways | * Types of communication pathways | * Interview * Written texts |
| 1. Promote use of communication strategies | * Application of elements of communication strategies * Effective communication techniques | * Interview * Written texts |
| 1. Conduct interview | * Types of interview * Establishing rapport * Facilitating resolution of issues * Developing action plans | * Interview * Written texts |
| 1. Facilitate group discussion | * Identification of communication needs * Dynamics of groups * Styles of group leadership * Presentation of information * Encouraging group members participation * Evaluating group communication strategies | * Interview * Written texts |
| 1. Represent the organization | * Presentation techniques * Development of a presentation * Multi-media utilization in presentation * Communication skills relevant to client groups | * Interview * Written texts |

**Suggested Methods of Instructions**

* Discussion
* Role playing
* Simulation
* Direct instruction

**Recommended Resources**

* Desktop computers/laptops
* Internet connection
* Projectors
* Telephone

# DIGITAL LITERACY

**UNIT CODE:** ENG/CU/MAR/BC/02/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Digital Literacy

**Duration of Unit:** 60 hours

**Unit Description**

This unit describes competencies required to demonstrate digital literacy. It involves in identifying computer software and hardware, applying security measures to data, hardware, software in automated environment, computer software in solving task, internet and email in communication at workplace, desktop publishing in official assignments and preparing presentation packages.

**Summary of Learning Outcomes**

1. Identify computer software and hardware
2. Apply security measures to data, hardware, software in automated environment
3. Apply computer software in solving tasks
4. Apply internet and email in communication at workplace
5. Apply desktop publishing in official assignments
6. Prepare presentation packages

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify computer hardware and software | * Concepts of ICT * Functions of ICT * History of computers * Components of a computer * Classification of computers | * Written tests * Oral presentation |
| 1. Apply security measures to data, hardware, software in automated environment | * Data security and control * Security threats and control measures * Types of computer crimes * Detection and protection against computer crimes * Laws governing protection of ICT | * Written tests * Oral presentation * Project |
| 1. Apply computer software in solving tasks | * Operating system * Word processing * Spread sheets * Data base design and manipulation * Data manipulation, storage and retrieval | * Oral questioning * Project |
| 1. Apply internet and email in communication at workplace | * Computer networks * Network configurations * Uses of internet * Electronic mail (e-mail) concept | * Oral questioning * Written report |
| 1. Apply desktop publishing in official assignments | * Concept of desktop publishing * Opening publication window * Identifying different tools and tool bars * Determining page layout * Opening, saving and closing files * Drawing various shapes using DTP * Using colour pellets to enhance a document * Inserting text frames * Importing and exporting text * Object linking and embedding * Designing of various publications * Printing of various publications | * Oral questioning * Written report * Project |
| 1. Prepare presentation packages | * Types of presentation packages * Procedure of creating slides * Formatting slides * Presentation of slides * Procedure for editing objects | * Oral questioning * Written report * Project |

**Suggested Methods of Instruction**

* Instructor led facilitation of theory
* Demonstration by trainer
* Practical work by trainee
* Viewing of related videos
* Project
* Group discussions

**Recommended Resources**

* Computers
* Printers
* Storage devices
* Internet access

# ENTREPRENEURSHIP SKILLS

**UNIT CODE:** ENG/CU/MAR/BC/03/6/A

**Relationship to occupational standards**

This unit addresses the Unit of Competency: Demonstrate Understanding of Entrepreneurship

**Duration of unit:** 100 hours

**Unit Description**

This unit covers the competencies required to demonstrate understanding of entrepreneurship. It involves demonstrating understanding of an entrepreneur, entrepreneurship and self-employment. It also involves identifying entrepreneurship opportunities, creating entrepreneurial awareness, applying entrepreneurial motivation and developing business innovative strategies.

**Summary of Learning Outcomes**

* 1. Demonstrate understanding of who an entrepreneur
  2. Demonstrate knowledge of entrepreneurship and self-employment
  3. Identify entrepreneurship opportunities
  4. Create entrepreneurial awareness
  5. Apply entrepreneurial motivation
  6. Develop business innovative strategies
  7. Develop Business plan

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Demonstrate knowledge of entrepreneurship and self-employment | * Importance of self-employment * Requirements for entry into self-employment * Role of an Entrepreneur in business * Contributions of Entrepreneurs to National development * Entrepreneurship culture in Kenya * Born or made entrepreneurs | * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |
| 1. Identify entrepreneurship opportunities | * Business ideas and opportunities * Sources of business ideas * Business life cycle * Legal aspects of business * Assessment of product demand * Business environment * Factors to consider when evaluating business environment * Technology in business | * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |
| 1. Create entrepreneurial awareness | * Forms of businesses * Sources of business finance * Factors in selecting source of business finance * Governing policies on Small Scale Enterprises (SSEs) * Problems of starting and operating SSEs | * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |
| 1. Apply entrepreneurial motivation | * Internal and external motivation * Motivational theories * Self-assessment * Entrepreneurial orientation * Effective communications in entrepreneurship * Principles of communication * Entrepreneurial motivation | * Case studies * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |
| 1. Develop business innovative strategies | * Innovation in business * Small business Strategic Plan * Creativity in business development * Linkages with other entrepreneurs * ICT in business growth and development | * Case studies * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |
| 1. Develop Business Plan | * Business description * Marketing plan * Organizational/Management * plan * Production/operation plan * Financial plan * Executive summary * Presentation of Business Plan | * Case studies * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |

**Suggested Methods of Instructions:**

* Direct instruction
* Project
* Case studies
* Field trips
* Discussions
* Demonstration
* Question and answer
* Problem solving
* Experiential
* Team training

Recommended Resources

* Case studies
* Business plan templates
* Computers
* Overhead projectors
* Internet
* Mobile phone
* Video clips
* Films
* Newspapers and Handouts
* Business Journals
* Writing materials

# EMPLOYABILITY SKILLS

**UNIT CODE:** ENG/CU/MAR/BC/04/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Employability Skills

**Duration of Unit:** 80 hours

**Unit Description**

This unit covers competencies required to demonstrate employability skills. It involves conducting self-management, demonstrating interpersonal communication, critical safe work habits, leading a workplace team, planning and organizing work, maintaining professional growth and development, demonstrating workplace learning, problem solving skills and managing ethical performance.

**Summary of Learning Outcomes**

1. Conduct self-management
2. Demonstrate interpersonal communication
3. Demonstrate critical safe work habits
4. Lead a workplace team
5. Plan and organize work
6. Maintain professional growth and development
7. Demonstrate workplace learning
8. Demonstrate problem solving skills
9. Manage ethical performance

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Conduct self-management | * Self-awareness * Formulating personal vision, mission and goals * Strategies for overcoming life challenges * Managing emotions * Emotional intelligence * Assertiveness versus aggressiveness * Expressing personal thoughts, feelings and beliefs * Developing and maintaining high self-esteem * Developing and maintaining positive self-image * Setting performance targets * Monitoring and evaluating performance * Articulating ideas and aspirations * Accountability and responsibility * Good work habits * Self-awareness * Values and beliefs * Self-development * Financial literacy * Healthy lifestyle practices * Adopting safety practices | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Demonstrate interpersonal communication | * Meaning of interpersonal communication * Listening skills * Types of audience * Public speaking * Writing skills * Negotiation skills * Reading skills * Meaning of empathy * Understanding customers’ needs * Establishing communication networks * Assertiveness * Sharing information | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Demonstrate critical safe work habits | * Stress and stress management * Time concept * Punctuality and time consciousness * Leisure * Integratingpersonal objectives into organizational objectives * Resources mobilization * Resources utilization * Setting work priorities * Developing healthy relationships * HIV and AIDS * Drug and substance abuse * Managing emerging issues | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Lead a workplace team | * Leadership qualities * Power and authority * Team building * Determination of team roles and objectives * Team parameters and relationships * Individual responsibilities in a team * Forms of communication * Complementing team activities * Gender and gender mainstreaming * Human rights * Developing healthy relationships * Maintaining relationships * Conflicts and conflict resolution * Coaching and mentoring skills | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Plan and organize work | * Functions of management * Planning * Organizing * Time management * Decision making concept * Task allocation * Developing work plans * Developing work goals/objectives and deliverables * Monitoring work activities * Evaluating work activities * Resource mobilization * Resource allocation * Resource utilization * Proactive planning * Risk evaluation * Problem solving * Collecting, analysing and organising information * Negotiation | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Maintain professional growth and development | * Avenues for professional growth * Training and career opportunities * Assessing training needs * Mobilizing training resources * Licenses and certifications for professional growth and development * Pursuing personal and organizational goals * Managing work priorities and commitments * Recognizing career advancement | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Demonstrate workplace learning | * Managing own learning * Mentoring * Coaching * Contributing to the learning community at the workplace * Cultural aspects of work * Networking * Variety of learning context * Application of learning * Safe use of technology * Taking initiative/proactivity * Flexibility * Identifying opportunities * Generating new ideas * Workplace innovation * Performance improvement * Managing emerging issues * Future trends and concerns in learning | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Demonstrate problem solving skills | * Critical thinking process * Data analysis tools * Decision making * Creative thinking * Development of creative, innovative and practical solutions * Independence in identifying and solving problems * Solving problems in teams * Application of problem-solving strategies * Testing assumptions * Resolving customer concerns | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Manage ethical performance | * Meaning of ethics * Ethical perspectives * Principles of ethics * Ethical standards * Organization code of ethics * Common ethical dilemmas * Organization culture * Corruption, bribery and conflict of interest * Privacy and data protection * Diversity, harassment and mutual respect * Financial responsibility/accountability * Etiquette * Personal and professional integrity * Commitment to jurisdictional laws * Emerging issues in ethics | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |

**Suggested Methods of Instructions**

* Demonstrations
* Simulation/Role play
* Group Discussion
* Presentations
* Assignments
* Q&A

**Recommended Resources**

* Computers
* Stationery
* Charts
* Video clips
* Audio tapes
* Radio sets
* TV sets
* LCD projectors

# ENVIRONMENTAL LITERACY

**UNIT CODE**:ENG/CU/MAR/BC/05/6/A

**Relationship to Occupational Standards**:

This unit addresses the Unit of Competency: Demonstrate Environmental Literacy

**Duration of Unit:** 40 hours

**Unit Description**

This unit describes the competencies required demonstrate environmental literacy.it involves controlling environmental hazard, controlling environmental pollution, complying with workplace sustainable resource use, evaluating current practices in relation to resource usage, identifying environmental legislations/conventions for environmental concerns, implementing specific environmental programs, monitoring activities on environmental protection/programs, analysing resource use and developing resource conservation plans.

