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

Course Code	**:**	Thermodynamics
Course Descriptive Title	**:**	Thermodynamics
Course Credits	**:**	4 units
Lecture Contact Hours per Week	**:**	3 hours
Laboratory Contact Hours per Week	**:**	3 hours
Prerequisite	**:**	Math 1
Reference/s	**:**	1. IMO Model Courses 7.02 and 7.04 2. Annex A of CMO No. 20, Series of 2015 (Curriculum Mapping for BSMarE) 3. STCW '78 as amended

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Basic Engineering Science	Thermodynamic Properties	– Describes the properties used to specify the state, or condition, of a substance, the units in which the property is measured and the usual symbol, e.g.: — pressure — temperature — volume — energy – Explains what is meant by: — absolute quantities — specific quantities — intensive values — extensive values – Explains that a substance can exist in three states, or phases, which are: — solid — liquid — gaseous – Describes the energy required to change phase as: — enthalpy of fusion (solid－liquid) — enthalpy of evaporation (liquid－vapour) – States that a change of phase is a constant－temperature process – Explains that fluids can have a liquid or a gaseous form	4 Hours
	Thermodynamic Energy	– States that "internal" or "intrinsic" energy(U) is related to the motions of the molecules of a substance or a system – States that internal energy is derived only from molecular motions and vibrations, is dependent only on thermodynamic temperature and is energy stored in the molecules – States that the total energy stored in a body, or system, is termed enthalpy (H) – Defines total stored energy the sum of internal energy and the product of pressure(P) and volume (V), i.e. $H = U + PV$ – Defines potential energy as energy stored in the molecules by virtue of their vertical	8 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Basic Engineering Science (Cont)		position above some datum level – Defines kinetic energy as energy stored in molecules by virtue of their velocity; kinetic energy has a value of $v^2/2$ (i.e. 0.5 of velocity squared) per unit mass of substance – States that energy in transition between bodies or systems can only be heat flow (or Heat transfer) (Q) and work flow (or work transfer) (W) – Defines the first law of thermodynamics as "the energy stored in any given thermodynamic system can only be changed by the transition of energies Q and/or W" – Solves problems to demonstrate the above objectives	
	Thermodynamic Systems	– States that systems are identified in terms of mass of substance (i.e. molecules) contained within a system and/or the mass entering and leaving – States that this identification is of importance when evaluating property changes taking place during thermodynamic operations	1 Hour
	Energy Change Energy Change (cont)	– Explains that the "non－flow" equation derives directly from the first law of thermodynamics and is applicable only to "'closed" systems (i.e. no molecules of substance are entering or leaving the system during the thermodynamic operation) – Defines the general form of the non－flow equation as $(U1-U2) = \pm W \pm Q$ – Explains that the mathematical sign associated with the transition energies of Q and W will be governed by "direction", i.e. whether the energy transfer is "into" or "out of" the closed system – Solves simple problems concerning energy changes in practice	6 Hours
	Heat Transfer	– States that heat transfer can take place by conduction, convection and radiation and that when substances at different temperatures are placed in contact they will, in time, reach a common temperature through transfer of heat – Defines specific heat capacity as the heat transfer, per unit mass, per unit of temperature change, for any given body or system – Uses laboratory equipment to determine: — specific heat capacity of substances — final temperature of mixtures, and verifies the observed value by calculation – States that the Fourier law for the conduction of heat through a substance as given by $Q = \lambda Aet/x$ – Identifies the quantities in the Fourier law as: Q = heat flow, measured in joules	16 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Basic Engineering Science (Cont)	Heat Transfer (cont) Vapours Ideal Gases	A = surface area, measured in square metres e = temperature difference between the surface, measured in ℃ t = time interval, measured in seconds x = distance travelled between the surface by the heat, measured in metres λ = the coefficient of thermal conductivity – Explains that the units for the coefficient of thermal conductivity are watts per metre per kelvin i.e. *joules x metres/seconds x metres^2 x kelvin* – Solves simple numerical problems involving heat transfer between substances when placed in contact with each other; to include mixtures of liquids and solids placed in liquids – Solves simple problems on the application of the Fourier law to solid homogeneous materials – Performs laboratory work to verify the above objective – Defines the vapour phase as intermediate stage between the solid and the perfect gas – State, and the property values, such as pressure, energy, volume – States that the important fluids in this group are H_2O (i.e. steam) and the refrigerants – Defines the following conditions: – saturated vapour – dry vapour – wet vapour – dryness fraction – superheated vapour – Explains and uses the "corresponding" relationship that exists between pressure and temperature for a saturated liquid or saturated vapour – Demonstrates the above objective, using laboratory equipment – Uses tables of thermodynamic properties to determine values for enthalpy, internal energy and volume at any given condition of pressure and/or temperature defined in the above objective – States the "critical temperature" as being the limit of the liquid phase – Defines an "ideal" gas as one which behaves almost as a perfect gas, whose temperature is above the critical one and whose molecules have a simple monatomic structure – States that an "ideal" gas cannot be liquefied by alteration of pressure alone – States the laws of Boyle and Charles and identifies the following statements with them: $P \times V = \alpha$ constant – Boyle	 16 Hours 15 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Basic Engineering Science (Cont)	Ideal Gases (cont)	*V/T* = *α* constant – Charles – Sketches a P–V curve demonstrating Boyle's law – Sketches a graph of V and T, demonstrating Charles' law – States that the result of combining the laws of Boyle and Charles is: *PV/T* = *α* constant – Defines the specific ideal gas equation as: *PV/T* = *R* per unit mass of gas – Explains that R will have a different numerical value for each ideal gas or mixture of Ideal gases – Applies simple numerical calculations involving the elements of the above objectives	

