**ANNEX B OF CMO NO. 20, SERIES OF 2015**
**BACHELOR OF SCIENCE IN MARINE ENGINEERING**
**COURSE SPECIFICATIONS**

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| **Course Code** | **:** | E Mat |
| **Course Descriptive Title** | **:** | Engineering Materials |
| **Course Credits** | **:** | 4 units |
| **Lecture Contact Hours per Week** | **:** | 4 hours |
| **Laboratory Contact Hours per Week** | **:** | 0 hours |
| ○ **Prerequisite** | **:** | None |
| **Reference/s** | **:** | ○ Table A-III/1 Function: Maintenance and Repair<br>○ Table A-III/2 Function: Marine Engineering<br>○ STCW'78 as amended<br>○ IMO Model Courses 7.02 and 7.04<br>○ Annex A of CMO No. 20, Series of 2015 (Curriculum Mapping for BSMarE) |

| COMPETENCE | KNOWLEDGE, UNDERSTANDING AND PROFICIENCY | PERFORMANCE | APPROX HOURS |
|---|---|---|---|
| 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 | 1. Basic Metallurgy, Metals and Processes<br>- Describes in simple terms the production of pig iron from iron ore<br>- Describes the principles of the open-hearth, the Bessemer and more modem processes used in the production of steel from pig iron<br>- Explains the principal differences between sand casting, die casting, centrifugal casting, forgings, cold working and hot-rolled plate, bars and other sections<br>- States the normal range of carbon content in mild steel, tool steel, cast steel and cast iron<br>- Describes the principle difference between ferrous and non-ferrous metals<br>- Gives examples of applications of non-ferrous metals in marine engineering<br>- States the purpose of the alloying elements nickel, chromium and molybdenum in steels used in marine engineering<br>- Identifies the metals used in non-ferrous alloys commonly employed in Marine engineering | 6 Hours |
| Appropriate use of hand tools, machine tools and measuring instruments for fabrication and repair on board (Cont) | Characteristics and limitations of materials used in construction and repair of ships and equipment (Cont) | 2. Properties and Uses<br>- Explains in simple terms what influences the choice of material for a marine engineering component<br>- Describe in simple terms what is meant by the following mechanical properties:<br>- elasticity<br>- brittleness<br>- hardness<br>- strength<br>- toughness<br>- ductility<br>- malleability<br>- plasticity<br>- Explains what is meant by low-, medium-and high-carbon steels<br>- Compares the tensile strength, ductility and hardness of low-, medium-and high-carbon steels<br>- States the uses of low-, medium and high-carbon steels<br>- Describes the properties of cast iron and gives examples of its use<br>- Defines an alloy<br>- States the uses of aluminium, copper, zinc, lead, tin and antimony<br>- States the component metals of brass, bronze and white metal<br>- States the uses of the above alloys | 6 Hours |

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| | | - Explains why the above alloys are suitable for the uses in the above objective<br>- Identifies samples of metals described in the above objectives | |
| Appropriate use of hand tools, machine tools and measuring instruments for fabrication and repair on board (Cont) | Characteristics and limitations of materials used in construction and repair of ships and equipment (Cont) | 3. Non-Metallic Materials<br>- Explains the reasons for using the following fillers in polymers:<br>  - glass fibre<br>  - mica<br>- States that polymers can be plastic, rigid, semi-rigid or elastomeric<br>- States the properties and limitations of polymers<br>- Lists polymers and other non-metallic materials in common use<br>- States applications of polymers and other non-metallic materials on board ship | 3 Hours |
| Appropriate use of hand tools, machine tools and measuring instruments for fabrication and repair on board (Cont) | Characteristics and limitations of processes for fabrication and repair | 4. Process<br>- Explains the purpose of heat treatment<br>- Describes the following heat treatment processes and the types of steel to which they might be applied:<br>  - Annealing<br>  - Normalizing<br>  - Hardening<br>  - Tempering | 5 Hours |
| Appropriate use of hand tools, machine tools and measuring instruments for fabrication and repair on board (Cont) | Characteristics and limitations of processes for fabrication and repair (cont) | 5. Heat Treatment of Carbon Steel<br>- States how low-carbon steels can be cases hardened<br>- States why low-carbon steels are sometimes cases hardened<br>- Describes in basic terms a suitable heat-treatment process for common carbon steels, given the properties required<br>- Completes items of information in a table which gives the following details for the tempering of high-carbon steel:<br>  - Temperatures (230 to 320 ℃)<br>  - Colour<br>  - Application conditions<br>  - Typical tool applications<br>- Explains how a component is tempered throughout its whole cross-section | 5 Hours |
| | | 6. Materials Under Load<br>- Defines stress as the internal resistance per unit area of a material to an externally applied load<br>- Defines strain as the deformation produced in a material by an externally applied | 5 Hours |

