Course Syllabus — Heat Transfer and Fluid Flow Syllabus (AES-2051)

Credit Hours: 3 Credit hours

Prerequisites: Physics Principles (AES-1016)

Co-requisites: Heat Transfer and Fluid Flow Laboratory (AES-2052)

QFE Level: 6

Knowledge: Specialized factual knowledge and an understanding of the boundaries in a field of work or discipline, encompassing a broad and coherent body of knowledge and concepts, with depth in the underlying understanding of the principles and concepts. An understanding of allied knowledge and theories in related fields of work or disciplines and in the case of paraprofessional respective discipline including related regulations, standards, codes, conventions. An understanding of critical approach and analysis, research approaches and methods and analytical problem-solving techniques from a range of sources familiarity with sources of current and existing knowledge and the integration of concepts from related fields. Literacy to comprehend and/or produce coherent texts, covering complex and/or diverse relations from a wide range of information. Numeracy covering a wide-range of mathematical procedures and representations used across a broad-range of contexts.

Skills: Specialist technical, creative and conceptual skills appropriate to solving complex problems associated with a field of work or discipline. A comprehensive range of specialist cognitive and practical skills appropriate to planning and implementing solutions to varied, unpredictable and unfamiliar problems within a field of work or discipline. Selection and use of appropriate research tools and strategies associated with the field of work or discipline. Advanced communication and information technology skills to present, explain and/or critique interdependent complex matters. Literacy skills to comprehend and/or produce, from a wide range of information, coherent texts covering complex and/or diverse relations. Numeracy skills to select, apply, assess and communicate a wide range of mathematical procedures and representations in a broad range of contexts.

Competence:

Autonomy and responsibility: Can take responsibility for developing appropriate approaches to managing complex work procedures and processes, resources or learning, including leading teams within a technical or professional activity with little support. Can supervise technical, supervisory or design processes in varied, unpredictable, unfamiliar and a broad range of contexts. Can work effectively as a specialist or in team leadership roles. Can express an internalized, personal world view, reflecting engagement in society at large and in sociocultural relationships.

Role in context: Can function with full autonomy in technical and supervisory contexts and adopt paraprofessional roles under guidance. Can take responsibility for the setting and achievement of group outcomes and for the supervision of the work of others. Can take responsibility for supervising the development of individuals and groups. Can participate in peer relationships with qualified practitioners and lead multiple groups.

Self-development: Can evaluate own learning and identify learning weaknesses and needs, in a familiar and unfamiliar environment. Can take initiative to address learning needs and function independently and within learning groups. Can support and observe ethical standards.

Course Description

This course covers thermodynamics units, volumetric properties of pure fluids, important thermodynamics properties, mechanisms of heat transfer by conduction, convection, and radiation, heat exchanger design and sizing, fluid mechanics and fluid statics, and application of thermodynamics to flow systems, in particular the Rankine cycle in nuclear power production.

Instructors: TBD, TBD@adpoly.ac.ae

Schedule and Duration: 15 weeks plus examination week; lecture: 3 hours/week; tutorial: 1 hour/week (3 Credit Hours)

Course Objectives

The overall course objective is to develop student basic knowledge in: volumetric properties of pure fluids, the first law of thermodynamics, the second law of thermodynamics, principles and concepts related to heat transfer, principles of steam and power systems (phase change, steam tables, Rankine cycle applied to PWR NPP), principles of fluid flow (laminar and turbulent flow, Bernoulli's principle, water hammers), concepts and principles of heat exchangers.

Text Book

1. ACAD Basic Curriculum, Heat Transfer and Fluid Flow, General Physics Corporation, Elkridge, Maryland, 2003.

Attendance

Sessions start on the hour. Students arriving after the session starts will be counted absent. Students will receive warnings and potential penalties from the Student Services Office or their sponsor if they reach 5%, 10%, and 15% absence. After 15% absence, students will receive a FA (fail due to absence) grade.

Academic Honesty Policy

Students must conduct their studies at AD Poly honestly, ethically, and in accordance with accepted standards of academic conduct. Any form of academic conduct which is contrary to these standards is academic misconduct, for which AD Poly may penalize the student.

Specifically, it is academic misconduct for a student to:

- Present copied, falsified, or improperly obtained data as if it were the result of laboratory work, field trips, or other investigatory work;
- Include in the student's individual work material which is the result of significant assistance from another person if that assistance was unacceptable according to the instructions or guidelines for that work;
- Cheat or attempt to cheat; or
- Plagiarize (knowingly presenting the work or property of another person as if it were one's own)

Abu Dhabi Polytechnic considers cheating or attempting to cheat a serious offense that will result in disciplinary action taken against involved individuals. Students caught cheating or attempting to cheat will earn an "F" grade in the course.

Course Learning Outcomes (CLOs)

Upon successful completion of the course a student should be able to:

CLO1: Demonstrate knowledge of thermodynamic units and properties.