**Summary of Learning Outcomes**

1. Control environmental hazard
2. Control environmental Pollution
3. Demonstrate sustainable resource use
4. Evaluate current practices in relation to resource usage
5. Identify Environmental legislations/conventions for environmental concerns
6. Implement specific environmental programs
7. Monitor activities on Environmental protection/Programs
8. Analyze resource use
9. Develop resource conservation plans

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Control environmental hazard | * Purposes and content of Environmental Management and Coordination Act 1999 * Storage methods for environmentally hazardous materials * Disposal methods of hazardous wastes * Types and uses of PPE in line with environmental regulations * Occupational Safety and Health Standards (OSHS) | * Written questions * Oral questions |
| 1. Control environmental Pollution control | * Types of pollution * Environmental pollution control measures * Types of solid wastes * Procedures for solid waste management * Different types of noise pollution * Methods for minimizing noise pollution | * Written questions * Oral questions * Role play |
| 1. Demonstrate sustainable resource use | * Types of resources * Techniques in measuring current usage of resources * Calculating current usage of resources * Methods for minimizing wastage * Waste management procedures * Principles of 3Rs (Reduce, Reuse, Recycle) * Methods for economizing or reducing resource consumption | * Written questions * Oral questions * Role play |
| 1. Evaluate current practices in relation to resource usage | * Collection of information on environmental and resource efficiency systems and procedures, * Measurement and recording of current resource usage * Analysis and recording of current purchasing strategies. * Analysis of current work processes to access information and data * Identification of areas for improvement | * Written questions * Oral questions * Role play |
| 1. Identify Environmental legislations/conventions for environmental concerns | * Environmental issues/concerns * Environmental legislations /conventions and local ordinances * Industrial standard /environmental practices * International Environmental Protocols (Montreal, Kyoto) * Features of an environmental strategy | * Written questions * Oral questions |
| 1. Implement specific environmental programs | * Community needs and expectations * Resource availability * 5s of good housekeeping * Identification of programs/Activities * Setting of individual roles /responsibilities * Resolving problems /constraints encountered * Consultation with stakeholders | * Written questions * Oral questions * Role play |
| 1. Monitor activities on Environmental protection/Programs | * Periodic monitoring and Evaluation of activities * Gathering feedback from stakeholders * Analyzing data gathered * Documentation of recommendations and submission * Setting of management support systems to sustain and enhance the program * Monitoring and reporting of environmental incidents to concerned /proper authorities | * Oral questions * Written tests * Practical test |
| 1. Analyze resource use | * Identification of resource consuming processes * Determination of quantity and nature of resource consumed * Analysis of resource flow through different parts of the process. * Classification of wastes for possible source of resources. | * Written tests * Oral questions * Practical test |
| 1. Develop resource Conservation plans | * Determination of efficiency of use/conversion of resources * Causes of low efficiency of use of resources * Plans for increasing the efficiency of resource use | * Written tests * Oral questions * Practical test |

**Suggested Methods of Instructions**

* Instructor led facilitation of theory
* Practical demonstration of tasks by trainer
* Practice by trainees
* Observations and comments and corrections by trainers

**Recommended Resources**

* Standard operating and/or other workplace procedures manuals
* Specific job procedures manuals
* Environmental Management and Coordination Act 1999
* Machine/equipment manufacturer’s specifications and instructions
* Personal Protective Equipment (PPE)
* ISO standards
* Company environmental management systems (EMS)
* Montreal Protocol
* Kyoto Protocol

# OCCUPATIONAL SAFETY AND HEALTH PRACTICES

**UNIT CODE:** ENG/CU/MAR/BC/06/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Demonstrate occupational safety and health practices

**Duration of Unit:** 40 hours

**Unit Description**

This unit specifies the competencies required to demonstrate occupational health and safety practices. It involves identifying workplace hazards and risk, identifying and implementing appropriate control measures to hazards and risks and implementing OSH programs, procedures and policies/guidelines.

**Summary of Learning Outcomes**

1. Identify workplace hazards and risk
2. Control OSH hazards
3. Implement OSH programs

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify workplace hazards and risks | * Identification of hazards in the workplace and/or the indicators of their presence * Evaluation and/or work environment measurements of OSH hazards/risk existing in the workplace * Gathering of OSH issues and/or concerns | * Oral questions * Written tests * Portfolio of evidence * Third party report |
| 1. Control OSH hazards | * Prevention and control measures e.g. use of PPE * Risk assessment * Contingency measures | * Oral questions * Written tests * Portfolio of evidence * Third party report |
| 1. Implement OSH   programs | * Company OSH program, evaluation and review * Implementation of OSH programs * Training of team members and advice on OSH standards and procedures * Implementation of procedures for maintaining OSH-related records | * Oral questions * Written tests * Portfolio of evidence * Third party report |

**Suggested Methods of instructions**

* Assigments
* Discussion
* Q&A
* Role play
* Viewing of related videos

**Recommended Resources**

* Standard operating and/or other workplace procedures manuals
* Specific job procedures manuals
* Machine/equipment manufacturer’s specifications and instructions
* Personal Protective Equipment (PPE) e.g.
* Mask
* Face mask/shield
* Safety boots
* Safety harness
* Arm/Hand guard, gloves
* Eye protection (goggles, shield)
* Hearing protection (ear muffs, ear plugs)
* Hair Net/cap/bonnet
* Hard hat
* Face protection (mask, shield)
* Apron/Gown/coverall/jump suit
* Anti-static suits
* High-visibility reflective vest

# COMMON UNITS OF LEARNING

# MECHANICAL SCIENCE PRINCIPLES

**UNIT CODE:** ENG/CU/MAR/CC/01/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply Mechanical science principles

**Duration of Unit: 75** hours

**Unit Description**

This unit describes the competencies required by a technician in order to apply a wide range of Mechanical science principles in their work. It includes using concepts of mechanical science, determining effects of loading on static and dynamic engineering systems, analyse properties of materials, determine parameters of a fluid system and use of basic systems in power transfer.

**Summary of Learning Outcomes**

1. Use the concept of mechanical science
2. Determine effects of loading in static and dynamic engineering systems
3. Analyse properties of materials
4. Determine parameters of a fluid system
5. Use of basic mechanical systems in power transfer

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Use the concept of mechanical science | * Define work, force, mechanical advantage and efficiency * State and explain newton’s laws of motion * Calculation velocity, distance, and acceleration * Conversion and SI units of energy, power and work | * Written tests * Oral questioning * Assignments * Supervised exercises |
| 1. Determine effects of loading in static and dynamic engineering systems | * Explain type of forces * Discussion and analysis of reaction of forces * Calculation of coefficient of friction and inclined plane * Resolve the forces * Calculate the resultant force and equilibrium * Discuss the application of different forces * Calculation of moments of a force, | * Written tests * Oral questioning * Assignments * Supervised exercises |
| 1. Analyse properties of materials | * Definition of mechanical properties of materials * Draw the stress strain graph * Discuss application of material depending on their properties * Discuss effect of environmental factors on material properties. | * Assignments * Oral questioning * Supervised exercises * Written tests |
| 1. Determine parameters of a fluid system | * Discussion of Pascal’s principles * Measuring fluid parameters * State the laws of gases * Discuss properties of water and steam | * Assignments * Oral questioning * Practical tests * Observation * Supervised exercises * Written tests |
| 1. Use of basic mechanical systems in power transfer | * + Uses and working principle of Gear trains   + Uses and working principles of Pulley system, hoists and lifts   + Uses and working principles of screws | * Assignments * Supervised exercises * Written tests * Practical test |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by trainer
* Online video clips
* Power point presentation
* Exercises by trainee

**Recommended Resources**

* Scientific Calculators
* Relevant reference materials
* Stationeries
* Electrical workshop
* Relevant practical materials
* Dice
* Computers with internet connection

# FLUID MECHANICS PRINCIPLES

**UNIT CODE:** ENG/CU/MAR/CC/02/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply fluid mechanics principles

**Duration of Unit: 75** hours

**UNIT DESCRIPTION**

This unit describes the competencies required by a technician in order to apply a wide range of fluid mechanics principles in their work. It includes understanding flow of fluids, demonstrating knowledge in viscous flow, performing dimensional analysis and operating fluid pumps

**Summary of Learning Outcomes**

1. Understand flow of fluids
2. Demonstrate knowledge in viscous flow
3. Perform dimensional analysis
4. Operate fluid pumps

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Understand flow of fluids | * + Flow rate in pipes   + Losses in pipes are determined   + Causes of losses in pipes * Flow losses equations * Bernoulli’s principle | * Written tests * Oral questioning * Assignments * Supervised exercises |
| 1. Demonstrate knowledge in viscous flow | * + Viscous flow between parallel surfaces   + Viscous flow equations between parallel surfaces   + Viscous flow equations in circular pipes * Application of viscous flow equations | * Written tests * Oral questioning * Assignments * Supervised exercises |
| 1. Perform dimensional analysis | * + Dimensional analysis definition   + Principle of dimensional homogeneity   + Fundamental dimensions   + Dimensional units   + Physical quantities * Application of dimensional analysis | * Assignments * Oral questioning * Supervised exercises * Written tests |
| 1. Demonstrate understanding of fluid pumps | * Principle of operation of pumps * Deriving Reciprocating pump equation * Deriving Centrifugal pump equation * Application of Pump equation in problem solving | * Assignments * Oral questioning * Practical tests * Observation * Supervised exercises * Written tests |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by trainer
* Online video clips
* Power point presentation
* Exercises by trainee

**Recommended Resources**

* Scientific Calculators
* Relevant reference materials
* Stationeries
* Relevant practical materials
* Computers with internet connection