	Thermodynamic Processes	– Defines a thermodynamic process as "an operation during which the properties of state, pressure, volume and temperature may change, with energy transfer in the form of work and/or heat flow taking place"
		– States that the following processes are applicable to ideal gases and vapours:
		  – heat transfer: heating and cooling
		  – work transfer; compression and expansion
		– Explains in simple terms the second law of thermodynamics
		– Explains with the aid of a sketched P–V diagram, where appropriate, the following "standard" processes;
		  – pressure remaining constant
		  – volume remaining constant
		  – temperature remaining constant
		  – zero heat transfer
		  – polytrophic expansion and compression
		– Describes a process of constant temperature as "isothermal"
		– Describes a process in which there is no heat transfer as "adiabatic"
		– Describes practical applications of the process described in the above objectives
		– Solves simple numerical problems relating to the elements in the above objectives
			12 Hours

	Work Transfer	– Explains that "work" is calculated by force × distance moved by that force – Sketches a P–V diagram relating the area of the diagram to the work done when a fluid exerts constant pressure on a piston in a cylinder – Explains the work transfer for a vapour or an ideal gas terms of pressures and volumes – Sketches a P–V diagram, relating the area of the diagram to work done on or by a piston	12 Hours

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Basic Engineering Science (Cont)	Work Transfer (cont)	in a cylinder during polytrophic expansion and compression – States the equation for work transfer, i.e. $W = (P_1V_1 – P_2V_2)/(n-1)$ where: W is the work done, in joules P is the pressure at specific points in the process, in newtons/m^2 V is the volume at the same points as for pressure, in m^3 n is a numerical index – States that the numerical index n is derived by experiment, using the equation $(P_1V_1)^n = P_2V_2)^n$ – States that, for most practical operations, n has numerical values between 1.2 and 1.5 – Applies simple numerical calculations related to the elements in the above objectives	
Plan and schedule operations in Management Level	Thermodynamics and heat transmission	Properties of Vapours - T-s, p-h, p-v, h-s diagrams - Fluid properties using steam tables - Throttling and separating calorimeters - Air in condensers Steam Cycles - Demonstrates knowledge and understanding of: - Rankine cycle. Turbine isentropic efficiency - Feed heating - Thermal efficiency - Cycle on T-s diagram Combustion - Demonstrates knowledge and understanding of: - Combustion equations - Fuel composition - Air-fuel ratio - Excess air - Volumetric analysis of combustion products - Calorific value Heat Transfer - Demonstrates knowledge and understanding of: - Conduction, radiation and convection	18 hrs

COMPETENCE	KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	PERFORMANCE	APPROX HOURS
Plan and schedule operations in Management Level (cont.)	Thermodynamics and heat transmission (cont.)	- Composite walls. Insulation - Film coefficient - Interface temperature - Stefan-Boltzmann Law - Parallel flow and cross flow heat exchangers - Logarithmic mean temperature difference	
		Total No. of Hours	108 Hours

* discrepancy between course specifications and course map total number of hours is intended for assessment