ST213 Jan 3:0

Turbomachines in Renewable Energy

Instructor

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Department: Centre for Sustainable Technologies

Course Time: Tue, Thu 3.30 - 5 pm

Lecture venue:

Detailed Course Page:

Announcements

First meeting on January 4th, 2018 at 3.30 pm, CST classroom

Brief description of the course

Renewable energy has become the mascot and reality for future supply of worldâ€™s energy. Therefore, the role of turbomachinery in renewable energy will have to become synchronous with its characteristics of variability in supply and low intensity in addition to geographical confines. These constraints are starkly different from that the turbomachines encounter in the existing fossil fuel based energy scenario.

Turbomachinery will have to reinvent itself to factor all these constraints.

Prerequisites

Fluid Mechanics, Kinematics and rotational dynamics of rigid body, Basic electrical science

Syllabus

The course will begin with the fundamental physics involved in momentum transfer of fluid in a rotary frame and first thrust would be to design a blade shape independent of fluid. It will encompass the system variables, dimensionless groups, their functionality, velocity triangles, Euler theory, mean line analysis and loss mechanisms. A common case will be brought up for radial, diagonal and axial flow turbomachines. The course will then address both incompressible and compressible fluid application. Within the incompressible scenario,

hydro turbines, centrifugal pumps and wind turbines shall be discussed in detail. The compressible turbomachinery study will include gas turbines (including compressors) and steam turbines with both classical working fluids (like air for gas turbines and water for steam turbines) to newer fluids in the form of various refrigerants. The shape of the turbomachine will be developed from the perspective of variable input supply condition of different renewable energy sources. In hydropower, variable flow and low head that pose the severest constraints will be handled in the course. In wind power, the variable wind velocity naturally becomes a controlling factor and modern day horizontal axis turbines will be investigated for this change along with analogy to turbo-propellers. With solar thermal energy (including other heat sources from waste or alternate fuels) the turbomachineryâ€™s adaption for change in enthalpy drop, temperature and density of different working fluids will be discussed in the course. Notwithstanding the input variability, the renewable energy based turbomachines are encountered with demand side constraints as well, which is becoming key issue to the grid operators and planners. In this context, design characteristics of new generation pumped storage power plants in conjunction with larger renewable energy system will be elaborated. Variable geometry and variable speed (power electronic drives) techniques will be discussed. Further, the course will also highlight the most significant and least understood link between water supply and renewable energy through turbomachinery. To conclude the course will lay stress on innovation in different applications and encourage a creative process of student designers irrespective of their backgrounds.

Course outcomes

- Origin of blade shape of different turbomachines operating with incompressible and compressible flows.
- Design under conditions of variability in input fluid and output load
- Specialized design of water pumps
- Renewable energy dynamics in both turbine and pumps

Grading policy

30% assignment, 40% tests and 30% project

Assignments

Resources