# THERMODYNAMICS PRINCIPLES

**UNIT CODE:** ENG/CU/MAR/CC/03/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply thermodynamics principles

**Duration of Unit: 75** hours

**UNIT DESCRIPTION**

This unit describes the competencies required by a technician in order to apply thermodynamics principles in their work. It includes understanding fundamentals of thermodynamics, performing steady flow processes, performing non steady flow processes, understanding perfect gases, generating steam, performing thermodynamics reversibility and entropy, understanding idea gas cycle, demonstrating fuel and combustion, perform heat transfer, understanding heat exchangers, understanding air compressors, understanding gas turbines and understanding of impulse steam turbines

**Summary of Learning Outcomes**

1. Understand fundamentals of thermodynamics
2. Perform steady flow processes
3. Perform non steady flow processes
4. Understand perfect gases
5. Generate steam
6. Perform thermodynamics reversibility and entropy
7. Understand idea gas cycle
8. Demonstrate fuel and combustion
9. Perform heat transfer
10. Understand heat exchangers
11. Understand air compressors
12. Understand gas turbines
13. Understanding impulse steam turbines

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Understand fundamentals of thermodynamics | * + Terms used in thermodynamics   + Thermodynamics processes and cycles * Laws of thermodynamics | * Written tests * Oral questioning * Assignments * Supervised exercises |
| 1. Perform steady flow processes | * + Deriving Steady flow energy equation   + Applying Steady flow energy equation   + Application of Steady flow energy equation in utilities | * Written tests * Oral questioning * Assignments * Supervised exercises |
| 1. Perform non-steady flow processes | * + Deriving non-steady flow energy equation * Application of non-steady flow energy equation in problem solving | * Assignments * Oral questioning * Supervised exercises * Written tests |
| 1. Understand perfect gases | * + State Perfect gas laws   + Carrying out Gas laws experiment * Application of Gas laws | * Assignments * Oral questioning * Supervised exercises * Written tests |
| 1. Generate steam | * + Determining Dryness fraction   + Determining Relationship between pressure and boiling point   + Carrying out Energy balance calculations   + Determining Relationship between temperature and pressure | * Assignments * Oral questioning * Practical tests * Observation * Supervised exercises |
| 1. Perform thermodynamics reversibility and entropy | * + Thermodynamics reversibility principles   + Principles of heat engine   + Second law of thermodynamics and calculations   + Entropy in thermodynamics | * Assignments * Oral questioning * Observation * Supervised exercises |
| 1. Understand idea gas cycle | * + Ideal gas cycle processes   + Air standard efficiency and actual efficiency are differentiated   + Problems are solved in ideal gas cycle | * Assignments * Oral questioning |
| 1. Demonstrate understanding of fuel and combustion | * + Classification of fuels   + Properties of fuels   + Deriving of Combustion equation   + Application of Combustion equation | * Oral questioning * Practical tests * Observation * Supervised exercises |
| 1. Perform heat transfer | * + Modes of heat transfer     - Radiation     - Convection     - Conduction   + Deriving Conduction equation from Fourier’s law   + Heat transfer equation is derived and applied from Newton’s law of cooling and Fourier’s law | * Assignments * Oral questioning |
| 1. Understand heat exchangers | * + Definition of heat exchangers   + Classification of Heat exchangers   + Recuperative heat exchangers are described   + Application of Heat equations | * Assignments * Oral questioning * Practical tests * Observation * Supervised exercises |
| 1. Understand air compressors | * + Classification of Air compressors   + Types of air compressors   + Deriving and applying Equations of reciprocating compressors | * Assignments * Oral questioning * Practical tests * Observation * Supervised exercises |
| 1. Understand gas turbines | * + Theoretical cycle for gas turbines   + Open cycle gas turbine   + Closed cycle gas turbine   + Deriving Gas turbine equations | * Assignments * Oral questioning * Practical tests * Observation * Supervised exercises |
| 1. Understanding impulse steam turbines | * + Principles of operations of the impulse steam turbines   + Deriving and applying Impulse steam turbine equation | * Assignments * Oral questioning * Practical tests * Observation * Supervised exercises |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by trainer
* Online video clips
* Power point presentation
* Exercises by trainee

**Recommended Resources**

* Scientific Calculators
* Relevant reference materials
* Stationeries
* Relevant practical materials
* Dice
* Computers with internet connection

# SHIP CONSTRUCTION PRINCIPLES

**UNIT CODE:** ENG/CU/MAR/CC/04/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply ship construction principles

**Duration of Unit:** 150 hours

**Unit Description**

This unit describes competencies required to apply ship construction principles. It involves categorising ship types, interpreting ship drawings, identifying ship construction materials, monitoring stress effects induced on ship structures, assesing conditions of ship principle structural members, loading a ship and carrying out elementary ship yard practices

**Summary of Learning Outcomes**

1. Categorize ship types
2. Interpret ship drawings
3. Identify ship construction materials
4. Monitor stress effects induced on ships
5. Assess conditions of ship principle structural members
6. Load a ship
7. Carry out elementary ship yard practices

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Categorize ship types | * Ship categorization * Ship functions/purposes * Ship cargo types | * Written tests * Oral * Practical/Projects |
| 1. Interpret ship drawings | * General arrangement drawings * Sectional drawings * Plumbing and pipe work drawings and colour coding * Electrical drawings * Machineries drawings | * Written tests * Oral * Practical/Projects |
| 1. Identify ship construction materials | * Materials used in ship construction   + Types of materials   + Properties of materials * Use of forged, rolled and cast components in hull construction * Applicable standards for materials used in ship construction | * Written tests * Oral * Practical/Projects |
| 1. Monitor stress effects induced on ships | * Terminologies * Forces acting on ships * Analysis of forces acting on ships * Stresses induced on hull components * Sketch diagrams   + Bending moment   + Shear force curves   + Weight   + Load | * Written tests * Oral * Practical/Projects |
| 1. Assess conditions of ship principle structural members | * Ship principle structural members   + Hull structures   + Bow and stern structures   + Fittings   + Rudders, propellers and shafts   + Superstructure | * Written tests * Oral * Practical/Projects |
| 1. Load a ship | * Cargo plan review * Identification of ship’s load capacity and load chart * Loading procedure and processes   + Preparation   + Supervision | * Written tests * Oral * Practical/Projects |
| 1. Carry out elementary ship yard practices | * Ship inspection procedure and processes * Preparation of work schedules * Preparation of ship docking plan * Vessel docking and undocking * Surface preparation and painting * Welding practices * Ship husbandry   + Standard shore power supply   + Standard water and fuel supply   + Ship cleaning | * Written tests * Oral * Practical/Projects |

**Suggested Delivery Methods**

* Demonstration by trainer
* Practical work by trainee
* Demonstration videos
* Projects
* Group discussions

**Recommended Resources**

**Tools and equipment**

* Ship loading equipment
* Welding equipment
* Painting equipment
* Maintenance tools and equipment
* Computers

**Materials and supplies**

* Ship drawings
* Ship docking plans
* Ship loading plans
* Cargo plans
* Ship construction materials
* Ship construction standards

**Personal protective equipment (PPEs)**

* Helmet
* Dust coat
* Safety boots
* Goggles
* Dust mask
* Reflective jacket
* Gloves

# SHIP STABILITY

**UNIT CODE:** ENG/CU/MAR/CC/05/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Monitor and Evaluate ship stability

**Duration of Unit:** 120 hours

**Unit Description**

This unit describes competencies required to monitor and evaluate ship stability. It involves monitoring hydrostatic data variation, demonstrating knowledge on buoyancy, applying fresh water allowance principles, applying statistical data, determining angle of loll, determining movement of a ships centre of gravity and maintaining ship stresses within permissible limits

**Summary of Learning Outcomes**

1. Monitor hydrostatic variation
2. Demonstrate knowledge on ship buoyancy
3. Apply fresh water allowance principles
4. Apply statistical data
5. Determine angle of loll
6. Determine movement of a ship’s centre of gravity
7. Maintain ship stresses within permissible limits
8. Apply damage control principles

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Monitor hydrostatic variation | * Principles of hydrostatic variation * Hydrostatic variation tests * Hydrostatic variation analysis * Tools, equipment and materials used in monitoring hydrostatic variation | * Written tests * Oral * Practical/Projects |
| 1. Demonstrate knowledge on ship buoyancy | * Principles of buoyancy * Factors affecting buoyancy * Apparent weight calculations * Relative density calculations | * Written tests * Oral * Practical/Projects |
| 1. Apply fresh water allowance principles | * Draft measurement   + Vessel draft in sea water   + Vessel draft in fresh water * Measurement of fresh water allowance | * Written tests * Oral * Practical/Projects |
| 1. Determine angle of loll | * Definition of angle of loll * Vessel equilibrium condition checks * Metacentric heights   + Negative   + Positive * Corrective measures   + Lowering center of gravity   + Minimising free surfaces   + Ballast tanks   + Flooding and counter flooding   + Load balancing | * Written tests * Oral * Practical/Projects |
| 1. Determine movement of a ship’s centre of gravity | * Forces affecting ship’s center of gravity   + Identification   + Analysis * Mass analysis   + Effects of removing or discharging   + Effects of loading or adding * Weight shifts   + Horizontal   + Vertical * Application of movement of ship’s center of gravity calculation formulae | * Written tests * Oral * Practical/Projects |
| 1. Maintain ship stresses within permissible limits | * Identification of stresses affecting ship stability * Analysis of stresses affecting ship stability * Permissible stress limits * Stress monitoring and maintenance | * Written tests * Oral * Practical/Projects |
| 1. Apply damage control principles | * Damage control principles * Damage control organisations   + Shoring party   + Leak stop party   + Flooding and counter flooding party   + Containment party   + First Aid party * Damage control tools and equipment * Damage control plan * Damage control drills | * Written tests * Oral * Practical/Projects |

**Suggested Delivery Methods**

* Demonstration by trainer
* Practical work by trainee
* Demonstration videos
* Projects
* Group discussions

**Recommended Resources**

**Tools and equipment**

* Damage control tools and equipment
* Design tools

**Materials and supplies**

* Relevant manuals
* Stationery

**Personal protective equipment (PPEs)**

* Helmet
* Dust coat
* Safety boots
* Goggles
* Dust mask
* Reflective jacket
* Gloves

