Addis Ababa Institute of Technology (AAIT-AAU)
School of Mechanical and Industrial Engineering
Graduate Program in Thermal Engineering

Course Title : *Advanced Thermodynamics*
Course No. : *MEng 6301*
Credit Hours: *3 (ECTS 6)*
Instructor : *Abdulkadir A. Hassen (PhD)*

Module Title:	Advanced Thermodynamics
Module Code:	MEng 6301
Module Credit:	Credit Hours : 3 ESTC : 6
Pre-requisite Module:	Undergraduate level courses - Thermodynamics I & II, Fluid Mechanics I & II, and Heat Transfer
Co-requisite Module:	Non
Barred Combination Modules:	Non
Module Description:	Exergy and irreversibility to be dealt in great detail; Third law of Thermodynamics to be introduced; detailed coverage of Homogeneous and heterogeneous systems to be made as given in the following summarized module content. Introduction; Exergy analysis; Equations of state; Thermodynamic property relations; Third law of thermodynamics; Homogeneous systems; Multiphase-Multicomponent systems; chemical reactions; Chemical availability of moist air and fuels
Learning Outcome:	On successful completion of this module students will be able to: • Design and analyze practical and advanced thermodynamic processes and cycles • Follow advanced studies and handle independent research work on different topics in thermodynamics • Handle lectures on thermodynamics at undergraduate level with complete confidence

Content:

1. **Basic Relations and the First Law of Thermodynamics**
2. **Energy Analysis of Processes and Cycles:** Reversible work, energy, irreversibility and second law efficiency; Availability transfers; Reversible work, energy, irreversibility for a control mass; Reversible work, energy, irreversibility for a control volume; Simple cycles.
3. **Equations of State:** Compressibility factor; Two-parameter equations; Corresponding states; Three-parameter equations; Other equations of state.
4. **Thermodynamic Relations**: Some fundamental relations for simple compressible systems; Generalized relations for dh, ds, du, c_p, and c_v; Departure functions for enthalpy, entropy, and availability; Properties of the saturation state; Joule-Thomson coefficient
5. **The Third Law of Thermodynamics:** The third law of thermodynamics; Einstein's theory of specific heat; Debye's theory of specific heat; Absolute entropy evaluation.
6. **Homogeneous Systems:** Fundamental property relations for systems of variable composition; Partial molar property evaluation for binary phases; Fugacity and fugacity coefficients; Ideal solutions; Heat and work interactions for gaseous ideal solutions; The

enthalpy-composition diagram.

7. **Multiphase-Multicomponent Systems:** Equilibrium criteria; Phase equilibrium and mass transfer;The phase rule for nonreactive components; Vapor-liquid equilibrium and Raoult's law; Phase equilibrium of ideal binary solutions; Effect of total pressure on vapor pressure; Elevation of the boiling point and depression of the freezing point; Osmotic pressure of an ideal solution; Absorption refrigeration; The enthalpy-composition diagram.
8. **Chemical Reactions:** Combustion stoichiometry; Thermochemistry; Second-law, availability, and irreversibility;Work production from chemical reactions;Fuel cells; Criterion for reaction equilibrium; The equilibrium constant for gaseous mixtures; Equilibrium constant evaluation; Equilibrium composition evaluation.
9. **Chemical Availability:** Chemical availability; The environmental state; Air-conditioning processes; Chemical availability of fuels; Availability analysis of chemical processes

Teaching Strategy/Methods:

Lectures
Exercises

Assessment Strategy:

Exercises	20%
Midsemester examination	20%
Final examination	40%

Respective Role of Instructors and Students:

Teaching Support and Inputs:

Lectures supported by power point presentations
Power point handouts are made available

Module Requirements:

- Minimum of 75% attendance during lecture hours
- All exercises and project works must be submitted by the specified dead line date

Textbook:

1. Wark : Advanced Thermodynamics for Engineers

References:

1. Bejan, Adrian: *Advanced engineering Thermodynamics*
2. D. Winterbone **,** ***Advanced Thermodynamics for Engineers***, : Butterworth-Heinemann, Nov 1, 1996
3. Ingo Müller and Wolfgang H. Müller , ***Advanced Thermodynamics: With Historical Annotations*****,** Springer; 1 edition, Mar 1, 2008
4. Kalyan Annamalai and Ishwar K. Puri , ***Advanced Thermodynamics Engineering (Computational Mechanics and Applied Analysis Series)***, : CRC; 1 edition, Aug 31, 2001
5. Kenneth Wark , ***Advanced Thermodynamics for Engineers,*** McGraw-Hill Companies, Sep 1, 1994
6. Rowland Benson , ***Advanced Engineering Thermodynamics***, : Pergamon Press