College of Micronesia – FSM
P.O. Box 159
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Course Outline Cover Page

Heat and Heat Engines — Course Title
ME 229 — Department and Number

Course Description: This course will provide the student with the knowledge and skills required to explain the basic thermodynamic concepts; solve thermodynamic problems of basic marine systems; use steam tables to solve thermodynamic problems; apply thermodynamic principles to components and systems of a typical marine power plant and solve heat transfer and insulation problems in marine systems.

Prepared by: Brent Villiers **State:** FSM-FMI

	Hours per Week	No. Of Weeks	Total Hours	Semester Credits
Lecture	3/6/12/24	16/8/4/2	48	3
Laboratory	3/6/12/24	16/8/4/2	48	1
		Total Semester Credits:		4

Purpose of Course

Degree Requirement	XX
Degree Elective	
Advanced Certificate	
Certificate	
Remedial	
Other (Workshop)	

Prerequisite Course(s): ME 222 Heat and Heat Engines I

_____ _____
Signature, Chairman, Curriculum Committee **Date Approved by Committee**

_____ _____
Signature, President, COM-FSM **Date Approved by the President**

General Objective: Marine engineering, maintenance and repair at the operational level requires the student to explain basic thermodynamic concepts; solve thermodynamic problems of basic marine systems; use steam tables to solve thermodynamic problems; apply thermodynamic principles to components and systems of a typical marine power plant and solve heat transfer and insulation problems in marine systems.

Learning Outcomes: On successful completion of this course the student will be able to:

1. Identify thermodynamic terms and principles dealing with heat transfer and work.
2. Investigate constant volume and constant pressure thermodynamic processes.
3. Investigate isothermal, adiabatic, and polytrophic thermodynamic processes.
4. Monitor the performance and maintain efficient operation of reciprocating air compressors.
5. Manage and monitor the combustion process between fuel and air.
6. Monitor the performance and maintain efficient operation of internal combustion (IC) engines.
7. Investigate the heat transfer and insulation effects of marine systems.
8. Monitor the performance and maintain efficient operation of auxiliary steam plants and their components.
9. Monitor the performance and maintain efficient operation of refrigeration plants.

STUDENTS SHOULD BE MADE AWARE OF OCCUPATIONAL HEALTH AND SAFETY ISSUES IN ALL SITUATIONS AND BE EXPECTED TO DEMONSTRATE SAFE WORKING PRACTICES AT ALL TIMES.

Outline of Content: This course contains:

1. Thermodynamic Properties and Processes
   - Enthalpy
   - The First Law of Thermodynamics
   - Entropy
2. Gas Processes and Combustion
   - Specific heat capacity
   - C_v, C_p, R, and γ
   - Effect of insulation on heat transfer

- Compression and expansion of gases
- Constant volume and pressure processes
- Isothermal, adiabatic, and polytrophic processes
- Properties
- Heat and work transfer
- Constituents and products of combustion
- Fuel / air ratio
- Calorific value of fuel

3. Compressed Air
   - Reciprocating compressors
   - Clearance volume and volumetric efficiency
   - Properties
   - Air mass
   - Multi-staging and inter-cooling
4. The Internal Combustion Engines
   - Air standard cycles, i.e. Otto, Diesel, and Dual Combustion cycles.
   - Mean effective pressure
   - Indicated and brake power
   - Mechanical efficiency
   - SFC
   - Turbo charging
5. Heat Transfer
   - Conduction, convection, and radiation
   - Insulation
6. Steam
   - Saturated dry, wet steam, and dryness fraction
   - Superheating and under cooling
   - Steam tables
   - Principles and arrangements of basic steam plants
   - Temperature versus entropy diagrams
   - Properties, heat, and work transfer
   - Steam turbines and nozzles
7. Thermodynamics of Refrigeration
   - Properties of refrigerants
   - Refrigerants and the environment
   - Use of tables and charts of properties of refrigerants

Learning Outcomes: On completion of this course the learner will be able to:

Learning Outcome 1 **Identify thermodynamic terms and principles dealing with heat transfer and work.**

Assessment criteria	1.1 The term enthalpy is explained. 1.2 The First Law of Thermodynamics is explained. 1.3 Simple problems involving the First Law of Thermodynamics are solved. 1.4 The term entropy is identified.
Conditions and Method of assessment	As specified in the Assessment Strategy listed at the end of this outline and by a combination of: • Written assessment • Calculations • Assignments • Oral assessment
Learning Outcome 2	**Investigate constant volume and constant pressure thermodynamic processes.**
Assessment criteria	2.1 The specific heat capacity of a gas is defined. 2.2 The terms Cp, Cv, R, γ, and their relationships are identified. 2.3 Simple heat transfer problems for constant pressure and constant volume processes are solved.
Conditions and Method of assessment	As specified in the Assessment Strategy listed at the end of this outline and by a combination of: • Written assessment • Calculations • Assignments • Oral assessment
Learning Outcome 3	**Investigate isothermal, adiabatic, and polytrophic thermodynamic processes.**
Assessment criteria	3.1 Isothermal, adiabatic, and polytrophic processes are described. 3.2 Properties after expansion and compression of gases are calculated. 3.3 Work done and heat transfer of process involved with the expansion and compression of gases are calculated. 3.4 The advantages of insulation in heat transfer situations are identified.
Conditions and Method of assessment	As specified in the Assessment Strategy listed at the end of this outline and by a combination of: • Written assessment