# ELECTRICAL PRINCIPLES

**UNIT CODE:** ENG/CU/MAR/CC/06/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply Electrical principles skills

**Duration of Unit:** 150 hours

**Unit Description**

This unit describes the competencies required by a technician in order to apply a wide range of Electrical principles in their work. Which includes; Use of the concept of basic Electrical quantities, use of the concepts of D.C and A.C circuits in electrical installation, use of basic electrical machine, use of power factor in electrical installation, use of earthing in Electrical installations, apply lightning protection measures, apply Electromagnetic field theory , apply Electrodynamics, apply Energy and momentum in Electromagnetic field, apply Transient in Electrical circuit analysis, use two port network, Demonstrate understanding of Refrigeration and Air conditioning

**Summary of Learning Outcomes**

1. Use the concept of basic Electrical quantities
2. Use the concepts of D.C and A.C circuits in electrical installation
3. Use of basic electrical machine
4. Use of power factor in electrical installation
5. Use of earthing in Electrical installations
6. Apply lightning protection measures
7. Apply Electromagnetic field theory
8. Apply Electrodynamics
9. Apply Energy and momentum in Electromagnetic field
10. Apply Transient in Electrical circuit analysis
11. Use two port network
12. Demonstrate understanding of Refrigeration and Air conditioning

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + 1. Use the concept of basic Electrical quantities | * The meaning of SI unit * SI unit of various types of Electrical parameters * Ohm’s law * Capacitors and inductors * Calculations involving various Electrical parameters e.g. Power, Current, Voltage, Resistance * Instruments used in measuring various types of Electrical parameters | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * + 1. Use the concepts of D.C and A.C circuits in electrical installation | * Meaning of terms * AC and DC, parallel and series circuits * AC and DC networks * R-L-C transients * AC to DC and DC to AC Conversion * Basic solar photovoltaic systems * Delta star conversion * Definition of power factor * Power triangle * Power factor correction | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * + 1. Use Two Port networks | * + Meaning passive networks   + Types of Passive network   + Characteristic impedance in T & pie networks   + Design of T & pie networks   + Transmission lines   + ABCD Constants * Network in cascade | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * + 1. Use of basic electrical machine | * Types of Electrical machines * DC machines, * AC Single and three phase motors, generators and Transformers * Application of AC and DC machines * Special machines and their Applications | * Assignments * Oral questioning * Supervised exercises * Written tests * Practical tests |
| * + 1. Use of earthing in Electrical installations | * + Definition of terms in earthing   + Earthing points in Electrical installation   + Types of earthing systems   + Factors to consider in selecting an earthing method   + Testing an earthing system | * Assignments * Supervised exercises * Written tests * Practical test |
| * + 1. Apply electrical system protection | * + Electrical faults and abnormal conditions   + Components of protection systems   + Protective devices   + Testing of protection systems   + Coordination of protection systems | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * + 1. Apply Electromagnetic field Theory | * + Introduction to magnetism   + Meaning of Electromagnetic Field Theory   + Sources of Electromagnetic Fields   + Detectors of Electromagnetic radiation   + Application of Electromagnetic waves   + Electromagnetics Laws * Faraday’s Law * Lenz’s law * Fleming’s Laws * Properties and Effects of Electromagnetic waves * Wave Characteristics and Shielding * Skin Effect   + Energy conservation theorem: * Poyntings’ Theorem * Momentum Energy Flow * Electromagnetic Energy flow | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * + 1. Apply Electrodynamics | * + Meaning of Electrostatics   + Identification of Electrostatic terms and their meaning   + Meaning of terms in magnetostatics   + Electrodynamics laws | * Assignments * Oral questioning * Supervised exercises * Written tests |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by trainer
* Exercises by trainee

**Recommended Resources**

* Scientific Calculators
* Relevant reference materials
* Stationeries
* Electrical workshop
* Electrical machines
* Relevant practical materials
* Computers with internet connection

# ENGINEERING MATHEMATICS

**UNIT CODE:** ENG/CU/MAR/CC/07/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **Apply engineering mathematics**

Duration of Unit: 150 hours

**Unit Description**

This unit describes the competencies required by a Marine engineering technician to apply a wide range of Engineering mathematics in their work. This includes applying algebraic functions, trigonometry and hyperbolic functions, complex numbers, coordinate geometry, binomial expansion, calculus, ordinary differential equations, Laplace transforms, power series, Statistics, Fourier series, vector theory, matrix, numerical methods, probability, commercial calculations, estimations and measurements in solving problems

**Summary of Learning Outcomes**

1. Apply Algebra
2. Apply Trigonometry and hyperbolic functions
3. Apply complex numbers
4. Apply Coordinate Geometry
5. Carry out Binomial Expansion
6. Apply Calculus
7. Solve Ordinary differential equations
8. Apply Laplace transforms
9. Apply Power Series
10. Apply Statistics
11. Apply Fourier Series
12. Apply Vector theory
13. Apply Matrix
14. Apply Numerical methods
15. Apply concept of probability for work
16. Perform commercial calculations
17. Perform Estimations, Measurements and calculations of quantities

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Electrical Curriculum** | | |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * 1. Apply Algebra | * Base and Index * Law of indices * Indicial equations * Laws of logarithm * Logarithmic equations * Conversion of bases * Use of calculator * Reduction of equations * Solution of equations reduced to quadratic form * Solutions of simultaneous linear equations in three unknowns * Solutions of problems involving AP and GP | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * 1. Apply Trigonometry and hyperbolic functions | * Half -angle formula * Factor formula * Trigonometric functions * Parametric equations * Relative and absolute measures * Measures calculation * Meaning of hyperbolic equations * Properties of hyperbolic functions * Evaluations of hyperbolic functions Hyperbolic identities * Osborne’s Rule * Ashx+bshx=C equation * One-to-one relationship in functions * Inverse functions for one-to-one relationship * Inverse functions for trigonometric functions * Graph of inverse functions * Inverse hyperbolic functions | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * 1. Apply complex numbers | * Meaning of complex numbers * Stating complex numbers in numbers in terms of conjugate argument and * Modulus * Representation of complex numbers on the Argand diagram * Arithmetic operation of complex numbers * Application of De Moivre’s theorem * Application of complex numbers to engineering | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * 1. Apply Coordinate Geometry | * Polar equations * Cartesian equation * Graphs of polar equations * Normal and tangents * Definition of a point * Locus of a point in relation to a circle * Loci of points for given mechanism | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * 1. Carry out Binomial Expansion | * Binomial theorem in determination of Roots of numbers * Estimation of errors of small changes using binomial theorem. * Binomial Expansion in   deriving power series | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * 1. Apply Calculus | * Meaning of derivatives of a function * Differentiation from first principle i.e sin x, cos x, xn and ln x * Tables of some common derivatives * Rules of differentiation i.e. product, chain, quotient, sum, implicit * Rate of change and small change * Derivative of inverse functions * Stationery points of functions of two variables * Meaning of integration * Indefinite and definite integral * Methods of integration, application of integration i.e., Integration by parts, Substitution, polynomials, inverse functions * Integrals of hyperbolic and inverse functions | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * 1. Solve Ordinary differential equations | * Types of first order differential equations * Linear Differential Equations * Homogeneous Equations * Exact Equations * Separable Equations * Integrating Factor * Formation of first order differential equation * Solution of first order differential equations * Application of first order differential equations * Formation of second order differential equations for various systems * Solution of second order differential equations * Application of second order differential equations | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * 1. Apply Laplace transforms | * Meaning of Laplace transforms * Deriving Laplace transforms from first principles * State properties of Laplace transform * Determination of inverse LT of simple transforms and partial fractions * Solution of differential equation by LT * Solution of simultaneous differential equation by given initial conditions | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * 1. Apply Power Series | * Meaning of the term power series * Taylor’s theorem * Deduction of Maclaurin’s theorem to obtain power series * Application of Taylor’s theorem and Maclaurin’s theorems in numerical work | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * 1. Apply Statistics | * Classification of data * Grouped data * Ungrouped data * Data collection * Importance of sampling * Errors in sampling * Types of sampling and their limitations * Tabulation of data   + Class intervals   + Class boundaries   + Frequency tables   + Cumulative frequency * Diagrammatic and graphical presentation of data e.g.   + Histograms   + Frequency polygons   + Bar charts   + Pie charts   + Curves * Measures of central tendency (mean, mode and median) * Measures of dispersion * Variance and standard deviation | * Assignments * Oral questioning * Supervised exercises * Written tests * Simulation * Data modelling |
| * 1. Apply Fourier Series | * Determination of the Fourier series as a periodic function of the period 2π and extend to π * Determination of Fourier series of non-periodic functions over a given range * Determination of Fourier series for even and odd functions and the half-range series for a given function * Determination of Fourier series over any range | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * 1. Apply Vector theory | * Definition of dot and cross product of vectors * Solution of problems involving dot and cross production of cross * Definition of operators * Definition of vector field * Solutions of problems involving vector fields * Definition of Gradient, Divergence and curl * Solutions of involving Gradient, Divergence and curl * Application of vectors * Green’s, Gauss’s and Stoke’s theorem and their application | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * 1. Apply Matrix methods | * Matrix operation * Determinant of 3x3 matrix * Inverse of 3x3 matrix * Solutions of linear simultaneous equations in three unknowns * Calculations of Eigen values and Eigen vectors * Application of matrices | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * 1. Apply Numerical methods | * Meaning of interpolation and extrapolation * Application of interpolation * Application of interactive methods to solve equations * Application of interactive methods to areas and volumes | * Assignments * Oral questioning * Supervised exercises * Written tests |
| 1. Apply concepts of probability in work | * Probability * Laws of probability * Expectation variance and S.D. * Types of distributions * Mean, variance and S.D of probability distributions   + Types of probability events * Dependent * Independent * Mutually exclusive   + Counting techniques * Permutation * Combination * Tree diagrams * Venn diagrams   + Application of probability distributions | * Assignments * Oral questioning * Supervised exercises * Written tests |
| 1. Perform commercial calculations | * + Product pricing   + Average sales determination   + Stock turnover   + Calculation of incomes   + Profit and loss calculations   + Salaries * Gross * Net   + Wages * Time rate * Flat rate * Overtime * Piece rate * Commission * Percentage * Bonus   + Conversion of one currency to another   + Exchange rates calculation * Devaluation * Revaluation | * Oral questioning * Written tests * Assignments * Supervised exercises |
| 1. Perform estimations, measurements and calculations of quantities | * Units of measurements and their symbols * Conversion of units of measurement * Calculation of length, width, height, perimeter, area and angles of figures * Measuring tools and equipment * Measurements and estimations of quantities e.g., Areas and volumes using Pappus theorem | * Assignments * Oral questioning * Practical tests * Observation * Supervised exercises * Written tests |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by trainer
* Exercises by trainee

**Recommended Resources**

* Scientific Calculators
* Rulers, pencils, erasers
* Charts with presentations of data
* Graph books
* Dice
* Computers with internet connection
* Standard mathematical tables

# SEA SURVIVAL SKILLS

**UNIT CODE:** ENG/CU/MAR/CC/08/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Demonstrate basic sea survival skills

**Duration of Unit:** 100 hours

**Unit Description**

This unit covers the competencies required to effectively demonstrate basic sea survival skills. It entails identifying and being able to utilize lifesaving equipment such as life boat, life jacket, and emergency communication devices such as EPIRB, SART, and being able to swim a minimum of 25 metres.

