COURSE PACKAGE

Part A: Course Specifications

Course Code	:	E Mat					
Course Descriptive Title	:	Engineering Materials					
Prerequisite	:	NGEC 9		**Corequisite**	:	None	
Year Level	:	First Year		**Semester Offered**	:	Second Semester	
Course Credits	:	3 units	**Theoretical Contact Hours Per Week**	:	3 hours	**Demonstration/ Practical Work Contact Hours Per Week**	: None
Course Description	:	The Course provides fundamental knowledge and understanding, which involves identifying the different characteristics and limitations of construction, fabrication, and repair onboard ships. The Course also tackles the structures of matter, metallurgy, mechanical properties, fracture mechanics, ship's iron and steel, metal fabrication techniques, heat treatment of steel, non-ferrous metals and alloys, plastics materials and rubbers, adhesives, destructive and non-destructive testing.					

STCW Reference	:	**STCW Table**	**Function**	**Competence**	**Knowledge, Understanding, and Proficiency**
		A-III/1	Maintenance and repair at the Operational level	Appropriate use of hand tools, machine tools, and measuring instruments for fabrication and repair on board	Characteristics and limitations of materials used In construction and repair of ships and equipment Characteristics and limitation of processes used for fabrication and repair Properties and parameters considered in the fabrication and repair of system and components
				Maintenance and repair of shipboard machinery and equipment	Design characteristics and selection of materials in construction of equipment
		Specific underpinning knowledge and understanding under Table III/2 of the STCW Code are incorporated into the Course.			

		A-III/2	Marine engineering at the management level	Plan and schedule operations	*Theoretical knowledge* Technology of materials
			Maintenance and repair at the management level	Detect and identify the cause of machinery malfunctions and correct faults	Non-destructive examination
Course Outcome	:	*PO-E.1* *PO-E.4* *PO-E.5* *PO-E.8* *PO-E.9*	*After completing this course, the student must be able to*: **CO1.** Identify the materials considering the types, properties and characteristics of engineering materials related to maritime applications **CO2.** Identify the replacement materials considering its compatibility		
Course Intake Limitations	:	The number of students that can be accommodated shall not exceed 40.			
Faculty Requirement	:	***Instructor*** The faculty that will be assigned to handle the Course must possess the following qualifications: • graduate of Bachelor of Science in Marine Engineering; • Officer-in-charge of an Engineering Watch on seagoing ships powered by propulsion machinery of 750 kW propulsion power or more; • completed Training Course for Instructors (IMO Model Course 6.09); • completed Training Course on Assessment, Examination and Certification of Seafarers (IMO Model Course 3.12); OR • Registered professional holding a bachelor's degree in Engineering with Master's degree in the same discipline; • with at least one year (1) industrial and/or teaching experience; • completed Approved Training Course for Instructors (IMO Model Course 6.09); • completed Approved Training Course on Assessment, Examination and Certification of Seafarers (IMO Model Course 3.12); OR • Registered professional holding a bachelor's degree in Engineering;		

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- completed Approved Training Course for Instructors (IMO Model Course 6.09);
- completed Approved Training Course on Assessment, Examination and Certification of Seafarers (IMO Model Course 3.12);

Assessor
The assessor assigned should have the same qualifications above.
Note:
1. *The instructor shall conduct the formative assessment.*
2. *Summative assessment shall be conducted by an Assessor not teaching the students (assessee).*

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<tr><td>Teaching Facilities and Equipment</td><td>:</td><td>

CLASSROOM
The standard classroom size shall be a minimum of 48 square meters, no side shall be less than 6 meters for a class of 40 students. The classroom must be illuminated at 50.76 Lux and well-ventilated. It should contain the following:

- Tables and chairs or armed chairs
- Whiteboards or chalkboards
- Multimedia equipment
- Scientific Calculator *(shall be provided by the student)*