- Calculations
- Assignments
- Oral assessment

Learning Outcome 4	**Monitor the performance and maintain efficient operation of reciprocating air compressors.**
Assessment criteria	4.1 The properties during the cycle within an air compressor are calculated. 4.2 The mass of air delivered by an air compressor is calculated. 4.3 The effect of clearance volume on volumetric efficiency is explained and calculated. 4.4 Multistaging, intercooling, and their advantages are described.
Conditions and Method of assessment	As specified in the Assessment Strategy listed at the end of this outline and by a combination of: • Written assessment • Calculations • Assignments • Oral assessment
Learning Outcome 5	**Manage and monitor the combustion process between fuel and air.**
Assessment criteria	5.1 The combustion processes of solid, liquid, and gaseous fuels are described. 5.2 The air/fuel ratio is identified, and typical products of combustion for sufficient, insufficient, and excess air are analyzed. 5.3 The calorific value of a liquid fuel and its applications are identified.
Conditions and Method of assessment	As specified in the Assessment Strategy listed at the end of this outline and by a combination of: • Written assessment • Calculations • Assignments • Oral assessment
Learning Outcome 6	**Monitor the performance and maintain efficient operation of internal combustion (IC) engines.**
Assessment criteria	6.1 Otto, Diesel, and Dual Combustion air standard cycles relating to internal combustion engines are explained.

6.2 The mean effective pressure is identified and calculated.
6.3 Indicator diagrams are described and indicated power, brake power, and mechanical efficiency is calculated.
6.4 Specific fuel consumption is calculated.
6.5 Ideal and typical air/fuel ratios for internal combustion engines are identified and reasons for their difference explained.
6.6 The reasons for turbo charging internal combustion engines are explained.

Conditions and Method of assessment

As specified in the Assessment Strategy listed at the end of this outline and by a combination of:

- Written assessment
- Calculations
- Assignments
- Oral assessment

Learning Outcome 7 **Investigate the heat transfer and insulation effects of marine systems.**

Assessment criteria

7.1 The heat transfer across non-composite walls due to conduction is calculated.
7.2 Heat transfer by radiation between bodies is calculated.
7.3 The effects of insulations in marine systems are identified.

Conditions and Method of assessment

As specified in the Assessment Strategy listed at the end of this outline and by a combination of:

- Written assessment
- Calculations
- Assignments
- Oral assessment

Learning Outcome 8 **Monitor the performance and maintain efficient operation of auxiliary steam plants and their components.**

Assessment criteria

8.1 The thermodynamic properties of steam are defined.
8.2 Enthalpy for water and various properties of steam are obtained from steam tables.
8.3 Basic steam plant cycles are identified and the function of each component described.
8.4 Basic steam plant cycles are represented on pressure/volume diagrams.
8.5 The effects of superheating and under cooling are explained.

8.6 Simple problems involving heat transfer; work done, and thermal efficiency of steam plants are solved.
8.7 Methods of improving cycle efficiency are identified.
8.8 The operation of a steam nozzle is explained and its uses identified.
8.9 The basic operation of impulse and reaction steam turbines is explained.

Conditions and Method of assessment

As specified in the Assessment Strategy listed at the end of this outline and by a combination of:

- Written assessment
- Calculations
- Assignments
- Oral assessment
- Practical assessment

Learning Outcome 9 **Monitor the performance and maintain efficient operation of refrigeration plants.**

Assessment criteria

9.1 The basic refrigeration system and its operation are explained.
9.2 The properties of refrigerants used in refrigeration plants are identified and compared.
9.3 Using refrigeration tables, the refrigeration effect and plant capacity of basic refrigeration systems are calculated.

Conditions and Method of assessment

As specified in the Assessment Strategy listed at the end of this outline and by a combination of:

- Written assessment
- Calculations
- Assignments
- Oral assessment

Delivery strategy

The course provides for delivery by on and off-the-job training and assessment.

Some areas of content may be common to more than one learning outcome, and therefore integration of training and assessment may be appropriate.

Methods of instruction includes:

1. Classroom lectures with handouts, course notes, overhead transparencies (or

equivalent), slide presentations, video material, and whiteboard notes;
2. Calculation via examples and tutorials; and
3. Practical demonstrations.

Resource requirements — Delivery of the training will require:

- Classroom
- Whiteboard
- Overhead projector (or equivalent)
- Access to appropriate vessels or models.

Assessment Strategy

Assessment Method — Knowledge based criteria will be satisfied through a combination of calculations, written and oral assessments.
Skill based criteria will be satisfied through practical exercises.

Condition of Assessment — This course may be assessed on and off the job. Competence may be assessed in the following situations: classroom; laboratories; and appropriate vessels.

Evaluation:

Final Grade for this course will be based on meeting the course requirements at the following percentage rates:

96% - 100%	A – Superior
90% - 95%	B – Above Average
80% - 89%	C – Average
69% - 79%	D – Below Average
0 % - 69%	F – Failure

Attendance:

The COM-FSM attendance policy will apply.