**Summary of Learning Outcomes**

1. Demonstrate ability to swim
2. Understand the SOLAS convention
3. Identify lifesaving equipment
4. Identify emergency signalling devices
5. Use lifesaving and emergency signalling equipment
6. Apply proper storage and maintenance of life saving equipment

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply first aid techniques | * ABCs of first aid * CPR process * First aid procedures   + Electric shock   + Choking   + Drowning   + Burns   + Bone fracture   + Ingestion of hazardous substances   + Extreme temperatures | * Written tests * Oral * Practical/Projects |
| 1. Demonstrate ability to swim | * Swimming strokes   + Freestyle   + Breast stroke   + Back stroke * Water treading | * Written tests * Oral * Practical/Projects |
| 1. Understand the SOLAS Convention | * International Convention for the Safety of Life at Sea (SOLAS) * International Ship and Port Facility Security (ISPS) * Maritime Security (MARSEC) * International Life Saving Appliance Code (LSA) | * Written tests * Oral * Practical/Projects |
| 1. Identify lifesaving equipment | * Lifesaving equipment * Lifesaving crafts | * Written tests * Oral * Practical/Projects |
| 1. Identify emergency signaling devices | * Emergency signalling devices | * Written tests * Oral * Practical/Projects |
| 1. Use lifesaving and emergency signaling equipment | * Use of lifesaving equipment * Use of emergency signalling equipment | * Written tests * Oral * Practical/Projects |
| 1. Apply proper storage and maintenance of life saving equipment | * Lifesaving equipment level 1 checks * Lifesaving equipment maintenance | * Written tests * Oral * Practical/Projects |

**Suggested Delivery Methods**

* Demonstration by trainer
* Practical work by trainee
* Demonstration videos
* Projects
* Group discussions

**Recommended Resources**

**Tools and equipment**

* Lifesaving equipment
* Emergency signalling services
* Communication equipment

**Materials and supplies**

* SOLAS, ISPS, LSA Manuals
* Stationery
* First Aid Supplies

**Personal protective equipment (PPEs)**

* Helmet
* Dust coat
* Safety boots
* Goggles
* Dust mask
* Reflective jacket
* Gloves

# CORE UNITS OF LEARNING

# VESSEL HULL AND SUPERSTRUCTURE SURVEY

**UNIT CODE:** ENG/CU/MAR/CR/01/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Survey hull and superstructure of a vessel

**Duration of Unit:** 120 hours

**Unit Description**

This unit describes competencies required to survey hull and superstructure of a vessel. It involves idenitfying deck numbering, compartments and location markings, planning and preparing for survey tasks, identifying hull type and material construction, conducting periodic survey of hull and superstructure and assessing non-compliance

**Summary of Learning Outcomes**

1. Identify deck numbering and location markings
2. Plan and prepare for survey task
3. Identify hull type and construction materials
4. Conduct periodic survey of hull and superstructure
5. Assess non-compliance and remedies

**Learning Outcomes, Content and Suggested Assessment Methods**

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| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify deck numbering and location markings | * Deck identification * Ship markings and colour codes | * Written tests * Oral * Practical/Projects |
| 1. Plan and prepare for survey task | * Vessel survey types and applications   + Initial acceptance   + Periodic   + Condition monitoring   + Post maintenance   + Breakdown * Survey methods   + Ultrasonic   + X-Ray   + Dye penetrant inspection test   + Magnetic particle inspection   + Dimension measurement * Rules for classification of ships * Hull and superstructure operation standards * Report writing | * Written tests * Oral * Practical/Projects |
| 1. Identify hull type and construction materials | * Types of hull   + Displacement   + Planning * Hull construction materials * Hull construction regulations | * Written tests * Oral * Practical/Projects |
| 1. Conduct periodic survey of hull and superstructure | * Ship surveying procedures * Hull protection | * Written tests * Oral * Practical/Projects |
| 1. Assess non-compliance and remedies | * Compliance criteria for hull and superstructure * Reporting non-compliance * Preparation of non-compliance assessment reports | * Written tests * Oral * Practical/Projects |

**Suggested Delivery Methods**

* Demonstration by trainer
* Practical work by trainee
* Demonstration videos
* Projects
* Group discussions

**Recommended Resources**

* Standards and regulations of ship construction
* Hull survey manuals
* Hull survey tools and equipment
* Detailed ship architectural drawings
* Ship construction materials

**Personal protective equipment (PPEs)**

* Helmet
* Dust coat
* Safety boots
* Goggles
* Dust mask
* Reflective jacket
* Gloves

# VESSEL OPERATIONAL SYSTEMS SURVEY

**UNIT CODE:** ENG/CU/MAR/CR/02/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Survey vessel operational systems

**Duration of Unit: 120 hours**

**Unit Description**

This unit describes competencies required to identify ship operational systems, idenitifying survey requirements, preparing for survey, conducting periodic survey of operational systems and assessing non-compliance

**Summary of Learning Outcomes**

1. Identify ship operational systems
2. Identify survey requirements
3. Prepare for survey
4. Conduct survey of operational systems
5. Assess non-compliance

**Learning Outcomes, Content and Suggested Assessment Methods**

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| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify ship operational systems | * Main operational systems   + Main engines   + Gearbox   + Engine oil coolers   + Heat exchangers   + Separators   + Air coolers   + Preheat systems   + Gas turbines   + Propeller and shafts * Auxiliary operational systems   + Generators   + Steering system   + Stabilizers   + Reverse osmosis plant   + Sewage treatment plant   + Firefighting system   + Air conditioning units   + Refrigeration   + Bow thrust system   + Slow speed drive * Working principles of main and auxiliary systems * Diagnosis of main and auxiliary operational system faults * Repair of main and auxiliary operational system faults | * Written tests * Oral * Practical/Projects |
| 1. Identify survey requirements | * Role of surveyors * Legal obligations * Survey objectives   + Periodic   + Preventive   + Breakdown   + Initial acceptance   + Condition based monitoring * Survey tools, equipment and operational system requirements * Survey plan * Operational requirements checklist | * Written tests * Oral * Practical/Projects |
| 1. Prepare for survey | * Handover notes * Maintenance records | * Written tests * Oral * Practical/Projects |
| 1. Conduct survey of operational systems | * Operational systems survey and legal obligations * Survey scheduling for operational systems * Report writing | * Written tests * Oral * Practical/Projects |
| 1. Assess non-compliance | * Compliance criteria for main and auxiliary operational systems * Reporting non-compliance * Preparation of non-compliance assessment reports | * Written tests * Oral * Practical/Projects |

**Suggested Delivery Methods**

* Demonstration by trainer
* Practical work by trainee
* Demonstration videos
* Projects
* Group discussions

**Recommended Resources**

* Stationery
* Survey tools and equipment

**Personal protective equipment (PPEs)**

* Helmet
* Dust coat
* Safety boots
* Goggles
* Dust mask
* Reflective jacket
* Gloves

# ENGINEERING DRAWINGS

**UNIT CODE:** ENG/CU/MAR/CR/03/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: prepare and interpret engineering drawings

**Duration of Unit: 100 hours**

**Unit Description**

This unit describes competencies required to prepare and interpret engineering drawings. It involves preparing cam followers and profile drawings, sketching and labelling screw threads, identifying machine bearings, drawing gear profiles, interpreting limits and fits, interpreting palnt layout design, electrical plans and diagrams, applying computer aided design packages and producing 3D drawings and animation

**Summary of Learning Outcomes**

1. Prepare cam followers and profile drawings
2. Sketch and label screw threads
3. Identify machine bearings
4. Draw gear profiles
5. Interpret limits and fits
6. Interpret marine plant layout design
7. Prepare and interpret electrical drawings
8. Apply computer aided design packages
9. Produce 3D drawings and animation

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Prepare cam followers and profile drawings | * Types of curves   + Basic   + Modified Cam   + Polynomial and Fourier series * Geometry of planer cam followers   + Free hand cam sketching   + Cam technical drawing techniques * Cam manufacturing, materials and lubrication * Cam system modelling, dynamics and special cam mechanisms | * Written tests * Oral * Practical/Projects |
| 1. Sketch and label screw threads | * Screw threads and types   + Parts of screws   + Dimensions of screws * Screw thread measurement and equipment used * Screw thread geometry | * Written tests * Oral * Practical/Projects |
| 1. Identify machine bearings | * Machine bearings and types * Bearing codes and their meaning   + Numbering and sizes of bearings * Bearing type and application   + Operation conditions | * Written tests * Oral * Practical/Projects |
| 1. Draw gear profiles | * Types of gears * Gear nomenclature * Gear geometry   + Free hand sketching   + Computer Aided Drawing | * Written tests * Oral * Practical/Projects |
| 1. Interpret limits and fits | * Definition of terms   + Limits and fits * Importance of limits and fits * Application of limits and fits * Limits and fits table   + Calculations | * Written tests * Oral * Practical/Projects |
| 1. Interpret marine plant layout design | * Types of marine plant   + Purpose of marine plant * Schematic drawings and symbols | * Written tests * Oral * Practical/Projects |
| 1. Prepare and interpret electrical drawings | * Electrical symbols   + Resistor   + Capacitors   + Inductors   + Transformers   + Antennae   + Semi-conductor diodes   + Bipolar junction transistor   + Field effect transistor   + Thyristors   + Motors   + Generators   + Motor winding * Electrical drawings   + Electrical plans   + Electrical diagrams     - One-line diagram     - Panel wiring diagram     - Instrument wiring diagram     - Interconnection diagram     - Ladder diagram | * Written tests * Oral * Practical/Projects |
| 1. Apply computer aided design packages | * Measurements   + Area   + Length   + Width * Line work   + Polylines   + Arcs * Scaling of drawings * Interpretation of 3D drawings and animation | * Written tests * Oral * Practical/Projects |

