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|---|---|---|---|
| **Course title:** Fluid mechanics and wind turbine models | | | |
| **Course code:** ENR 158 | **No. of credits:** 3 | **L-T-P:** 28-14-0 | **Learning hours:** 42 |
| **Pre-requisite course code and title (if any):** NA | | | |
| **Department:** Department of Energy and Environment | | | |
| **Course coordinator:** Dr. Jami Hossain | **Course instructor:** Dr. Jami Hossain | | |
| **Contact details:** jami.hossain@teriuniversity.ac.in | | | |
| **Course type**: Elective | **Course offered in:** Semester 2 | | |

**Course description**

The course is about fundamental concepts of fluid flow, fluid kinematics and fluid dynamics and its application to design aspects of wind turbines.

The course also carries a description on system design and Wind Turbine Sub-systems

**Course objective**

- The aim of this core course is to impart knowledge on the fundamentals of fluid flow to the student and to apply these concepts to design aspects of wind turbines
- To impart knowledge on different Engineering Systems associated with a wind turbine

**Course contents**

| Module | Topic | L | T | P |
|---|---|---|---|---|
| **1** | **Physics of Fluid Flow**<br><br>Shear stain and stress<br>Classification of fluids on the basis of flow<br>System and control volume<br>Fluid properties, fluid statistics<br>Fluids in rigid-body motion<br>Fluid kinematics<br>Reynolds transport theorem<br>Mass, Bernoulli and energy equations<br>Energy analysis of steady flows<br>Conservation of momentum<br>Linear momentum equation, angular momentum equation<br>Differential analysis and modellilng<br>Continuity equation, divergence theorem<br>Stream function, Navier-stokes equation and its approximate solutions | 8 | 4 | 0 |
| **2** | **Boundary Layer Theory**<br><br>Similarity theory<br>Surface roughness<br>Power law, modified power law, logarithmic laws | 4 | 2 | 0 |
| **3** | **Fundamentals of Aerodynamics**<br><br>Drag and lift, friction and pressure drag<br>Flow separation, parallel flow over flat plates, flow over cylinders and spheres<br>Aerofoils and Aerofoil Terminology | 4 | 2 | 0 |
| **4** | **Aerodynamics in Wind Turbines**<br><br>HAWT<br>Momentum theory<br>Blade element theory<br>Coefficient of performance<br>BETZ limit<br>Axial flow | 6 | 3 | 0 |

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|---|---|---|---|---|
| | Wake<br>Rotor design/ blade design/ structure<br>Loads / forces and mechanics, gyroscopic motion<br>Thrust<br>Power curve<br>VAWT | | | |
| **5** | **Wind Turbine Sub – Systems**<br><br>***Mech Transmission:*** Hub, Shafts, Bearings, Gear Box, Torque Converter<br>***Generation Systems:*** Induction, Synchronous, DFIG, Variable Speed, PMG, Ring Generators<br>Power Regulation<br>Power Electronics – IGBT, Thyristors etc.<br>Controls & Instrumentation<br>Grid Connection | 6 | 3 | 0 |
| | | **28** | **14** | **0** |

**Evaluation criteria**

- Assignments : 10%
- Two Minor tests : 20% (each)
- Major exam : 50%

**Learning outcomes**

- Understand and apply laws of fluid mechanics
- Application of these laws to wind turbine design
- Gain understanding of the environment in which WTG functions (Boundary Layer)
- Systems and Sub-systems of wind turbines

**Pedagogical approach**

A combination of class-room interactions, tutorials, assignments and projects.

**Materials**

**Suggested readings**

YA Cengel and JM Cimbala, “Fluid Mechanics: Fundamentals and Applications”, Tata McGraw Hill
Manwell et. “Wind Energy Explained: Theory Design and Application” Al Wind Energy Handbook by Burton et. al

**Additional information (if any):**NA

**Student responsibilities**

Attendance, feedback, discipline: as per university rules.

**Course Reviewers**

1. Dr. Rajesh Katyal, DDG, NIWE
2. Prof. Tanay Uyar, Marmara University, Istanbul