SEE4118: WIND AND MARINE ENERGY

Effective Term
Semester A 2022/23

Part I Course Overview

Course Title
Wind and Marine Energy

Subject Code
SEE - School of Energy and Environment
Course Number
4118

Academic Unit
School of Energy and Environment (E2)

College/School
School of Energy and Environment (E2)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
SEE2001 Electromagnetic Principles for Energy Engineers or equivalent; and
SEE3101 Engineering Thermofluids II or equivalent

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

Wind and marine energy are two of the most important types of renewable energy. This course introduces the basic science and engineering behind systems that convert wind, wave and tide into usable energy. Advanced fluid dynamics and aerodynamics are introduced to understand the working principal of wind and marine energy systems. The outcome is to furnish students with the skills to evaluate the performance of wind and marine energy systems. Topics include resource availability and characteristics, working principle of wind and marine energy systems, aerodynamics and fluid dynamics for energy systems, design consideration and environmental impact. Computational labs will expose students to the design of wind and marine energy systems via computational fluid dynamics.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Assess wind or marine energy potential of a site or region	20	x		x
2	Describe the physics of advanced fluid dynamics and aerodynamics	20		x	
3	Describe the physical principles governing the operation and effectiveness of turbines	20		x	
4	Design conversion systems for wind or marine energy	20			x
5	Evaluate the performance of wind and marine energy systems in terms of engineering fundamentals and environmental impact.	20	x		x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Explaining the fundamental and practical aspects of wind and marine energy systems	1, 2, 3, 4, 5	2.5 hrs/week for 9-10 weeks
2	Tutorial	Interpreting the examples and assignment questions of advanced fluid dynamics and aerodynamics	1, 2, 3, 5	0.5 hrs/week for 9-10 weeks

3	Computational labs	Use computational fluid dynamics software to solve problems and design conversion systems	3, 4	3 hrs/week for 3-4 weeks

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Assignments	1, 2, 3, 4, 5	15	
2	Midterm	1, 2, 3	30	
3	Project	4, 5	15	

Continuous Assessment (%)

60

Examination (%)

40

Examination Duration (Hours)

2

Additional Information for ATs

Examination duration: 2 hours
Percentage of coursework, examination, etc.: 60% by coursework; 40% by exam

To pass a course, a student must do ALL of the following:
1) obtain at least 30% of the total marks allocated towards coursework (combination of assignments, pop quizzes, term paper, lab reports and/ or quiz, if applicable);
2) obtain at least 30% of the total marks allocated towards final examination (if applicable); and
3) meet the criteria listed in the section on Assessment Rubrics.

Assessment Rubrics (AR)

Assessment Task

1. Assignments

Criterion

Capacity for self-directed learning to understand principles of wind and marine energy systems

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not reaching marginal levels

Assessment Task
2. Midterm

Criterion
Ability to analyse, calculate and solve practical problems in wind and marine energy

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not reaching marginal levels

Assessment Task
3. Project

Criterion
Ability to use computational fluid dynamics software to solve problems and to design and analyse conversion systems for wind and/or marine energy

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not reaching marginal levels

Assessment Task
4. Final exam

Criterion
Ability to analyse, calculate and solve practical problems in wind and marine energy

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not reaching marginal levels

Part III Other Information

Keyword Syllabus

Wind energy
Brief overview of global wind power
Origin and nature of wind types/wind characteristics
Wind energy and power density calculations
Marine energy
Brief overview of global marine power (Wave & Tidal)
Waves, currents and tides: physical origin and theories
Marine fluid dynamics
Fluid Statics: pressure, manometry, hydrostatic force
Fluid Kinematics: Bernoulli equation, conservation laws, Euler equations, Naiver Stokes equation, irrotational flows, vortex dynamics, turbulence
Wind turbines
Aerodynamics of wind turbines: one-dimensional momentum theory and the Betz limit, airfoils and general concepts of aerodynamics, momentum theory and blade element theory, blade design for modern wind turbines, unsteady aerodynamic effects on wind turbines
Engineering issues: power output from a turbine, energy production and capacity factor
Computational fluid dynamics
Partial differential equations, discretization, numerical scheme
Turbulence modelling, Reynolds-averaged Navier-Stokes, large-eddy simulation
Environmental Aspects of Wind and Marine Energy Systems
Environmental aspects and impacts: visual impact, noise, electromagnetic interference effects and other environmental considerations

Reading List

Compulsory Readings

	Title
1	J. D. Anderson, Fundamentals of aerodynamics Sixth., McGraw-Hill Education, 2017
2	B.R. Munson et al., Fundamentals of fluid mechanics 7th ed., Hoboken, NJ: Wiley, Inc. 2013

Additional Readings

	Title
1	J. F. Manwell, J. G. McGowan and A. L. Rogers, Wind Energy Explained, Wiley, 2009.
2	H-J Wagner and J. Mathur, Introduction to Wind Energy Systems : Basics, Technology and Operation Second Edition, Springer, 2013
3	P.A. Lynn, Electricity from Wave and Tide An Introduction to Marine Energy, Wiley, 2014.
4	G. Boyle, Renewable Energy: Power for a Sustainable Future. Oxford University Press , 2012.