<table>
<tr><th>Facilities and Equipment for Class Delivery / Discussion
(Shall be provided by the MHEI)</th></tr>
<tr><td>1. Material used onboard composed of the following:
a. Cast Iron
b. Low alloy steels
c. High alloy steels
d. Toll Steel
e. Bronze
f. Aluminum
g. Magnesium
h. Nickel
i. Zinc
j. Titanium
k. Sample Plastics or Polymers
l. Adhesives</td></tr>
<tr><td>2. Non-metallic materials such as glass fibers and mica</td></tr>
<tr><td>3. Sample bearings</td></tr>
<tr><td>4. Sample Plastics or Polymers</td></tr>
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		5. Ceramics 6. Dye Penetrant *Note: The MHEIs can use additional teaching facilities and equipment as deemed necessary to meet the learning outcomes of this course.*
Teaching Aids	:	**TA1** Structures of Matter and Introduction to Metallurgy **TA2** Mechanical Properties and Fracture Mechanics **TA3** Ship's Iron and Steel **TA4** Metal Fabrication Techniques **TA5** Heat Treatment of Steel **TA6** Non – Ferrous Metals and Alloys **TA7** Plastic Materials and Rubber **TA8** Ceramics and Glass **TA9** Adhesives **TA10** Destructive Testing **TA11** Non-Destructive Testing *Note: The MHEIs can use alternate and/or additional teaching aids as deemed necessary to meet the learning outcomes of this course.*
References/ Bibiliographies	:	**References:** **R1** Young, J.F. and Shane, 1985 R.S Materials and Processes 3rd Edition **R2** Higgins, R.A. 1994, Properties of Engineering Materials 2nd Edition **R3** Callister, W.D and Rethwisch D.G (2011) Material Science and Engineering 8th Edition **R4** Russel, Paul A. (2018) General Engineering Knowledge 6th Edition **R5** Tupkary, R.H, V.R Tupkary (2018) Modern Iron Making Handbook **R6** Hudd, R.C. & Llewellyn D.T. (1998), Steels: Metallurgy and Application 3rd Edition **R7** IACS Requirements concerning Materials and Welding **R8** Study of the Open Hearth: A Treatise on the Open Hearth Furnace and the Manufacture of Open Hearth Steel. Harbison-Walker Refractories Company. (2015), 102 pages 102 **R9** http://www.wirralmodelengineeringsociety.co.uk/Articles/The_Bessemer_Process.pdf Hudd, R.C. & Llewellyn D.T. (1998), Steels: Metallurgy and Application 3rd Edition

		R10 IACS Requirements concerning Materials and Welding **R11** https://uomustansiriyah.edu.iq/media/lectures/5/5_2016_05_01!08_27_09_PM.pdf **R12** Sears, F.W., Zemansky M.W., Young H.D. (1992); College Physics 7th Edition; Addison-Wesley Publishing Company **Note:** *Note: The MHEIs can use alternate and/or additional references/bibliographies as deemed necessary to meet the learning outcomes of this course.*

Part B: Course Outline and Timetable

Term	Week	Topic	Time Allotment (in hours)	
			Theoretical	Demonstration / Practical Work
Note: MHEIs shall determine the number of periods for terms the semester is divided based on their school calendar activities	1	**1. Structure of Matter and Introduction to Metallurgy** 1.1 Structure of an Atom 1.2 States of Matter 1.3 Carbon and its Components 1.4 Crystal Structures in Metals and Non-Metallic Materials	3	-
	2 – 3	**2. Mechanical Properties and Fracture Mechanics** 2.1 Stress 2.2 Stain 2.3 Mechanical Properties 2.4 Hooke's Law 2.5 Stress-Strain Curve	6	-
	4 - 5	**3. Thermal Conductivity of Materials** 3.1 Thermal Expansion 3.2 Thermal Stress	6	-
	6 - 7	**4. Ship's Iron and Steel** 4.1 Types of Steel Production 4.2 Steel Making 4.3 Effects of Alloying Element in Steel 4.4 Wrought Steels	6	-
	8 - 9	**5. Heat Treatment of Metal** 5.1 Objective of Heat Treatment 5.2 Heat Treatment Processes	6	-
	10 - 11	**6. Non-Ferrous Metals and Alloys** 6.1 Alloying Metals 6.2 Non-Ferrous Alloys	6	-
	12	**7. Plastics, Rubbers and Composites** 7.1 Plastics 7.2 Rubbers 7.3 Composites	3	-
	13	**8. Adhesives** 8.1 Types of Adhesives	3	-

Term	Week	Topic	Time Allotment (in hours)	
			Theoretical	Demonstration / Practical Work
		8.2 Preparation of Adhesives		
	14 - 15	**9. Selecting Engineering Materials**	6	-
	16	**10. Destructive Testing** 10.1. Objectives of Destructive Testing 10.2. Types of Destructive Testing	3	-
	17	**11. Non-Destructive Testing** 11.1. Objectives of Non-Destructive Testing 11.2. Types of Non-Destructive Testing	3	-
Sub-total (Contact Hours)			**51**	**-**
Total Contact Hours			**51**	
Examination and Assessment				