**Suggested Delivery Methods**

* Demonstration by trainer
* Practical work by trainee
* Demonstration videos
* Projects
* Group discussions

**Recommended Resources**

* Drawing papers
* Drawing tables
* Drawing studio
* Drawing tools and equipment
* AutoCAD software
* Computers
* Solid works software
* Animation software
* Stationery
* Machinery and components

**Personal protective equipment (PPEs)**

* Helmet
* Dust coat
* Safety boots
* Goggles
* Dust mask
* Reflective jacket
* Gloves

# MARINE PUMPS INSTALLATION AND MAINTENANCE

**UNIT CODE:** ENG/CU/MAR/CR/04/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Install and maintain marine pumps

**Duration of Unit: 200 hours**

**Unit Description**

This unit describes competencies required to install and maintain marine pumps. It involves identifying constructional features and operating principles of pumps and pump types, installing marine pumps, diagnosing marine pump faults, maintaining marine pumps, preparing spare parts list and special maintenance tools, preparing work schedules and preparing work reports

**Summary of Learning Outcomes**

1. Identify constructional features and operating principles of pumps and pump types
2. Install marine pumps
3. Diagnose marine pump faults
4. Maintain marine pumps
5. Prepare spare parts list and special maintenance tools
6. Prepare work schedule and methodology

**Learning Outcomes, Content and Suggested Assessment Methods**

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| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify constructional features and operating principles of pumps and pump types | * Definition of terms * Pumps and pump types   + Reciprocating pumps   + Gear pumps   + Screw pump   + Centrifugal pump   + Diaphragm pump * Operating principles and application of pumps * Parts of pumps and their functions * Pump specifications   + Head   + Flow rate   + Operating conditions * Functions of pumps   + Bilge pumps   + Sludge pumps   + Sewage pumps   + Sea water pumps   + Fuel pumps   + Oil pumps | * Written tests * Oral * Practical/Projects |
| 1. Install marine pumps | * Mounting of a pump * Pump installation requirements and procedures | * Written tests * Oral * Practical/Projects |
| 1. Diagnose marine pump faults | * Pump common faults, diagnosis and remedies | * Written tests * Oral * Practical/Projects |
| 1. Maintain marine pumps | * Marine pump maintenance procedures * Types of maintenance   + Preventive maintenance   + Breakdown   + Routine * Assembly and disassembly of pumps | * Written tests * Oral * Practical/Projects |
| 1. Prepare spare parts list and special maintenance tools | * Spare parts acquisition procedures | * Written tests * Oral * Practical/Projects |
| 1. Prepare work schedule and methodology | * Preparation of maintenance/work schedule checklist | * Written tests * Oral * Practical/Projects |

**Suggested Delivery Methods**

* Demonstration by trainer
* Practical work by trainee
* Demonstration videos
* Projects
* Group discussions

**Recommended Resources**

* Pumps
* Sectioned pumps
* Pumps survey and maintenance manuals
* Pumps inspection and maintenance tools
* Detailed pump engineering drawings and parts list
* Stationery

**Personal protective equipment (PPEs)**

* Helmet
* Overall
* Safety boots
* Goggles
* Dust mask
* Reflective jacket
* Gloves

# AIR COMPRESSOR INSTALLATION AND MAINTENANCE

**UNIT CODE:** ENG/CU/MAR/CR/05/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Install and maintain air compressors

**Duration of Unit: 200 hours**

**Unit Description**

This unit describes competencies required to install and maintain air compressors. It involves identifying operating principles of air compressors, identifying common failures of air compressors and remedies, identifying air compressor maintenance procedures, preparing spare parts list and special maintenance tools, installing air compressors, preparing work schedule and preparing work reports

**Summary of Learning Outcomes**

1. Identify operating principles of air compressors
2. Identify air compressor maintenance procedures
3. Prepare spare parts list and special maintenance tools
4. Install air compressors
5. Prepare work schedule and methodology
6. Prepare work reports

**Learning Outcomes, Content and Suggested Assessment Methods**

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| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify operating principles of air compressors | * Definition of terms * Compressors and compressor types   + Centrifugal   + Reciprocating   + Rotary screw   + Rotary vane * Parts of a compressor * Operating principles and theories of compressors * Functions of major components of compressors * Compressor specifications   + Condition monitoring parameters and limits | * Written tests * Oral * Practical/Projects |
| 1. Identify air compressor maintenance procedures | * Common faults, diagnosis and remedies of air compressors * Maintenance procedures for common faults in air compressors | * Written tests * Oral * Practical/Projects |
| 1. Prepare spare parts list and special maintenance tools | * Spare parts and consumables acquisition procedures * Special maintenance tools | * Written tests * Oral * Practical/Projects |
| 1. Install and operate air compressors | * Air compressor installation procedure   + Mounting air compressors   + Operation of air compressors * Installation requirements and procedures   + Tools   + Location   + Power requirement | * Written tests * Oral * Practical/Projects |
| 1. Prepare work schedule and methodology | * Preparation of maintenance checklist | * Written tests * Oral * Practical/Projects |
| 1. Prepare work reports | * Report writing | * Written tests * Oral * Practical/Projects |

**Suggested Delivery Methods**

* Demonstration by trainer
* Practical work by trainee
* Demonstration videos
* Projects
* Group discussions

**Recommended Resources**

* Air compressors
* Stationery
* Detailed engineering drawings
* Compressor operation and maintenance manuals
* Maintenance tools and equipment
* Spare parts

**Personal protective equipment (PPEs)**

* Helmet
* Dust coat
* Safety boots
* Goggles
* Dust mask
* Reflective jacket
* Gloves

# MARINE ENGINE WORKS

**UNIT CODE:** ENG/CU/MAR/CR/06/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Perform marine engine works

**Duration of Unit: 180 hours**

**Unit Description**

This unit describes competencies required to perform marine engine works. It involves identifying operating principles of engines, identifying common failures of engines and remedies, carrying out engine maintenance and repair, performing engine overhaul, preparing work schedule/maintenance plan and preparing work reports.

**Summary of Learning Outcomes**

1. Identify operating principles, common faults and remedies of engines
2. Carry out engine maintenance and repair
3. Perform engine overhaul
4. Prepare work schedule/maintenance plan and methodology
5. Prepare work reports

**Learning Outcomes, Content and Suggested Assessment Methods**

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| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify operating principles, common faults and remedies of engines | * Definition of terms * Engines and types of engines   + Diesel   + Gas turbines   + Gas (LPG)   + Electrical (hybrid)   + Petrol engines   + Diesel On electric (DOE)   + Diesel On gas turbine (DOGT)   + Diesel On Diesel   + Two stroke engines   + Four stroke engines * Operating principles and theories of engines * Components of engines and their functions * Engine specifications   + Condition monitoring parameters and their limits * Common engine failures and their remedies | * Written tests * Oral * Practical/Projects |
| 1. Carry out engine maintenance and repair | * Types of diagnostic tests   + Observing parameters   + Remote control system (RCS) * Maintenance of lubrication, fuel and cooling systems * Spare parts acquisition and replacement procedures * Engine maintenance procedures * Report writing | * Written tests * Oral * Practical/Projects |
| 1. Perform engine overhaul | * Definition of terms   + Overhaul   + Overhaul kit * Types of engine overhaul and requirements   + Top overhaul   + Major overhaul * Importance of servicing engine components | * Written tests * Oral * Practical/Projects |
| 1. Prepare work schedule/maintenance plan and methodology | * Preparation of work schedule/maintenance checklist | * Written tests * Oral * Practical/Projects |
| 1. Prepare work reports | * Report writing | * Written tests * Oral * Practical/Projects |

**Suggested Delivery Methods**

* Demonstration by trainer
* Practical work by trainee
* Demonstration videos
* Projects
* Group discussions

**Recommended Resources**

* Marine engine
* Engine cross section
* Lifting equipment
* Engine operation and maintenance manuals
* Stationery
* Maintenance tools and equipment

**Personal protective equipment (PPEs)**

* Helmet
* Dust coat
* Safety boots
* Goggles
* Dust mask
* Reflective jacket
* Gloves

# MARINE ELECTRICAL AND ELECTRONIC SYSTEM OPERATION

**UNIT CODE:** ENG/CU/MAR/CR/07/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Operate marine electrical and electronic systems

**Duration of Unit: 220 hours**

**Unit Description**

This unit describes competencies required to operate marine electrical and electronic systems. It involves monitoring AC generator operating conditions, monitor DC power, installing and testing transformers, operating shipboard power, installing and testing 3 phase motors, installing and operating DC motors, operating and maintaining electrical protection systems, monitoring high voltage installation performance, carrying out electrical components and equipment repair, preparing spare parts list and special maintenance tools, preparing work schedule/maintenance plan and preparing work reports

**Summary of Learning Outcomes**

1. Monitor AC generator operating conditions
2. Monitor DC power operating conditions
3. Install and test transformers
4. Operate shipboard power distribution systems
5. Install and operate AC motors
6. Install and operate DC motors
7. Operate and maintain electrical protection system
8. Monitor medium voltage installation performance
9. Carry out electrical components and equipment repair
10. Prepare spare parts list and special maintenance tools
11. Prepare work schedule/maintenance plan and work methodology
12. Prepare work reports