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| Appropriate use of hand tools, machine tools and measuring instruments for fabrication and repair on board | Properties and parameters considered in the fabrication and repair of systems and components | load<br>- Describes three types of loading as:<br>- Tensile<br>- Compressive<br>- Shear<br>- Illustrates with the aid of simple sketches a material under each of the applied loadings given in the above objectives, using arrows to indicate load and stress and dotted lines to indicate deformation<br>- Explains how stress and strain can be calculated in terms of loading and material dimensions, for the cases in the above objectives<br>- Defines, for an elastic material subjected to a tensile load:<br>- Elastic limit<br>- Yield point<br>- Ultimate strength<br>- Breaking strength<br>- States that, within the elastic limit, Hooke's law will apply<br>- Defines Hooke's law as:<br>- *Stress/Strain = a* Constant<br>- Defines the constant contained in Hooke's law as the Modulus of Elasticity<br>- Applies the above objectives with simple numerical calculations<br>- Shows, on a sketched graph of load to a base of corresponding extension values, the behaviour of an elastic materials under tensile loading and indicates the condition points listed above<br>- States the significance in engineering practice of the four physical properties in the above objectives | |
| Appropriate use of hand tools, machine tools and measuring instruments for fabrication and repair on board (cont.) | Properties and parameters considered in the fabrication and repair of systems and components (cont.) | 7. Vibration<br>- States that vibration is caused by the effect of a single force or a succession of forces applied suddenly to elastic materials<br>- States that the forces causing vibration in a ship usually result from an imbalance in the machinery<br>- Describes the main sources of ship vibration as:<br>- machinery with reciprocating components (e.g. pistons etc.)<br>- ship's propeller blades rotating through water of varying pressure and velocity<br>- rotating machinery which has not been balanced (e.g. some crankshafts)<br>- rotating machinery becoming unbalanced through damage, erosion, corrosion or deposits (e.g. dirt, scale, etc.) | 3 Hours |

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| Appropriate use of hand tools, machine tools and measuring instruments for fabrication and repair on board (cont.) | Properties and parameters considered in the fabrication and repair of systems and components (cont.) | - unbalanced power in the cylinders of a diesel engine<br>- worn bearings in rotating machinery<br>- States that a ship's structure and machinery are constructed largely of materials which are elastic<br>- States that vibrations are transmitted from one elastic material or component to another<br>- States that anti—vibration materials are sometimes placed between connecting parts in order to reduce vibration<br>- States that if a component is vibrating a reversing stress is present in the material<br>- States that in normal working conditions the stresses due to vibrations are well within limits allowed for in the design<br>- States that vibrations in a component may be from different sources, which can cause resonance and magnify the effect<br>- States that if vibrations become excessive the stresses induced can cause permanent damage<br>- States that excessive vibration should not be allowed to continue<br>- States that when varying the rotational speed of machinery, stages may be encountered where vibrations become excessive<br>- Explains that the condition described in the above objective is normally due to a resonance of vibrations which occurs at what is known as 'critical speeds'<br>- States that excessive vibration within machinery is not always apparent<br>- States that critical speeds are predictable and should be clearly marked on controls and known to engineer officers<br>- States that machinery should not be allowed to operate either at or close to a critical speed<br>- States that critical speed ranges should be passed through as quickly as possible<br>- States that in addition to including stress, vibration may cause securing devices to work loose<br>- Explains how vibration may be reduced | |
| Appropriate use of hand tools, machine tools and measuring instruments for fabrication and repair on board (Cont) | Properties and parameters considered in the fabrication and repair of systems and components (cont) | 8. Self-Secured Joints<br>- Sketches the stages of making self-secured joints | 1 Hour |

