

Course title: Fluid mechanics and wind turbine models				
Course code: ENR 158		No. of credits: 3	L-T-P: 31-14-0	Learning hours: 45
Pre-requisite course code and title (if any): NA				
Department: Department of Energy and Environment				
Course coordinator: Dr. Aviruch Bhatia			Course instructor: Dr. Aviruch Bhatia/ Dr. Naqui Anwer	
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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				
<ul style="list-style-type: none">▪ 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	8	4	0
	Shear stain and stress			
	Classification of fluids on the basis of flow			
	System and control volume			
	Fluid properties, fluid statistics			
	Fluids in rigid-body motion			
	Fluid kinematics			
	Reynolds transport theorem			
	Mass, Bernoulli and energy equations			
	Energy analysis of steady flows			
	Conservation of momentum			
	Linear momentum equation, angular momentum equation			
	Differential analysis and modelling			
	Continuity equation, divergence theorem			
	Stream function, Navier-stokes equation and its approximate solutions			
2	Boundary Layer Theory	6	2	0
	Similarity theory, The method of repeating variables and the Buckingham Pi theorem			
	Surface roughness			
	Power law, modified power law, logarithmic laws			
3	Fundamentals of Aerodynamics	4	2	0
	Drag and lift, friction and pressure drag			
	Flow separation, parallel flow over flat plates, flow over cylinders and spheres			
4	Aerofoils and Aerofoil Terminology	6	3	0
	Aerodynamics in Wind Turbines			
	HAWT			
	Momentum theory			
	Blade element theory			
	Coefficient of performance			
	BETZ limit			
	Axial flow			
	Wake			
	Rotor design/ blade design/ structure			
	Loads / forces and mechanics, gyroscopic motion			

	Thrust Power curve VAWT			
5	Wind Turbine Sub – Systems <i>Mech Transmission:</i> Hub, Shafts, Bearings, Gear Box, Torque Converter <i>Generation Systems:</i> Induction, Synchronous, DFIG, Variable Speed, PMG, Ring Generators Power Regulation Power Electronics – IGBT, Thyristors etc. Controls & Instrumentation Protection against lightning Grid Connection	7	3	0
		31	14	0
Evaluation criteria <ul style="list-style-type: none"> ▪ Assignments : 10% ▪ Written Test 1 : 20% ▪ Written Test 2 : 20% ▪ Written Test 3 : 50% 				
Learning outcomes <ul style="list-style-type: none"> ▪ 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