**Learning Outcomes, Content and Suggested Assessment Methods**

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| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Monitor AC generator operating conditions | * Generator starting systems   + Pneumatic   + Electric motor   + Hydraulic   + Hand starting * Voltage regulation * Types of generators, construction and operating principles of generators * Specifications of generators | * Written tests * Oral * Practical/Projects |
| 1. Monitor DC power operating conditions | * Types of DC power, construction and their parameters * Types of faults, causes and remedies   + Open circuit   + Short circuit   + Overload | * Written tests * Oral * Practical/Projects |
| 1. Install and test transformers | * Definition of terms * Types of transformers and their functions * Transformer tests   + Winding resistance test   + Transformer ratio test   + Open circuit test   + Short circuit test   + Insulation resistance   + Dielectric test * Transformer installation requirements and procedures * Methods of transformer cooling | * Written tests * Oral * Practical/Projects |
| 1. Operate shipboard power distribution systems | * Parallel operation of generators   + Conditions for parallel operation of generators * Methods of synchronising generators   + Synchro scope method   + Three lamp method * Types of isolators and relays * Electrical power distribution | * Written tests * Oral * Practical/Projects |
| 1. Install and operate AC motors | * Types and internal construction of motors   + Wiring diagram * Methods of starting, running and stopping AC motors * Control circuits for AC motors * Delta Y conversion * Types of AC motor tests   + Mega tests   + Insulation testing   + Winding resistance test   + Rotation test * Best practices in motor installation | * Written tests * Oral * Practical/Projects |
| 1. Install and operate DC motors | * Types and internal construction of motors   + Wiring diagram * Methods of starting, running and stopping DC motors * Control circuits for DC motors * Types of DC motor tests   + Mega tests   + Insulation testing   + Winding resistance test   + Rotation test * Best practices in motor installation | * Written tests * Oral * Practical/Projects |
| 1. Operate and maintain electrical protection systems | * Types of earthing   + Fault loop impedance   + Earth electrode resistance   + Polarity test * Electrical protection systems and their working principles   + Short circuit protection   + Overload protection   + Under and over frequency   + Phase sequence failure protection | * Written tests * Oral * Practical/Projects |
| 1. Monitor medium voltage installation performance | * Power transformers operating conditions and parameters   + Transformer efficiency   + Transformer cooling   + Voltage drop and regulation   + Parallel operation of transformers * Protection control and monitoring   + Protective relays   + MV fault detection and clearing   + Grid automation * Prefabricated metal enclosed and metal clad switchgear * Short circuit currents * Busbar calculation in switchgear | * Written tests * Oral * Practical/Projects |
| 1. Carry out electrical components and equipment repair | * Steps in fault finding   + Define the problem   + Determine the root cause   + Develop alternative solutions   + Select a solution   + Implement the solution   + Evaluate the outcome | * Written tests * Oral * Practical/Projects |
| 1. Prepare spare parts list and special maintenance tools | * Spare parts acquisition process | * Written tests * Oral * Practical/Projects |
| 1. Prepare work schedule/maintenance plan and work methodology | * Preparation of maintenance/work schedule checklist | * Written tests * Oral * Practical/Projects |
| 1. Prepare work reports | * Report writing | * Written tests * Oral * Practical/Projects |

**Suggested Delivery Methods**

* Demonstration by trainer
* Practical work by trainee
* Demonstration videos
* Projects
* Group discussions

**Recommended Resources**

* Motor starting/stopping components
* Electrical system schematic drawings
* Electrical tools, measuring devices and equipment
* Stationery
* AC and DC machines
* Manufacturer’s manuals
* Sectioned electrical motors

**Personal protective equipment (PPEs)**

* Helmet
* Dust coat
* Safety boots
* Goggles
* Dust mask
* Reflective jacket
* Gloves

# OPERATION AND MAINTENANCE OF SHIP CONTROL AND AUTOMATION SYSTEMS

**UNIT CODE:** ENG/CU/MAR/CR/08/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: operate and maintain ship control and automation systems

**Duration of Unit: 220 hours**

**Unit Description**

This unit describes competencies required to operate and maintain ship control and automation systems. It involves monitoring and operating measuring instruments, maintaining and repairing automatic control system components, operating ship open loop control system, operating and maintaining ship sequential control systems, monitoring proportional-integral-derivative control systems performance, operating, maintaining and repairing manipulator elements, operating, maintaining and repairing signal transmitting components, installing and operating a monitoring system, preparing work schedule/maintenance plan, preparing work reports and installing, operating and updating monitoring system

**Summary of Learning Outcomes**

1. Monitor and operate measuring instruments
2. Maintain and repair automatic control system components
3. Operate ship open loop control system
4. Operate and maintain ship sequential control systems
5. Monitor Proportional-Integral-Derivative control system performance
6. Operate, maintain and repair manipulator elements
7. Operate, maintain and repair signal transmitting components
8. Install and operate monitoring system
9. Prepare work schedule/maintenance plan and methodology
10. Prepare work reports

**Learning Outcomes, Content and Suggested Assessment Methods**

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| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Monitor, measure, transduce and transmit measures parameters | * Introduction to concepts of automation and control systems   + Control loop     - Open control systems     - Closed control systems     - Multiple loop control systems * System performance   + Mathematical modelling of a control system   + Steady state characteristics   + Dynamic response * Types of control action   + On-Off control   + Proportional control   + Integral control   + Derivative controller   + Multiple term controller * Parameters to be measured, types of measuring instruments and their working principles   + Pressure measurement   + Temperature   + Level measurement   + Flow measurement   + Displacement measurement   + Speed   + Vibration   + Torsion   + Salinity   + Oil content   + Gas analysis   + Electricity   + Fire detectors * Control signals and respective methods of transducing and transmission   + Electronics     - Semi-conductors     - Amplifiers     - Operational amplifiers     - Signal generator     - DC power supplies   + Pneumatics   + Hydraulics   + Photocouplers   + Fibre optics   + Coded or digital signal transmission     - Logic gates     - Flip-flops * Digital and analogue signals * Analogue to digital conversion * Digital to analogue conversion | * Written tests * Oral * Practical/Projects |
| 1. Install, operate, maintain and repair automatic control system components | * Functions of components of automatic control system and recommended operating conditions * Controllers * Microprocessor theory * Ladder diagram * Machine instruction (programming) * Boiler and turbine control systems * Diesel engine control system * Auxiliary equipment control system | * Written tests * Oral * Practical/Projects |
| 1. Operate, maintain and repair correcting units | * Correcting units and their principles of operation   + Actuators   + Valve body   + Self-acting control valves | * Written tests * Oral * Practical/Projects |
| 1. Prepare work schedule/maintenance plan and methodology | * Preparation of work schedule/maintenance checklist | * Written tests * Oral * Practical/Projects |
| 1. Prepare work reports | * Report writing | * Written tests * Oral * Practical/Projects |

**Suggested Delivery Methods**

* Demonstration by trainer
* Practical work by trainee
* Demonstration videos
* Projects
* Group discussions

**Recommended Resources**

* Programming language
* Manufacturer operation and maintenance manuals
* Manufacturer electrical and electronic drawings
* Parts list
* Tools and equipment.
* Stationery
* Sensors
* Actuators
* Programmable Logic Controller (PLC) and components
* PLC simulator

**Personal protective equipment (PPEs)**

* Helmet
* Dust coat
* Safety boots
* Goggles
* Dust mask
* Reflective jacket
* Gloves

# MARINE TRANSMISSION, SHAFT AND PROPULSION SYSTEM MAINTENANCE

**UNIT CODE:** ENG/CU/MAR/CR/09/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Maintain marine transmission, shaft and propulsion system

**Duration of Unit: 220 hours**

**Unit Description**

This unit decribes competencies required to maintain marine transmission, shaft and propulsion system. It involves identifying working principles of gearboxes and propellers, identifying maintenance procedures of gearboxes, shafts and propellers, preparing spare parts list and special maintenance tools, preparing work schedule/maintenance plan, carrying out maintenance procedures and preparing work reports

**Summary of Learning Outcomes**

1. Identify working principles of gearboxes and propellers
2. Identify maintenance procedures of gearboxes, shafts and propellers
3. Prepare spare parts list and special maintenance tools
4. Prepare works schedule/maintenance plan and work methodology
5. Carry out maintenance procedures

**Learning Outcomes, Content and Suggested Assessment Methods**

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| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify working principles of gearboxes, shafts and propellers | * Ship propulsion system * Components of ship propulsion system and their functions   + Gearbox   + Propeller   + Shaft * Construction materials for shafts and propellers * Types of gearboxes, shafts and propellers * Bow thrust bearings and seals * Operating principles of gearboxes, shafts and propellers * Installation procedures for pedestal bearings, stand tube seal, cutlass, propellers and muff coupling * Methods of shaft alignment | * Written tests * Oral * Practical/Projects |
| 1. Identify maintenance procedures of gearboxes, shafts and propellers | * Maintenance procedures for gearboxes, shafts and propellers * Common faults and remedies of gearboxes, shafts, bearings and propellers | * Written tests * Oral * Practical/Projects |
| 1. Prepare spare parts list and special maintenance tools | * Spare parts acquisition procedures | * Written tests * Oral * Practical/Projects |
| 1. Prepare work schedule/maintenance plan and work methodology | * Preparation of work schedule/maintenance checklist | * Written tests * Oral * Practical/Projects |

**Suggested Delivery Methods**

* Demonstration by trainer
* Practical work by trainee
* Demonstration videos
* Projects
* Group discussions

**Recommended Resources**

* Sectioned gearbox
* Manufacturer’s operation and maintenance manuals
* Propellers
* Shafts
* Engineering drawings

**Personal protective equipment (PPEs)**

* Helmet
* Dust coat
* Safety boots
* Goggles
* Dust mask
* Reflective jacket
* Gloves

# OPERATION AND MAINTENANCE OF NAVIGATION AND COMMUNICATION SYSTEMS

**UNIT CODE:** ENG/CU/MAR/CR/10/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Operate and maintain navigation and communication systems