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| | | 9. Permanent Joints<br>- Lists the different ways of making permanent joints | 1 Hour |
| Appropriate use of hand tools, machine tools and measuring instruments for fabrication and repair on board (Cont) | Properties and parameters considered in the fabrication and repair of systems and components (cont) | 10. Bonding Plastics<br>- Describes the principle of bending bonding plastics<br>- States the range of softening temperature for plastics<br>- Explains the care and safeguards necessary when heating plastics | 1 Hour |
| Appropriate use of hand tools, machine tools and measuring instruments for fabrication and repair on board (Cont) | Properties and parameters considered in the fabrication and repair of systems and components (cont) | 11. Adhesives and Bonding Health and safety<br>- Explains the care necessary when using adhesives, to include:<br>- Skin protection<br>- Storage<br>- Fire<br>- Toxicity<br>- States the advantages and disadvantage of adhesive bonding<br>- Describes the basic principles of joining by using an adhesive<br>- Sketches the four joint configurations<br>- States the purpose of an activator when using an epoxy resin<br>- States the significance of pot life<br>- Explains the limitations on the service conditions of epoxy resins<br>- States that special epoxy resins are made to meet particular service conditions<br>- Lists the steps necessary when bonding together:<br>- Two metal components<br>- Friction material to steel<br>- Describes briefly metal-to-metal bonding and applications using:<br>- Liquid or paste<br>- Beads or dry film | 3 Hours |
| | | 12. Joining Plastics<br>- States the three methods of joining plastics<br>- States the need to use the correct adhesive for the plastic to be joined<br>- Selects and uses the correct adhesive for a variety of applications for a variety of strength tests included in the above objectives<br>- Explains what is meant by sealant, gasket and packing<br>- Explains the differences between gasket and packing<br>- Explains how packings are used showing actual packings such as various types | |

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| | | of O-rings, gland packings, mechanical seals, oil seals and labyrinth packings<br>- Explains how gaskets are used showing actual gaskets such as various types of non-metallic gaskets, non-ferrous metallic gaskets, metallic gaskets and semi-metallic gaskets<br>- Explains how sealants are used showing actual sealants such as various types of sealants, liquid packings and seal tapes | |
| Appropriate use of hand tools, machine tools and measuring instruments for fabrication and repair on board (Cont) | Use of various types of sealants and packings | 13. Selection of Materials in Construction of Equipment<br>- Explains what materials are used for constructing major parts of the following equipment:<br>-diesel engines: crank shaft, cylinder liner and head, piston, exhaust valve, bearing<br>-steam turbines: turbine casing, rotor, blade, nozzle, reduction gear,<br>-gas turbine: turbine casing, rotor, compressor, gas generator<br>-boilers: water tube, furnace, steam, water drum, superheater<br>-shafting: propeller shaft, stern tube bearing, propeller<br>-pumps: impeller, casing, shaft, casing ring, sleeve, gear, screw, piston/bucket ring<br>-heat exchangers: heating tube, cooling tube, shell<br>- compressors: piston ring, valve, cylinder block, cylinder<br>- liner purifiers: spindle, gravity disc/ring dam, bowl body<br>- high pressure/temperature valve: body, valve, valve seat | 6 Hours |
| Maintenance and repair of shipboard machinery and equipment | Design characteristics and selection of materials in construction of equipment | 14. Design Characteristics<br>- Explains design characteristics developed to improve performance in:<br>-highly skewed propeller<br>-construction of diesel engines<br>-construction of steam turbine<br>-construction of gas turbine<br>-construction of boiler | 6 Hours |
| Maintenance and repair of shipboard machinery and equipment | Design characteristics and selection of materials in construction of equipment | 15. Design characteristics of Bearings<br>*Plain Bearings*<br>- Explains the limitations of direct-lined bearings<br>- Describes solid and lined inserts<br>- Describes briefly:<br>-thick-walled<br>-medium-walled liners<br>-thin-walled liners | 3 Hours |

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| | | -wrapped bushes<br>- Lists the ideal properties of a lubrication oil for plain bearings<br>- Describes the reasons for using white metal, copper-lead alloys, lead bronzes, tin bronzes, gun metals and aluminium-based alloys for plain bearings | |
| Maintenance and repair of shipboard machinery and equipment (cont) | Design characteristics and selection of materials in construction of equipment (cont) | *Ball and Roller Bearings*<br>- Compares the load-carrying abilities of ball and roller bearings<br>- Compares the ability of ball and roller bearings to carry radial and axial loads<br>- States the type of bearing suitable for shafts subject to angular misalignment<br>- Describes how ball and roller bearings are lubricated<br>- States the proportion of available volume to be filled when using grease<br>- States the maximum height of lubricant in a stationary bearing when using oil | |
| Manage the operation of propulsion plant machinery. Plan and schedule operations (ML) | Technology of materials | 16. Destructive and non-destructive testing of material<br>- Describe common methods of non-destructive testing of materials and their application to main and auxiliary machinery components.<br>- Discuss destructive tests on specimens such as stress tests, hardness tests and metallographic tests. | 7 hours |
| | | 17. Engineering processes used in construction and repair<br>- Evaluate common fabrication techniques, including welding, forging, and casting<br>- Assess common repair techniques | |
| | | Total No. of Hours | 61 hours |

* the discrepancy between course map and course specification total time allotment is intended for assessment