Note:

1. *The MHEIs are to develop their respective timetable according to their resources but meets with the minimum time allocation for the contact hours. OR*
2. *The MHEIs shall determine the time allotment for the conduct of summative assessments.*

Part C: Course Syllabus

CO	Topics Learning Outcomes	References/ Bibliographies	Teaching Aids
CO1	**1. Structure of Matter and Introduction to Metallurgy** 1.1. Explain the basic structure of matter with emphasis on the following: a. Nature of fundamental particles b. Structure of an atom c. Atomic nucleus d. Molecules e. States of Matter 1.2. Explain the properties and components of carbon and its effects on metallurgy 1.3. Explain the crystal structures of metallic and non-metallic materials	R6, R19	TA1
	2. Mechanical Properties and Fracture Mechanics 2.1. Explain the effects of stress in a material with externally applied load 2.2. Explain the types of stress in terms of the load applied to the material 2.3. Explain the relationship of stress and strain 2.4. Explain Hooke's Law 2.5. Explain the mechanical properties of a material 2.6. Explain the parameters in the stress-strain curve of a material 2.7. Calculate parameters involving mechanical properties of a material	R2, R3, R4	TA2
	3. Thermal Conductivity of Materials 3.1 Explain the principles of thermal expansion and thermal stress 3.2 Calculate parameters involving thermal expansion and thermal stress of a material	R11, R12	TA3
	4. Ship's Iron and Steel 4.1. Explain in simple terms the production of pig iron from iron ore 4.2. Explain the elements that naturally occur in iron and and its effect on mechanical property 4.3. Explain the processes involved in steelmaking 4.4. Explain the categories of wrought steels with emphasis on the following: a. Plain carbon steels b. Low alloy steels	R5, R6, R8, R9	TA4

CO	Topics Learning Outcomes	References/ Bibliographies	Teaching Aids
	c. High alloy steels d. Alloying limits for low alloy steels e. General characteristics of various tool steels		
	5. Heat Treatment of Metals 5.1. Explain the purpose of heat treatment of metal 5.2. Explain the following heat treatment process and the type of metal to which they may be applied: a. Stress relief heat treatment b. Annealing c. Normalizing d. Quenching e. Tempering f. Hardening	R1, R2, R3, R4, R11, R12	TA5
	6. Non – Ferrous Metals and Alloys 6.1. Explain the purpose of the alloying elements namely nickel, chromium, and molybdenum in steels used in marine engineering 6.2. Identify the metals used in non-ferrous alloys commonly used in marine engineering 6.3. Identify the applications non-ferrous metals in marine engineering	R1, R2, R3, R4	TA6
	7. Plastic, Rubbers and Composites 7.1. Explain the structure, properties and characteristics of composites, rubbers plastics and polymers 7.2. Identify the applications of composites on board 7.3. Identify the applications of rubbers and plastics on board	R1, R2, R3, R4	TA7
	8. Adhesives 8.1. Identify the different types of adhesives 8.2. Explain the procedure of surface preparation where adhesives shall be used 8.3. Identify the applications of adhesives on board	R1, R2, R3, R4	TA8
CO2	**9. Selecting Engineering Materials** 8.1 Explain the following factors required for selecting material: a. properties of the material b. availability of the material c. processing of the material d. cost of the material	R1, R2, R3, R4, R12	TA9

CO	Topics Learning Outcomes	References/ Bibliographies	Teaching Aids
	10. Destructive Testing 10.1. Explain the different destructive testing methodologies and their importance: a. Tension b. Compression c. Torsion d. Bending e. Hardness f. Fatigue g. Creep h. Impact 10.2. Determine the various Failure and Fracture of Materials based on the testing methodologies above.	R1, R2, R3, R4	TA10
	11. Non – Destructive Test 11.1. Explain the objectives of non-destructive testing 11.2. Explain the different non-destructive testing methodologies: a. Visual Inspection b. Dye Penetrant c. Magnetic Methods d. Thermal and Electrical Test e. X-Ray Methods of Radiography f. Ultrasonic Testing 11.3 Determine the non-destructive testing methodologies according to types of defect	R1, R2, R3, R4	

Note: The MHEIs are to develop Part D: Detailed Teaching Syllabus and Instructional Materials (IMs), and Part E: Course Assessment and Assessment Tools (ATs) which satisfactorily meets with the requirements of the course as prescribed in the course outcomes and learning outcomes.