**Duration of Unit: 200 hours**

**Unit Description**

This unit describes competencies required to operate and maintain navigation and communication systems. It involves operating navigation and communication equipment, interfacing and synchronising navigation and communication equipment, preparing work schedule/maintenance plan, maintaining navigation equipment and preparing work report

**Summary of Learning Outcomes**

1. Operate navigation and communication equipment
2. Interface and synchronize navigation and communication equipment
3. Prepare work schedule/maintenance plan and methodology
4. Maintain navigation equipment

**Learning Outcomes, Content and Suggested Assessment Methods**

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| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Operate navigation and communication equipment | * Introduction to concepts of maritime navigation   + Position     - Latitudes     - Longitudes   + Navigational aids   + Weather * Working principles of navigation and communication equipment   + Radar   + GPS   + GPRS   + Gyro-compass   + Magnetic compass   + Echo sounder   + Speed log   + Barometer   + Wind vane   + Chart plotter (electronic)   + HF Radio   + VHF Radio   + Navigation lights   + ECDIS-Electronic Chart Display and Information Systems   + Medium Frequency Radio (MF Radio)   + SONAR (Sound Navigation Ranging) * Operation and operating conditions of navigation and communication equipment * Navigation and communication equipment fault diagnosis and remedies | * Written tests * Oral * Practical/Projects |
| 1. Interface and synchronize navigation and communication equipment | * Signal propagation   + Wave guide termination   + Termination connectors | * Written tests * Oral * Practical/Projects |
| 1. Prepare work schedule/maintenance plan and methodology | * Preparation of work schedule/maintenance checklist | * Written tests * Oral * Practical/Projects |

**Suggested Delivery Methods**

* Demonstration by trainer
* Practical work by trainee
* Demonstration videos
* Projects
* Group discussions

**Recommended Resources**

* Navigation and communication equipment
* Stationery
* Manufacturer operation and maintenance manual

**Personal protective equipment (PPEs)**

* Helmet
* Dust coat
* Safety boots
* Goggles
* Dust mask
* Reflective jacket
* Gloves

# MARINE AUXILIARY SYSTEMS ASSESSMENT AND MONITORING

**UNIT CODE:** ENG/CU/MAR/CR/11/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Assess and monitor marine auxiliary systems

**Duration of Unit: 150 hours**

**Unit Description**

This unit describes competencies required to operate and monitor marine boiler systems and steam turbines and operating and maintaining refrigeration and air conditioning systems, heat exchangers and oil coolers, reverse osmosis plant and fresh water generation, storage and reticulation systems, ship steering system, ship stabiliser, anchor system, ship firefighting sytsem, ship ventilation system, sewerage and toilet/bathroom systems, bow thruster system, ship sea crane, ship visor door and ramp system and operaitng and maintaining main gallery equipment

**Summary of Learning Outcomes**

1. Operate and monitor marine boiler systems and steam turbines
2. Operate and maintain refrigeration and air conditioning
3. Operate and maintain heat exchangers and oil coolers
4. Operate and maintain reverse osmosis plant and fresh water generation, storage and reticulation systems
5. Operate and maintain ship steering system
6. Operate and maintain ship stabilizer
7. Operate and maintain anchor system
8. Operate and maintain ship firefighting system
9. Operate and maintain ship ventilation system
10. Operate and maintain sewage and toilet/bathroom systems
11. Operate and maintain bow thruster system
12. Operate and maintain ship sea crane
13. Operate and maintain ship visor door and ramp system
14. Operate and maintain main galley equipment

**Learning Outcomes, Content and Suggested Assessment Methods**

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| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Operate and monitor marine boiler systems and steam turbines | * Steam cycle * Types of marine boilers * Boiler and steam turbines components and construction * Boiler and steam turbine automation systems * Steam turbines   + Types of steam turbines * Working principles of steam turbines and boilers * Furnaces | * Written tests * Oral * Practical/Projects |
| 1. Operate and maintain HVAC (Heating Ventilation and Air Conditioning) systems | * Concept of refrigeration and air conditioning * Components of HVAC (heating, ventilation and air conditioning) system * Classification of air conditioning systems   + Construction   + Operating characteristics * Operation and maintenance of refrigeration and air conditioning equipment | * Written tests * Oral * Practical/Projects |
| 1. Operate and maintain heat exchangers and oil coolers | * Heat exchangers and oil coolers   + Definition   + Types   + Components   + Working principles * Control and monitoring heat exchangers * Air coolers | * Written tests * Oral * Practical/Projects |
| 1. Operate and maintain reverse osmosis plant and fresh water generation, storage and reticulation systems | * Water purification process * Components of water purification systems * Functions of components of a water purification system * Monitoring and control of water purification process | * Written tests * Oral * Practical/Projects |
| 1. Operate and maintain ship steering system | * Modes of steering   + Manual   + Automatic * Components of ship steering systems * Functions of components of ship steering systems | * Written tests * Oral * Practical/Projects |
| 1. Operate and maintain ship stabilizer | * Definition of terms * Types of stabilizer systems * Operating principles of ship stabilizer systems * Components of ship stabilizer systems   + Faults   + Repair methods * Control and monitoring of ship stabilizer systems | * Written tests * Oral * Practical/Projects |
| 1. Operate and maintain anchor system | * Definition of terms * Types of anchor systems * Operating principles of ship anchor systems * Components of ship anchor systems   + Faults   + Repair methods * Control and monitoring of anchor systems | * Written tests * Oral * Practical/Projects |
| 1. Operate and maintain ship firefighting system | * Concept of fire triangle * Types of fire   + Lithium fire * Fire detection methods * Types of ship firefighting   + Foam   + Carbon dioxide   + Water spray * Testing of fire detection and fighting system * Fire fighting equipment * Report writing | * Written tests * Oral * Practical/Projects |
| 1. Operate and maintain sewage and toilet/ bathroom systems | * Waste management   + Regulations   + Types of waste management systems   + Components of waste management systems   + Working principles of components of waste management systems   + Operation and maintenance of components of waste management systems | * Written tests * Oral * Practical/Projects |
| 1. Operate and maintain bow thruster system | * Definition of terms * Types of bow thruster system * Operating principles of bow thruster system * Components of ship bow thruster system   + Faults   + Repair methods * Control and monitoring of bow thruster system | * Written tests * Oral * Practical/Projects |
| 1. Operate and maintain ship sea crane | * Definition of terms * Types of ship sea cranes * Operating principles of ship sea cranes * Components of ship sea cranes   + Faults   + Repair methods * Control and monitoring of ship sea cranes * Hand signals * Safety and best practices in marine crane operation | * Written tests * Oral * Practical/Projects |
| 1. Operate and maintain ship visor door and ramp system | * Definition of terms * Types of ship visor door and ramp system * Operating principles of ship visor door and ramp system * Components of ship visor door and ramp system   + Faults   + Repair methods * Control and monitoring of ship visor door and ramp system | * Written tests * Oral * Practical/Projects |

**Suggested Delivery Methods**

* Demonstration by trainer
* Practical work by trainee
* Demonstration videos
* Projects
* Group discussions

**Recommended Resources**

* Manufacturer operation and maintenance manuals
* Engineering drawings
* Auxiliary equipment
* Stationery

**Personal protective equipment (PPEs)**

* Helmet
* Dust coat
* Safety boots
* Goggles
* Dust mask
* Reflective jacket
* Gloves

# MARINE ORGANISATION MANAGEMENT

**UNIT CODE:** ENG/CU/MAR/CR/12/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Manage marine organisation

**Duration of Unit:** 100 hours

**Unit Description**

This unit describes competencies required to manage marine organisation. It involves designing office operations, managing public relations, managing human resource, conducting on board training, designing job specifications, managing conflicts, implementing procurement procedures, carrying out emergency drills, performing PMO operations, coordinating workshop operations, performing quality control and quality assurance, applying occupational safety, health and environment procedures and performing MCR and engine room watchkeeping

**Summary of Learning Outcomes**

1. Design office operations
2. Manage public relations
3. Manage human resource
4. Conduct on-board training
5. Design job specifications
6. Manage conflicts
7. Implement procurement procedures
8. Carry out emergency drills
9. Perform PMO (Planned Maintenance Organization) operations
10. Coordinate workshop operations
11. Perform quality control and quality assurance
12. Apply occupational, health and environment (OSHE) procedures
13. Perform MCR and engine room watch keeping

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Manage public relations | * Fundamentals of public relations * Public relations in practice * Personal skills and development | * Written tests * Oral * Practical/Projects |
| 1. Manage human resource | * Introduction to human resource management * Occupational ethics * Conflict management * Maritime labour convention   + Work hours and rest hours on ships | * Written tests * Oral * Practical/Projects |
| 1. Conduct on-board training | * Definition of terms * Shipboard familiarisation training * Procedure for conducting on-board training | * Written tests * Oral * Practical/Projects |
| 1. Design job specifications | * Organisation of ship crew, their roles and responsibilities | * Written tests * Oral * Practical/Projects |
| 1. Implement procurement procedures | * Inventory management * Procurement and Asset Disposal Act, 2015 * International shipping   + Customs and taxes | * Written tests * Oral * Practical/Projects |
| 1. Carry out emergency drills | * Types of alarms on board a ship * Roles and responsibilities in drills   + Ship blackout drill   + Piracy attack   + Man-overboard drills   + Oil spill drill   + Fire drill * Damage control plan | * Written tests * Oral * Practical/Projects |
| 1. Coordinate workshop operations | * Workshop organisation and best practices | * Written tests * Oral * Practical/Projects |
| 1. Perform quality control and quality assurance | * International Marine Organisation standards (IMO) * ISO standards | * Written tests * Oral * Practical/Projects |
| 1. Apply Occupational Safety, Health and Environment (OSHE) Procedures | * First aid * Maritime environment hazards | * Written tests * Oral * Practical/Projects |
| 1. Perform MCR and engine room watch keeping | * Watchkeeping duties | * Written tests * Oral * Practical/Projects |

**Suggested Delivery Methods**

* Demonstration by trainer
* Practical work by trainee
* Demonstration videos
* Projects
* Group discussions

**Recommended Resources**

* First aid kit
* Stationery

**Personal protective equipment (PPEs)**

* Helmet
* Dust coat
* Safety boots
* Goggles
* Dust mask
* Reflective jacket
* Gloves