CLO2: Demonstrate knowledge of heat and heat transfer.

CLO3: Demonstrate knowledge of steam.

CLO4: Demonstrate knowledge of fluid flow.

CLO5: Demonstrate knowledge of heat exchangers.

Course Topics

CT1: Concepts and principles related to heat: heat transfer mechanisms and heat exchanger construction and types, and temperature including temperature scales, F, C and K (such as kinetic theory of gases).

CT2: Concepts and principles of steam: basic steam-water cycle, boiling and saturation, pressure-temperature relationship, properties of steam and water including pressure-temperature relationship, basic steam-water cycle, steam tables, boiling, saturation, temperature/pressure and thermal efficiency, and steam tables.

CT3: Principles of heat transfer: heat transfer mechanisms such as conduction, convection and radiation, heat exchangers, latent and sensible heat, and thermal efficiency.

CT4: Principles of Fluid Flow: effects of throttling on flow and pressure, filling and venting, understanding the concept of high point vents relating to air binding and water hammer, fluid properties and mechanics including laminar and turbulent flow, flow within a closed system to include water hammer, heating, draining, filling and venting and the effects of throttling, pump theory including cavitation, and water hammer types and mechanisms.

CT5: Units and properties: perform basic calculations and apply concepts for the following: measuring pressure, temperature, flow, volume, mass, weight, distance, and time; density, height and temperature effects on process fluids, mass, fluid mechanics, weight and heat; temperature system conversions such as Rankine, Fahrenheit, Kelvin, Celsius; temperature measuring systems.

CT6: Concepts and principles of thermodynamics: Closed, open, and isolated systems. Thermodynamic properties. The first law of thermodynamics. The second law of thermodynamics. Heat engine and Carnot cycle.

ABET Student Outcomes

The Higher Diploma in Nuclear Technology program student outcomes (SO) are taken from the 2019 ABET (Accreditation Board for Engineering and Technology) standard. Student Outcome 2 is from the associate degree standard and Student Outcomes 1, 3, 4, and 5 from the bachelor's degree standard.

SO1. An ability to apply knowledge, techniques, skills and modern tools of mathematics, science, engineering, and technology to solve broadly defined engineering problems appropriate to the discipline;

SO2. An ability to design solutions for well-defined technical problems and assist with the engineering design of systems, components, or processes appropriate to the discipline;

SO3. An ability to apply written, oral, and graphical communication in broadly defined technical and non-technical environments; and an ability to identify and use appropriate technical literature;

SO4. An ability to conduct standard tests, measurements, and experiments and to analyze and interpret the results to improve processes; and

SO5. An ability to function effectively as a member as well as a leader on technical teams.

Table 1: Relation Course Topics (CTs) to Course Learning Outcomes (CLOs)

	CT1	CT2	CT3	CT4	CT5	CT6
CLO1	H	M	M	L	H	H
CLO2	H	M	H	L	M	H
CLO3	L	H	M	L	M	H
CLO4	L	L	M	H	M	M
CLO5	H	L	H	M	M	H

H: High, M: Moderate, L: Low

Table 2: Relation Course Learning Outcomes (CLOs) to Students Outcomes (SOs*)

	SO1	SO2	SO3	SO4	SO5
CLO1	H				
CLO2	H				
CLO3	H				
CLO4	H				
CLO5	H				

H: High, M: Moderate, L: Low

* SOs correspond to the ABET Student Outcomes (see above).

Week-by-Week Teaching Plan

Week	Topic	Content	Textbook Reference
1-2	Properties of fluids	Thermodynamic systems and properties of systems. Temperature and pressure measurements and conversion	GPC Chapter 1
3-4	Laws of Thermodynamics	The First and Second Laws of Thermodynamics	GPC Chapter 1
5-6	Principles and concepts related to heat transfer	Conduction, convection, and radiation principles, applications, and calculations.	GPC Chapter 2
7	Steam	Latent and sensible heat. Water-steam mixtures. Steam tables.	GPC Chapter 3
8		Rankine cycle, factors affecting efficiency, Mollier diagrams.	GPC Chapter 3
8	Midterm Examination		
9-10	Principles of Fluid Flow	Relationships of mass and volumetric flow rate, density, and specific volume. Laminar, turbulent, and two-phase flow	GPC Chapter 4
11		Bernoulli's principle and applications.	GPC Chapter 4
12		Heat exchanger operation and water hammers.	GPC Chapter 4
13	Principles and concepts related to heat exchangers	Temperature profiles in heat exchangers. Log mean temperature difference.	GPC Chapter 5
14		Heat transfer rate, temperature difference, and enthalpy change calculations.	GPC Chapter 5
15		Heat exchanger tube fouling and scaling.	GPC Chapter 5
16	Final Examination	Comprehensive Examination	GPC Chapters 1-5